Nurses' Knowledge and Practice Regarding Applying Safety Measures during Neonates'Intravenous Infusion

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Abstract

Background: Intravenous therapy is an important part of the treatment of many hospitalized neonates. Intravenous solutions are medications. Administration of medications is part of the controlled acts authorized to nursing. This is the nurse's responsibility to ensure that the neonate receives the ordered solution and additives at the ordered rate. **Aim:** This study aimed to assess the neonatal nurses' knowledge and practice regarding applying safety measures during neonates' intravenous infusion. **Research design:** A descriptive study design applied in the current study. **Setting:** The study conducted at the Neonatal Intensive Care Unit at Minya Al-Qamh General Hospital affiliated to the Ministry of Health and Population and Al-Saadian Central Hospital affiliated to the Ministry of Health and Population. **Study subjects:** A convenient sample was included all nurses available in the previously mentioned setting regardless of their age, gender, qualifications, years of experience or any training courses regarding intravenous therapy. A purposive sample of neonates with inclusions criteria: Preterm neonates, low birth weight, normal birth weight and neonates with fluid and electrolyte imbalance. Total subjects number of 70 nurses and 70 neonates. **Tools:** Data collection obtained by using the following tools: Tool 1: Pre-designed interviewing questionnaire to assess nurse's knowledge, Tool (2): Observational checklist to assess nurse's practice. **Results:** The study found that, near a half of the studied nurses had a good level of knowledge regarding applying safety measures during neonates' intravenous infusion, while more than one quarter had average level and less than one quarter had poor level of knowledge. Also, the majority of the studied nurses had competent total practice level. **Conclusion:** The study concluded that there are statistically significant positive correlations between the nurses' total scores of knowledge and practice regarding applying safety measures during neonates' intravenous infusion. **Recommendations:** Establish continuous training courses to improve neonatal nurses' knowledge and practices about applying safety measures during neonates' intravenous infusion**.**

Keywords: Intravenous therapy, hospitalized neonates, safety measures, nurses' knowledge and practice

Introduction

Neonatal Intensive Care Units (NICUs) are a critical aspect in maintaining the health of neonates at hospitals, the focus of nursing care during this time is to protect and support the neonates as neonates undergo numerous physiological changes and adapt to extra uterine life **(Fox et al., 2017).**

Intravenous therapy is an important part of the treatment of neonates. Fluid and electrolyte therapy is an essential component of the care of neonates **(Mohamed et al., 2020).** Neonates admitted to NICU rely highly on

intravenous (IV) therapy, for which the peripheral intravenous catheter (PIVC) is the preferred device to allow such therapies to proceed **(Legemaat et al., 2016)**

Neonatal nurses are often required to place intravenous lines in neonates as part of the routine care. Cannulation of a vein is one of the most important procedures that neonatal nurses need to perform with precision and minimal discomfort to the neonates. Cannulation not only involves placing the intravenous cannulas at an appropriate location but also requires the nurses to monitor and access to circulatory system **(Ferdianingsih et al., 2023).**

Nurses play a vital role in the administration of IV therapy. Most of the interventions and prevention strategies such as insertion, monitoring and assessing peripheral venous catheter (PVC) sites are part of routine

nursing care. Nurses should have accurate knowledge of the preparation and administration of the IV Infusion and IV device. In addition, they should also know about the prevention, treatment and management of local and systematic complications supported by dynamic evidence-based practice guidelines ***(Osti et al., 2019)***.

the nurse should assess IV lines, prepare equipment for IV fluid infusions, If neonate is receiving continuous IV fluid infusion-observations of the IV site, type of fluid and volume infused, accurate rate of infusion and alarms of infusion pumps are observed by nurse hourly and documented in the fluid balance flow sheet. Each bag of fluid is independently double-checked and a signed neonate label is putting on the bag. Also the nurse should check that the solution is the prescribed one, the rate of infusion and the amount infused is noted **(Rickard et al., 2018).**

Significant of the study

At NICUs of obstetric and children hospitals of Zagazig University 2019, the commonest primary diagnoses during admission to NICU were prematurity with respiratory diseases (36.6%), septicemia (22.7%) and perinatal asphyxia (16.2%). The remaining reasons for NICU admission were meconium aspiration syndrome (13.9%), jaundice (6.0%) and others (4.6%). All newborns received antibiotics while (97.1%) received intravenous infusion and parenteral nutrition and (30.1%) received positive inotropes and (28.6%) received caffeine citrate. (15.5%) of neonates had surgical problems **(Abd El Aziz et al., 2020).**

Aim Of The Study

This study aimed to assess the neonatal nurses' knowledge and practice regarding applying safety measures during neonates' intravenous infusion.

This aim achieved through the following objectives:

- Assess nurses' knowledge regarding applying safety measures during neonates' intravenous infusion.
- Assess nurses' practice regarding applying safety measures during neonates' intravenous infusion.

Research questions

- What is the nurses' knowledge regarding applying safety measures during neonates' intravenous infusion?
- What is the nurses' practice regarding applying safety measures during neonates' intravenous infusion?

Subjects AND METHODS

This study aimed to assess the neonatal nurses' knowledge and practice regarding applying safety measures during neonates' intravenous infusion.

The subjects and methods of this study performed under the following four designs:

1.Technical design
2.Operational design
3.Administrative design
4.Statistical design

Research Design

A descriptive study design applied in the current study.

Research Setting

The study conducted at the Neonatal Intensive Care Unit (NICU) at Minya Al-Qamh General Hospital affiliated to the Ministry of Health and Population. The NICU unit is located in the fourth floor and is consisted of 9 rooms; 5 rooms contain 21 incubators, the remaining rooms are breast-feeding, artificial feeding, incubator disinfection and medication and solutions preparation.

The Neonatal Intensive Care Unit at Al-Saadian Central Hospital affiliated to the Ministry of Health and Population. This unit is located in the third floor and is consisted of 12 rooms; 2 large rooms contain 20 incubators, the remaining rooms are breast-feeding, artificial feeding, incubator disinfection and medication and solutions preparation. Additionally, there are emergency unit, preterm clinic, pharmacy, files area, doctor's lounge and nursing locker room.

The selection for these hospitals because they are large governmental hospitals which serve large number of the surrounding villages

Research subjects:

1. A convenient sample was included all nurses available in the previously mentioned setting, the sample size was calculated by using Chi-square (x2) test and Pearson's correlation coefficient (r) test, sample size was calculated by a known total nurses

number of 70 subjects. The confidence interval was set to 95% and the margin of error accepted was set to 5%. Total subjects number of 70 nurses and 70 neonates.

2. A purposive sample of neonates with inclusions criteria:

- Preterm neonates
- Low birth weight and normal birth weight
- Neonates with fluid and electrolyte imbalance

Tools of data collection:

Data collection obtained by using the following tools:

Tool (1): Pre-designed interviewing questionnaire.

Part 1:

It prepared by the researcher after reviewing the related literature and reviewed by supervisors. It wrote in a simple Arabic language to suit all nurses category. It was used to gather data concerned with characteristics of the studied nurses, questions included 7 multi choose questions, characteristics of the neonates, their questions included also 7 multi choose questions and there were 14 multi choose questions related to treatment data for neonate.

Part 2:

It prepared by the researcher and concerned with nurses' knowledge regarding applying safety measures during neonates' intravenous infusion. Questions included 44 multi choose questions (anatomical sites of intravenous access and their names for fluid therapy, criteria of selection of the proper site, indications of intravenous infusion, safety measures and nursing care and precautions during neonates' intravenous infusion).

Scoring system of knowledge:

A scoring system was followed to assess nurses' knowledge regarding applying safety measures during neonates' intravenous infusion. The right answer was scored as one point and the wrong answer was scored as a zero point. These scores was summed and converted into a percentage score. Total scoring was classified into 3 levels: Good knowledge if score ≥85%, Average knowledge if score from 70 to less than 85% and Poor knowledge if score <70%.

Tool (2): Observational checklist to assess nurse's practice

It adopted from **(Wilkinson et al., 2019), (Bowden and Greenberg, 2016)** and **(Lynn, 2018)**, used to assess nurses' practices regarding applying safety measures during neonates' intravenous infusion. Nurses assessed during daily activates in their work, which include the following: Hand washing, peripheral I.V. cannula insertion, peripheral I.V. cannula removal, initiating intravenous therapy, monitoring an intravenous infusion, peripheral IV site care, care of peripherally inserted central venous access device site care, changing intravenous solution and tubing, changing intravenous tubing connected directly into the hub of the intravenous access catheter and care the newborn during blood transfusion.

Scoring system of nurses practices:

A scoring system was followed to assess nurses' practices; where each done correct step was scored as a one score and incorrect done or not done step was scored as a zero score. These scores were summed up and converted into a percentage score. Then the result was classified into 2 categories competent if score ≥ 95% and incompetent if score <95%.

Pilot study:

A pilot study conducted on 10% of the total sample size (7 nurses) to test the feasibility of tools, clarity of study tools; time consumed to fill in the study tools. Based on the findings of the pilot study, no modifications were done to the questionnaire. The pilot study was included in the final study.

Validity and Reliability:

The tools reviewed by jury group consisted of three experts (Professors) in the field of pediatric nursing at the Faculty of Nursing, Ain Shams University to test its content validity. One of the jury group apologized for being busy. Two Jury group members judge tools for relevance, comprehensiveness, accuracy, clarity and applicability. Based on recommendations corrections, addition and \ or omission of some items was done. The study tools were tested for its internal consistency by alph- cronbach's test. It was 0.918 for the nurses' knowledge, 0.775 for the nurses' practice and 0.826 for total tool; this indicated high total internal consistency of the used tool.

Fieldwork:

Data collected over 4 months from 10 July 2023 to the end of October 2023. The study was carried out by the researcher for the studied sample in the selected setting of Minya Al-Qamh General Hospital affiliated to the Ministry of Health and Population and Al-Saadian Central Hospital affiliated to the Ministry of Health and Population. The researcher visited the previous setting two days per week (Sunday and Thursday) from 9:00 am to 2:00 mid-day. In the beginning, the aim of the study was explained to nurses, each nurse was observed for the needed procedures (20 minutes). Then they interviewed individually to gather the necessary data for the study. The questionnaire was distributed to each nurse to fill it, the time consumed 15 minutes.

Ethical considerations:

The research approval obtained from the Scientific Research Ethical Committee, Faculty of Nursing, Ain Shams University, before starting the study. Oral consent was obtained from the studied nurses before collection of any data and after explanation of the aim of the study in simple and clear manner to be understood by participants, the researcher was explained the study purpose and conduction way to the studied nurses. The studied nurses were assured about study confidentiality information. Each participant had the right to withdraw from the study without giving any justification.

Statistical Design:

The obtained data was organized, tabulated, analyzed, represented in tables and graphs as required, mean and standard deviation as well as percentages, suitable statistical tests was used to test the significance of results obtained.

Results

Table 1 reveals that, according to age groups, more than half of nurses (54.2%) aged from 20 to less than 25 years old with Mean±SD 26.66±6.40. In terms of academic qualifications, nearly half of nurses have obtained a diploma from the technical institute of nursing (48.6%) and the minority of them (5.7%) has a nursing school diploma. Concerning the years of experience, more than half of nurses (57.1%) has 1-<5 years of experience, while 2.9% of them had less than 1 year of experience with 6.79± 2.10. As regards previous training courses this table reveals that 45.7% of the nurses have participated in such courses, the remaining 54.3% of nurses have not undergone any previous training courses.

As clear from **table 2**, nearly three quarters (74.3%) of the neonates were born at a gestational age of 37-<42 weeks, while only 5.7% of the neonates were born post-term, with a gestational age of 42 weeks or more. Regarding weight on admission, 42.9% had a weight between 2500-3000 grams while a very small proportion 2.9% weighed between 1000-<1500 grams. The Apgar score distribution indicates that at 1 minute after birth, 20.0% of the neonates had an Apgar score of 1. A minority of them (5.7%) had an Apgar score below 5 at less than 5 minutes after birth. Additionally, 45.7% of the Apgar scores were not recorded. Among the studied neonates, three fourth (60.0%) were diagnosed with respiratory disorders and other 2.9%. concerning of hospital stay duration shows that three fourth of neonates (60.0%) had a stay of 1-<2 weeks and only a few neonates (2.9%) had a stay of 3-<4 weeks.

Table 3: shows that, 71.4% of studied nurses had correct knowledge about the cannula installation sites, 74.3% of the nurses accurately identified the causes of cannula installation in the upper part of the body and 65.7% of the nurses know the avoided sites of cannula installation. Meanwhile, 65.7% of nurses had incorrect knowledge about the factors of determining the type of cannula, 68.6% of nurses didn't identify the duration for changing, removing a cannula. Also 68.6% of nurses gave incorrect responses about pain relief methods.

Figure 1 shows that, 45.7% have good level of knowledge regarding applying safety measures during neonates' intravenous infusion, while 31.4% and 22.9% have average and poor level of knowledge respectively.

Table 4: describe that 97.1% and 98.6% of the studied nurses were competent in changing intravenous solution and tubing and care of neonates during blood transfusion respectively. While, 4.3% of nurses were incompetent in peripheral IV Cannula insertion and in peripherally inserted central venous access device site care. Also 7.1% of them were incompetent in peripheral IV site care.

As clear from **figure 2**, 92.9% of the studied nurses were competent regarding applying safety measures during neonates' intravenous infusion while only 7.1% were incompetent.

As clear from **table 5**, concerning academic qualification more than half of nurses (65.6%) who have obtained bachelor of nursing had good level of knowledge. As regards current job 78.1% of nurses that had good level of knowledge were nursing technician. Nurses who had 5-<10 years of experience 37.5% had good level of knowledge. According to previous training courses this table reveals that 65.6% of the nurses who have participated in previous training courses had good level of knowledge more than other.

Table 6 shows the level of practice of the studied nurses, who have obtained diploma of the technical institute of nursing and bachelor of nursing were more competent. As regards current job, nurses that were more competent, they were nursing technician. Nurses who had 1-<5 years of experience were more competent.

Table 7 displays statistically significant positive correlations between the nurses' total scores of knowledge and practice regarding applying safety measures during neonates' intravenous infusion.

Table (1): Distribution of the studied nurses according to their characteristics (N=70).

Items	No.	%
Age (years)		
20-<25 years	**38**	**54.2**
25-<30 years	16	22.9
≥30 years	16	22.9
Mean±SD	**26.66±6.40**	
Gender		
Male	22	31.4
Female	48	68.6
Marital status:		
Single	28	40.0
Married	42	60.0
Academic qualification:		
Nursing school diploma	**4**	**5.7**
Diploma of the technical institute of nursing	**34**	**48.6**
Bachelor of nursing	32	45.7
Current job:		
Nurse	4	5.7
Nursing technician	48	68.6
Shift official	14	20.0
Department supervisor	4	5.7
Years of experience		
<1 year	**2**	**2.9**
1-<5 years	**40**	**57.1**
5-<10 years	16	22.9
≥10 years	12	17.1
Mean±SD	**6.79±2.10**	
Previous training courses		
Yes	**32**	**45.7**
No	**38**	**54.3**

Table (2): Distribution of the studied neonates according to their characteristics (N=70).

Items	No.	%
Age (days)		
1-<10 days	50	71.4
10-<20 days	14	20.0
20-<30 days	6	8.6
Mean±SD	8.71±2.66	
Gender		
Male	40	57.1
Female	30	42.9
Gestational age (wks.)		
<37 wks.	14	20.0
37-<42 wks.	**52**	**74.3**
≥42 wks.	**4**	**5.7**
Weight on admission (grams)		
1000-<1500 gm.	**2**	**2.9**
1500-2000 gm.	8	11.4
2000-2500 gm.	18	25.7
2500-3000 gm.	**30**	**42.9**
≥3000 gm.	12	17.1
Apgar score		
1 min.	**14**	**20.0**
<5 min.	**4**	**5.7**
5-7 min.	10	14.3
>7 min.	10	14.3
Not done	**32**	**45.7**
Diagnosis		
Respiratory disorders	**42**	**60.0**
Neonatal jaundice	8	11.4
Small for gestational age	6	8.6
Sepsis	6	8.6
Meconium aspiration	6	8.6
Other	**2**	**2.9**
Hospital stay duration		
<1 week	12	17.1
1-<2 weeks	**42**	**60.0**
2-<3 weeks	14	20.0
3-<4 weeks	**2**	**2.9**

Table (3): Distribution of the studied nurses according to their knowledge regarding applying safety measures during neonates' intravenous infusion: (N=70).

Items	Correct		Incorrect	
	No.	%	No.	%
Cannula installation sites	**50**	**71.4**	20	28.6
Preferred sites of cannula installation	40	57.1	30	42.9
Causes of cannula installation in the upper part of body	**52**	**74.3**	18	25.7
Avoided sites of cannula installation	**46**	**65.7**	24	34.3
Reasons for avoiding sites of cannula installation	42	60.0	28	40.0
Types of cannulas	50	71.4	20	28.6
Purpose of peripheral venous cannula	40	57.1	30	42.9
Purpose of umbilical catheter	32	45.7	38	54.3
Purpose of central cannula	28	40.0	42	60.0
Factors of determining the cannula type	24	34.3	**46**	**65.7**
Factors of determining the intravenous drip sites	30	42.9	40	57.1
Characteristics of appropriate vein site	26	37.1	44	62.9
Duration of changing or removing cannula	22	31.4	**48**	**68.6**
Equipment of peripheral venous cannulation	44	62.9	26	37.1
Equipment of central venous catheter	34	48.6	36	51.4
Types of fixation plaster	26	37.1	44	62.9
Importance of cannula fixation	28	40.0	42	60.0
Pain relieve methods	22	31.4	**48**	**68.6**
Devices of administering medication	24	34.3	46	65.7
Factors determining IV infusion devices	32	45.7	38	54.3
Assessment points for the cannula place	26	37.1	44	62.9
Methods of unblock the cannula	30	42.9	40	57.1
Reasons of cannula removing	40	57.1	30	42.9

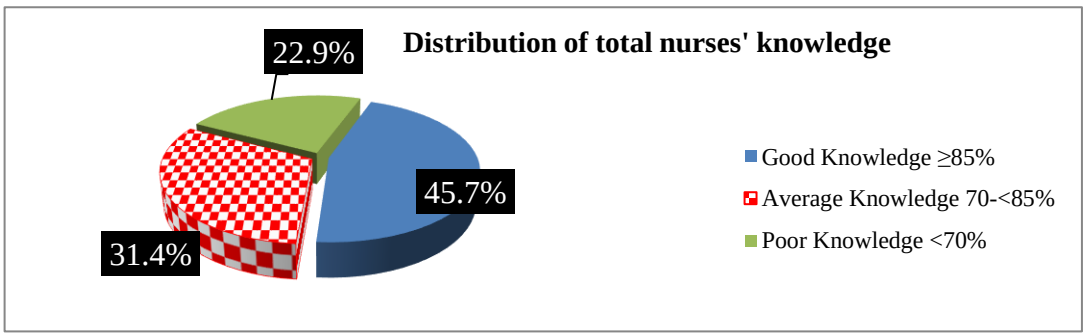

Figure (1): Percentage distribution of the studied nurses according to their total level of knowledge regarding applying safety measures during neonates' intravenous infusion.

Table (4): Distribution of the studied nurses according to their domain of practice regarding applying safety measures during neonates' intravenous infusion (N=70).

Items	Competent ≥95%		Incompetent ≥95%	
	No.	%	No.	%
Observational checklist of hand washing	65	92.9	5	7.1
Peripheral I.V. cannula insertion	67	95.7	**3**	**4.3**
Peripheral I.V. cannula removal	61	87.1	9	12.9
Initiating intravenous therapy	63	90.0	7	10.0
Monitoring an intravenous infusion	60	85.7	10	14.3
Peripheral IV site care	65	92.9	5	7.1
Peripherally inserted central venous access device site care	67	95.7	**3**	**4.3**
Changing intravenous solution and tubing	**68**	**97.1**	2	2.9
Changing intravenous tubing connected directly into the hub of the intravenous access catheter	65	92.9	**5**	**7.1**
Care of neonates during blood transfusion	**69**	**98.6**	1	1.4

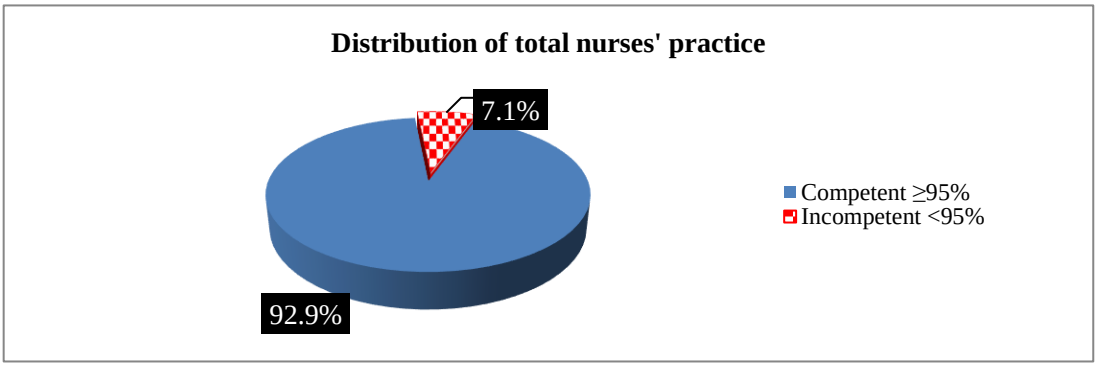

Figure (2): Percentage distribution of the studied nurses according to their total practice regarding applying safety measures during neonates' intravenous infusion.

Table (5): Relation between level of studied nurses knowledge regarding applying safety measures during neonates' intravenous infusion according to their characteristics (N=70).

Items	Level of knowledge						Chi-square test	
	Good knowledge *(n=32)*		Average knowledge *(n=22)*		Poor knowledge *(n=16)*			
	No.	%	No.	%	No.	%	x2	p-value
Age (years)								
20-<25 years	14	43.8	13	59.1	11	68.8	0.210	0.522
25-<30 years	9	28.1	4	18.2	3	18.8		
≥30 years	9	28.1	5	22.7	2	12.5		
Gender								
Male	8	25.0	8	36.4	6	37.5	1.136	0.567
Female	24	75.0	14	63.6	10	62.5		
Marital status:								
Single	11	34.4	9	40.9	8	50.0	1.096	0.578
Married	21	65.6	13	59.1	8	50.0		
Academic qualification:								
Nursing School Diploma	1	3.1	2	9.1	1	6.3	9.848	0.043*
Diploma of the technical institute of nursing	10	31.3	13	59.1	11	68.8		
Bachelor of Nursing	**21**	**65.6**	7	31.8	4	25.0		
Current job:								
Nurse	0	0.0	1	4.5	3	18.8	8.468	0.047*
Nursing technician	**25**	**78.1**	14	63.6	9	56.3		
Shift official	3	9.4	7	31.8	4	25.0		
Department supervisor	4	12.5	0	0.0	0	0.0		
Years of experience								
<1 yea	1	3.1	1	4.5	0	0.0	22.407	0.002*
1-<5 years	9	28.1	17	77.3	14	87.5		
5-<10 years	**12**	**37.5**	2	9.1	2	12.5		
≥10 years	10	31.3	2	9.1	0	0.0		
Previous training courses								
Yes	**21**	**65.6**	7	31.8	4	25.0	9.590	0.008*
No	11	34.4	15	68.2	12	75.0		

Using: Chi-square test

*p-value >0.05 NS; *p-value <0.05 S; **p-value <0.001 HS*

Table (6): Relation between level of studied nurses practice regarding applying safety measures during neonates' intravenous infusion according to their characteristics (N=70).

Items	Level of practice				Chi-square test	
	Competent *(n=65)*		Incompetent *(n=5)*			
	No.	%	No.	%	x2	p-value
Age (years)						
20-<25 years	35	53.8	3	60.0	0.071	0.965
25-<30 years	15	23.1	1	20.0		
≥30 years	15	23.1	1	20.0		
Gender						
Male	21	32.3	1	20.0	0.005	0.943
Female	44	67.7	4	80.0		
Marital status:						
Single	25	38.5	3	60.0	0.224	0.636
Married	40	61.5	2	40.0		
Academic qualification:						
Nursing School Diploma	1	1.5	3	60.0	29.453	<0.001**
Diploma of the technical institute of nursing	**33**	**50.8**	1	20.0		
Bachelor of Nursing	**31**	**47.7**	1	20.0		
Current job:						
Nurse	3	4.6	1	20.0	6.776	0.048*
Nursing technician	**47**	**72.3**	1	20.0		
Shift official	12	18.5	2	40.0		
Department supervisor	3	4.6	1	20.0		
Years of experience						
<1 yea	1	1.5	1	20.0	10.949	0.012*
1-<5 years	**40**	**61.6**	0	0.0		
5-<10 years	14	21.5	2	40.0		
≥10 years	10	15.4	2	40.0		
Previous training courses						
Yes	32	49.2	0	0.0	2.768	0.096
No	33	50.8	5	100.0		

Using: Chi-square test

*p-value >0.05 NS; *p-value <0.05 S; **p-value <0.001 HS*

Table (7): Correlation between nurses total score of knowledge and total score of practice regarding applying safety measures during neonates' intravenous infusion (N=70).

Items		Total score of knowledge	Total score of practice
Total score of knowledge	r		0.480
	p-value		0.017*
	N		70
Total score of practice	r	0.480	
	p-value	0.017*	
	N	70	
	N	70	70

r-Pearson Correlation Coefficient;

**p-value <0.05 significant correlation; **p-value <0.001 highly significant*

Discussion

Nurses play a critical role in ensuring the safety of neonates during intravenous (IV) infusion procedures. Their knowledge and practice regarding these safety measures are

crucial for preventing complications and providing high-quality care to neonates. Recent studies have highlighted the importance of ongoing education and training for nurses in neonatal care units. It is essential for nurses to stay updated on the latest evidence-based guidelines and best practices for IV infusion in neonates. This includes knowledge of appropriate catheter selection, site preparation and maintenance procedures to reduce the risk of infection and other complications **(Smith et al., 2022).**

Regarding to nurses' demographic data, the present study result revealed that more than half of nurses were aged from 20 to less than 25 years old with mean age (26.66±6.40), and more than two thirds of them were females and regarding marital status near to two thirds of study subjects were married. On the same line **Johnson et al., (2019)** study entitled "Enhancing Neonatal Intravenous Safety Practices" indicating that, near to three quarters of nurses in neonatal care units were aged between 21 to 27 years and the majority of them were females.

Additionally, **Ouda et al., (2019)** that studied "Nurses' Knowledge and Practices Regarding Peripheral Intravenous Cannulation and Blood Sampling in Paediatric Health Care Settings " reported that, the most of the studied sample was, in between 18:30 years and with mean ± SD 24.44 ± 4.30 years.

On the other hand, **Anderson et al., (2020)** entitled "Nurses' Attitudes and Practices in Neonatal IV Safety" which revealed that, more than a half of nurses were aged above 35 years and more than two thirds of them were males with a less than one third of his study subjects were married.

As regards academic qualifications, nearly half of nurses have obtained a diploma from the technical institute of nursing and concerning years of experience, more than half of them has from 1 to 5 years of experience, while for previous training courses more than a half of nurses have not undergone any previous training courses.

The current study is in agreement with **Smith et al., (2022),** who conducted a study entitled "Nurses' Role in Ensuring Neonatal Intravenous Infusion Safety". Where they found that, more than a half of nurses have obtained a degree from the technical institute and near a half of them had more than 4 years of experience and more than one third of them had received training regarding safety measures during neonates' intravenous infusion.

While the current study, was incongruent with **Martinez et al., (2018)** in a study entitled "Educational Background and Experience of Nurses in Neonatal Units". They reported that, the majority of nurses had bachelor's degrees in nursing. Moreover, they found that, near a half of nurses had more than five years of experience, indicating a mix of novice and experienced professionals within their sample and already received training regarding safety measures during neonates' intravenous infusion.

In relation to characteristics of the studied neonates the current study results revealed that nearly three quarters of the neonates were born at a gestational age of 37-<42 weeks. Regarding weight on admission, more than two fifth of them had a weight between 2500-3000 grams. The Apgar score distribution indicates that at 1 minute after birth near to one quarter of the neonates had an Apgar score of 1and near to two thirds diagnosed with respiratory disorders. Concerning of hospital stay duration shows that three fifth of neonates had a stay of 1-<2 weeks.

On the same line **Njung'e & Kamolo, (2021)**, in a study entitled "Nurses' Knowledge Regarding Intravenous Fluid Therapy at a County Hospital in Kenya" which revealed that, the majority of the study neonates were born at a gestational age of 36-<42 weeks. More than half of them had a weight between 2500-3000 grams and most of them had hospital stay duration more than from 8 to 14 days.

While the current study results were opposing **Soliman et al., (2019)** in a study entitled "Nurses' Knowledge and Practices Regarding Peripheral Intravenous Cannulation and Blood Sampling in Paediatric Health Care Settings" which stated that, less than half of study subjects were born at a gestational age

less than 40 weeks and the minority of them were diagnosed with respiratory disorders.

Regarding nurses' knowledge in applying safety measures during neonates' intravenous infusion, the current study results revealed that, near to three quarters of nurses accurately identified the causes of cannula installation in the upper part of the body and cannula installation sites. While more than two thirds of them had incorrect knowledge about the duration for changing or removing a cannula and pain relief methods.

The current study is in agreement with **Ambrow et al., (2019)** in a study entitled "Nurses' Knowledge Regarding Safety Measures during Neonates' Intravenous Infusion" which revealed that more than half of study subjects had correct knowledge about preparation phase for neonates' intravenous infusion such as cannulation indication, sites and sizes.

On the other hand, **Soliman et al., (2019)** who stated that, the majority of nurses had low knowledge level regarding peripheral intravenous cannulation, while they had a correct knowledge about changing cannulas and pain management methods.

Moreover, **Osti et al., (2019)** who mentioned that, the majority of the studied sample had proper knowledge regarding intravenous cannulation that includes the cannula size, site, duration, proper steps during cannulation, sign and symptom of infection and proper measure to prevent infection.

Regarding knowledge after cannulation **Ouda et al., (2019)** who revealed that, half of the studied nurses had satisfactory knowledge regarding peripheral intravenous cannulation and blood sampling.

This result comes in to agree with **Lamsal & Shrestha, (2019)** who studied "Nurses' Knowledge and Practice Regarding Intravenous Therapy in A teaching Hospital, Bhagalpur" and reported that, the level of knowledge found inadequate and level of practice found unsatisfactory on IV therapy.

Concerning to nurses' total level of knowledge regarding applying safety measures during neonates' intravenous infusion, the current study results revealed that, near a half of them have a good level of knowledge regarding applying safety measures during neonates' intravenous infusion, while more than one quarter had average level and less than one quarter had poor level of knowledge.

This result confirmed by **Qamar et al., (2017)** who studied " Nurses Knowledge and Practices towards Care and Maintenance of Peripheral Intravenous Cannulation in Services Hospital Lahore, Pakistan" and reported that, the most of nurses had good knowledge regarding care and peripheral IV cannula safe usage.

On the other side **Chan et al., (2020)** in a study entitled "Peripheral Intravenous Cannulation: Complication Rates in The neonatal Population" who reported that, more than a half of study participants had poor knowledge regarding safety measures during neonates' intravenous infusion.

In relation to nurses domain of practice about applying safety measures during neonates' intravenous infusion, the current study revealed that, the majority of nurses were competent in applying safety measures during neonates' intravenous infusion, care of neonates during blood transfusion and changing intravenous solution and tubing. This result comes inconsistent with **Ouda et al., (2019)** mentioned that, the majority of the studied nurse had unsatisfactory practices.

Regarding nurses' total practice regarding applying safety measures during neonates' intravenous infusion, the current study revealed that, the majority of the studied nurses were competent regarding applying safety measures during neonates' intravenous infusion.

This result comes in the line with **Arbaee, (2016)** in a study entitled "Nurse's Knowledge and Practice towards Care and Maintenance" and reported that, the majority of the studied nurses followed the correct practice of care and maintenance of IV cannula. While this result comes inconsistent with **Othman & Ahmed, (2019)** who studied "Nurses Knowledge, Attitude and Practice Concerning Fluid Therapy in Erbil City, Kurdistan Region Iraq" and reported that, less than two-thirds of the studied sample had fair practices.

Regarding the relation between level of nurses' knowledge regarding applying safety measures during neonates' intravenous infusion and their personal characteristics, there was a statistically significant relation between academic qualification, current job, years of experience, previous training courses and

nurses' knowledge regarding applying safety measures during neonates' intravenous infusion. Where more than half of nurses have obtained bachelor of nursing had good level of knowledge. As regards current job, more than three quarters of nurses that had good level of knowledge was nursing technician. Nurses who had 5-<10 years of experience had good level of knowledge. According to previous training courses, more than half of the nurses who have participated in previous training courses had good level of knowledge more than other.

This result comes in agree with **Mohammed et al., (2017)** in a study entitled "Assessment of Nurses' Knowledge Concerning Protein Energy Malnutrition for Children under Age Five Years at Medical Wards in Baghdad City" and reported that, there were statistical differences between socio-demographic characteristics and total nurse's knowledge score. Also, this result was confirmed by **Galvão et al., (2017)** in a study entitled "Knowledge of the Nursing Team on Pressure Ulcer Prevention" and reported that, there were statistical significance differences between the total knowledge score and year of experience (1-7) years.

This result comes in contrast with **Elsayed et al., (2020)** who studied "Knowledge and Performance of Health Team about Infection Control in the Neonatal Intensive Care Units at Assiut and El Minia University Hospitals" and stated that, the nurses who aged less than 20 years and years of experience less than one year had excellent score of knowledge.

Regarding the relation between level of nurses' practice regarding applying safety measures during neonates' intravenous infusion and their personal characteristics, there was a statistically significant relation between academic qualification, current job, years of experience, and nurses' practice regarding applying safety measures during neonates' intravenous infusion. The nurses who have obtained diploma of the technical institute of nursing and bachelor of nursing were more competent. As regards current job, nurses that were more competent, they were nursing technician. Nurses who had 1-<5 years of experience were more competent.

This result comes in agree with **Mukhlif& Neamah, (2021)** who studied "Effectiveness of An Educational Program on Nurses' Practices about Blood Exchange Transfusion Procedure in Neonatal Intensive Care Unit" reported that, there is statistical significance difference between age of studied nurses and level of practice and there was statistical significance difference between having training courses and level of practice.

As regards correlation between nurses' total score of knowledge and practice regarding applying safety measures during neonates' intravenous infusion, there was a statistically significant positive correlation between the nurses' total scores of knowledge and practice regarding applying safety measures during neonates' intravenous infusion.

On the same line **Mohamed et al., (2020)** in a study entitled "Assessment of Paediatric Nurses' Performance Regarding Intravenous Therapy" who stated that, there was a statistically significant positive correlation between the nurses' total scores of knowledge and practice regarding nurses' performance regarding intravenous therapy.

Conclusion

Based on findings of present study, it can be concluded that, near a half of the studied nurses had a good level of knowledge regarding applying safety measures during neonates' intravenous infusion, while more than one quarter had average level and less than one quarter had poor level of knowledge. In addition, the majority of the studied nurses had competent total practice level. There was a statistically significant positive correlation between total scores of knowledge and practice of the studied nurses. From afore mentioned information, the study achieved aim and answer questions.

Recommendations

The findings of the present study suggested the following recommendations:

- Periodic assessment of nurse's knowledge and practice regarding applying safety measures during neonates' intravenous infusion.
- Establish continuous training courses to improve neonatal nurses' knowledge and practices about applying safety measures during neonates' intravenous infusion.
- Develop a simplified illustrated and comprehensive booklet for improving nurses'

knowledge and practice regarding applying safety measures during neonates' intravenous infusion.

- Develop an educational guideline based on evidence-based nursing practices to promote excellence of nursing care and provides high-quality neonates care regarding IV infusion.
- Large sample should be done to generalize the results.

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