

Nurses' practical knowledge about neonatal safety using intravenous devices for prevention of medication errors

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Abstract: Medication errors remain a major source of morbidity and mortality among neonates. Intravenous devices support is required in medication administration process to mimic the incidence of medication errors until complete recovery of the neonate. Nurses play a vital role in neonatal safety through prevention of medication errors. Aim: to assess nurses' practical knowledge about neonatal safety using intravenous devices for prevention of medication errors. Methods: A descriptive research design was conducted on a sample of 82 nurses working in neonatal intensive care unit at Mansoura University Children Hospital. Structured interview questionnaire used to assess nurses' practical knowledge about neonatal safety using intravenous devices for prevention of medication errors. Results: More than half of the studied nurses had average level of knowledge about neonatal safety and methods of prevention of medication errors. Nearly half of the studied nurses have average to poor level of knowledge about medication administration process as well as the majority of them had average level of knowledge about medication errors. Also, the majority of the studied nurses know the strategies used to reduce medication errors among neonates. Conclusion: Nearly two thirds of neonatal nurses had average level of practical knowledge about neonatal safety using intravenous devices for prevention of medication errors. There was a statistical significant difference between nurses' level of practical knowledge about neonatal safety and their gender. There was no statistical significant difference between nurses' level of knowledge about neonatal safety using intravenous devices for prevention of medication errors and their demographic characteristics. Recommendations: Periodical in-service training programs for neonatal intensive care staff nurses about neonatal safety, medication administration process and methods of prevention of medication errors.

Keywords: Intravenous Devices, Medication Errors, Neonatal safety, Nurses, Practical Knowledge, Prevention.

I. INTRODUCTION

The neonatal care unit is an intensive and demanding environment where newborn infants are constantly bordering on life and death. It is an area that provides challenges to those working within it or being a parent or relative visiting an ill neonate (Caldeira & Hall, 2012).

Neonatal safety is defined as freedom from accidental injury to minimize errors and preventing them (Raju, Suresh & Higgins, 2011). Neonatal safety in the Neonatal Intensive Care Unit (NICU) environment is an under-researched area but, recently seems to get high priority on the healthcare quality improvement in the entire world (Chatziioannidis, et al, 2017). For achieving neonatal patient safety, healthcare organizations should follow the following recommendations as; raising healthcare teams' awareness, improving working knowledge and best practices of neonatal patient-safety issues, expanding educational efforts to reach all healthcare teams, ensuring that all clinicians can identify neonatal patient-safety issues in the medical settings (Miller, et al, 2011). Nurses should take individual responsibility for maintaining awareness

of neonatal patient-safety issues; enhance family-centered care by actively engaging patients and families in safety at all points of care and address issues of ethnic culture, language, and literacy (Epstein, et al, 2010).

Medication administration is considered as one of the main nurses' role. The medication administration process is complex (Dilles, et al, 2011). The intravenous route is a critical part in the treatment of patients admitted to hospital (Rothschild, Bsn, Msn & Bates, 2015). An intravenous route for a neonate is a challengeable mission due to difficult insertion of peripheral line and decreased blood volume that affect medication concentration and ability to carry IV fluids (Linakis, et al., 2016). Medical devices such as intravenous devices consider one of health care technology that could reduce some types of ME (Timmermans, & Berg 2010). Several infusion devices are now available from different manufacturers to improve the accuracy of intravenous fluid administration for patient safety. Neonates' patients or fluid-restricted patients may require a higher degree of infusion devices accuracy than other patients. A number of commonly used infusion pumps are designed for specialized purposes and in a variety of environments (Voss, & Butterfield, 2015).

An intravenous devices problems can be caused by; software problems, alarm errors, human factors, mechanical or electrical failures and broken components. These problems can lead to over or under infusion and/or delay in therapy (Trbovich, et al, 2010). There are some complications from the infusion and vascular access devices are expensive to organizations in terms of wasted human resources, wasted supplies, impaired customer satisfaction and delays in patient care. These complications include phlebitis, infiltration and extravasations (Gassiot, Searcy & Giles, 2011).

Medication errors (MEs) can be defined according to The National Coordinating Council for Medication Error Reporting and Prevention as any preventable event that may cause or lead to inappropriate medication use or patient harm while, the medication is in the control of the healthcare professional, patient or consumer. MEs are resulted from several factors such as human, institutional, organizational and environmental factors (Lisby, et al, 2010). Neonates are particularly vulnerable population because of changing body size, weight-based dosages, off-label drug usage, availability of stock solutions in a variety of concentrations, inability to communicate with healthcare providers, and changing developmental systems affecting drug absorption, distribution, metabolism, and excretion (Stavroudis, et al., 2010).

Medication errors (MEs) are underreported in all countries, particularly in developing countries. This occurs eight times more often in NICU than in adults hospital (Alsulami, Conroy & Choonara, 2013). In Egypt, a study at NICU in Benha University Hospital; detected 3819 errors that affected 97% of neonates (El-Shazly, et al, 2017). Another study at Abu El-Rish El-Monira and Sayed Galal NICUs revealed that, 74.5% prescription errors and 69.7% administration errors were detected in the two NICUs (Nawwar, Mohsen, Aly & Salah, 2015). MEs risks increase in intravenous route medications because it's more complex in calculation, preparation, administration, and follow up after administration. Causes of an intravenous MEs include; high workload, lack of supervision, defects in learning and practice, disturbances and interruptions during preparation or administration, lack of communication and skills, poor intravenous line in some patients and deficiencies in the design of related equipment (Jo, et al., 2016).

Finally, nurses' do an important function in preventing errors because they do the last security checks that medications need before medications are administered to patients. It is important to use an infusion pump in medication administration to decrease the incidence of MEs and adverse drug reactions (ADRs) (Pang, et al, 2011). Before starting or changing an infusion setting, confirm that the infusion pump is programmed correctly, perform an independent double check, when neonates receive multiple intravenous fluid or medications by infusion pump, every fluid or medication should be labeled with its name (Cummings & McGowan, 2011). Also, paying attention to displayed alerts, continuously reevaluate infusion, making sure that nurses properly educated to manage all infusion pumps used on unit, and finally, facility policies and procedures should be readily available and clinicians should be promptly notified of changes or updates (Alfaro-Lefevre, 2012). Neonatal patient safety is taking priority universally because it is an issue with significant substantial economic and human implications the hospital gives special attention to its achievement. It is very important for using intravenous devices in medication administration for neonates, which can contribute in decreasing the incidence of medication errors. So, nurses must have the necessary sufficient knowledge and competent practices regarding patient safety and using intravenous devices in medication administration to prevent the incidence of medications errors.

The Aim of this study is to:

Assess nurses' practical knowledge about neonatal safety using intravenous devices for prevention of medication errors.

Research questions:

- What is nurses' practical knowledge about neonatal safety using intravenous devices?
- What is nurses' practical knowledge about medication errors?
- What are methods used by neonatal nurses for prevention of medication errors?
- Is there a relation between neonatal nurses' characteristics and their practical knowledge?

II. SUBJECTS AND METHOD

Research Design: the researcher utilized descriptive research design to accomplish this study.

Setting: This study was conducted at Neonatal Intensive Care Unit (NICU) at Mansoura University Children Hospital (MUCH) in 6th floor.

Subjects: A convenience sample of nurses (82) working at the above mentioned setting who was providing care for neonates in neonatal intensive care unit regardless of their age and qualification or years of experience.

Tools of Data Collection: a structured interview questionnaire used to collect data that was developed by the researcher after reviewing the related literatures. It divided into four parts:

Part I: Characteristics of the studied nurses: which include nurses' age, level of education, job, years of experience and previous training courses about medication administration or medication errors.

Part II: Nurses' knowledge about Neonatal safety: including asking about the definition of neonatal safety, areas that neonatal safety covers, human factors of patient safety and factors associated with patient safety in NICU.

Part III: Nurses' practical knowledge about intravenous medication administration: including asking about the definition of the medication administration process, definition of systemic medication and medication rights.

Part IV: Nurses' practical knowledge about medication errors by using intravenous devices: including asking about the definition of medication errors, types of medications errors, general causes of medication errors and causes in neonates, factors affect in medication calculation in neonates, causes of refusal of reporting in medication errors, the instruments used to administer IV medication, complications of IV medication, definition of infusion pump and syringe pump, the alarm types in infusion pump and syringe pump, problems during using of syringe or infusion pump, hazards when using infusion or syringe pump and methods of prevention of medication errors.

Part V: Nurses' practical knowledge about methods used for prevention of medication errors: including asking nurses' action when one staff member asked you to administer a prepared drug, participation of giving medication with other staff, time of documentation of each medication that you are administering in NICU, following medication rights, items should be reviewed after drug prescription, action taken when medication changed in shape or color, items that should be written on drug label and strategies that are used to reduce medication error among neonates.

Scoring system: It was developed as the following: the complete correct answer was given the score (2), incomplete correct answer was given the score (1) and wrong or unknown answer was given the score (zero). The nurses' knowledge level was categorized as following: good level of knowledge if the percent score was $\leq 75\%$ (64 marks) and more, average level of knowledge from $50 \leq 75\%$ (40–46 marks) and poor if percent score was $< 50\%$ (40 marks)

Method:**1- Administrative design:**

- Official permission was obtained from the Dean of Faculty of Nursing, Mansoura University, to the head of the neonatal intensive care unit and the head of the hospital to conduct the study after explaining the aim of the study.

- The structured questionnaire was developed in the English language then translated to the Arabic language then retranslated to the English language to test its validity by the researcher after reviewing of the related literature, then revised and adjusted by supervisors. The developed tool was submitted to jury team experts in the nursing field.
- A pilot study was carried out to evaluate the applicability, clarity and feasibility and applicability of the tool. It was carried out on 10% (8 nurses) of the total sample size of the studied nurses, and there is no modification needed. The nurses were excluded from the final study sample.

Ethical considerations:

- Informed oral consent was obtained from each nurse for her participation after explaining the aim of the study

III. RESULTS

Table (1): Characteristics of the studied nurses in percentage distribution (no=82)

Demographic characteristics	No	%
Age in years		
≤30 y	42	51.2
>30 y	40	48.8
Mean ±SD	29.17±5.26	
Gender		
Male	4	4.9
Female	78	95.1
Educational level		
Bachelor of nursing	55	67.1
Nursing technician	21	25.6
Diploma	6	7.3
Occupation		
Bed side nurse	64	78.0
Nursing supervisor	16	19.5
Other	2	2.5

The studied nurses' characteristics in NICU are illustrated in **table (1)**. It is clear that more than half (51.2%) of the studied nurses were in the age group ≤30 years with a mean age of 29.17±5.26 years and the most of majority (95.1%) of them were females. More than two thirds (67.1%) had a Bachelor of nursing, and more than three quarters (78%) of them was bedside nurses.

Figure (1): Percentage distribution of the studied nurses regarding their years of experience at neonatal intensive care unit (No. = 82)

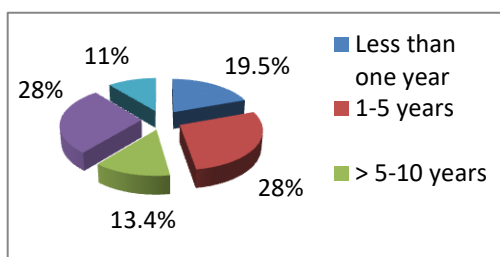


Figure (2): percentage distribution of the studied nurses according to their attendance to training courses at NICU

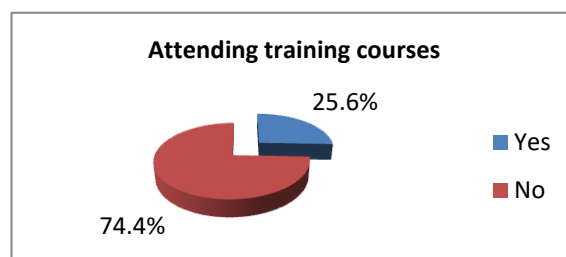


Figure (1) illustrated that, more than one quarter of the studied nurses had years of experience from one to five and, others had years of experience from ten to fifteen years as revealed by (28.0% & 28.0% respectively). It is also, observed that the minority (11%) of the studied nurses had years of experience for more than fifteen years.

It is showed from Figure (2) that, approximately three fourths (74.4%) of the studied nurses didn't take any training courses before while, more than one quarter (25.6%) of them attended training courses

Table (2): Levels of nurses' practical knowledge about neonatal safety, medication administration process, medication errors and methods of prevention of medication errors (No=82):

Items	Level of practical knowledge					
	Poor		Average		Good	
	NO	%	NO	%	NO	%
Neonatal safety	13	15.9%	48	58.5%	21	25.6%
Medication administration process	39	47.6%	37	45.1%	6	7.3%
Medication errors	6	7.3%	76	92.7%	0	0%
Methods of prevention of medication errors	32	39%	42	51.2%	8	9.8%

From Table (2), the majority (92.7%) of the studied nurses had average practical knowledge about medication errors. While, more than half (58.8%) of them had average knowledge about neonatal safety and less than half (45.1%) of them had average practical knowledge about medication administration process. Additionally, more than half (51.2%) of the studied nurses had average level of practical knowledge about methods of prevention of medication errors.

Figure (3): Total level of the studied nurses' about practical knowledge in patient safety, medication administration process, medication errors and methods of prevention of medication errors (No=82)

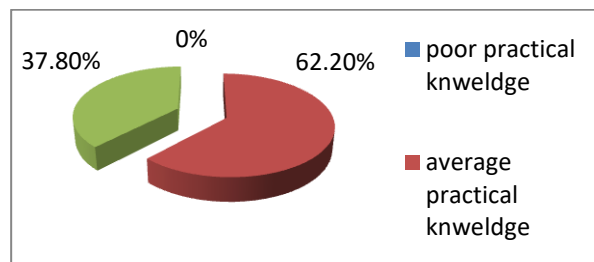


Figure (3) is illustrated that, less than two thirds (62.2%) of the studied nurses had average practical knowledge about patient safety, medication administration process, medication errors and methods of prevention of medication errors. While, more than one third of them (37.8%) had good knowledge in patient safety, medication administration process, medication errors and methods of prevention of medication errors.

Table (3) Relationship between the total level of nurses' practical knowledge about neonatal safety, medication administration process, medication errors and methods of prevention of medication errors and their characteristics:

Demographic and working data	Total knowledge				χ^2	p-value
	Average		Good			
	No	%	No	%		
Age in years						
≤ 30	26	56.5%	20	43.5%	1.417	0.234
>30	25	69.43%	11	30.6%		
Gender						
Male	2	50%	2	50%	0.263	0.608
Female	49	62.8%	29	37.2%		
Educational level						
Bachelor of nursing	35	63.6%	20	36.4%	0.215	0.643
Nursing technician	13	61.9%	8	38.1%		
Diploma	3	50%	3	50%		
Years of experience NICU						

< one year	10	62.5%	6	37.5%	0.200	0.654
1-5 years	13	56.5%	10	43.5%		
> 5-10 years	7	63.6%	4	36.4%		
> 10 - 15 years	15	65.3%	8	34.7%		
> 15 years	6	66.7%	3	33.3%		
Occupation						
Bedside nurse	40	62.5%	24	37.5%	0.018	0.894
Nursing supervisor	10	62.5%	6	37.5%		
Head nurse	1	50%	1	50%		
Attending the training course						
Yes	13	61.9%	8	38.1%	0.001	0.975
No	38	62.3%	23	37.7%		

From the table (3), it was clear that, there was no statistical significant difference between the total level of nurses' practical knowledge about neonatal safety, medication administration, medication errors by using intravenous devices and their characteristics.

IV. DISCUSSION

Medication errors may occur during hospitalization, and may lead to unnecessary cost; unnecessary diagnostic evaluations, unnecessary treatments, and deaths. Medication errors may occur at any stage of medication use system including storage, prescription, transcription, preparation, dispensation, and administration of drugs (Madhaw, Amit, & Sandeep, 2015). Medication administration could occur without device use, which could put patients at increased risk of over or under dosing, allergic reaction, or other adverse effects, such as electrolyte or hemodynamic instability (Smith, & Filiatrault 2013). Intravenous devices in neonates have a great significance. This study helps us to test nurses' levels of knowledge that will affect their performance directly either positively or negatively. Intravenous devices using saves thousands of neonates around world every year; it sustains their life and improves their outcomes from hospitalization. Neonatal nurses' knowledge about infusion pump and its types, uses, precautions, complication and how to deal with it will help in improving patient care.

Regarding the age of the studied nurses' the findings of current study showed that, more than half of the studied nurses were aged between 20 to less than 30 years old with mean age 29.17 ± 5.26 years (table 1). This finding may be related to large number of more experienced and trained nurses which had recently transferred to work in other places in hospital or taking long duration vacation or travelling outside country. This finding goes in the same line with Eskander, Morsy, & Elfeky, (2013) who conducted a study about Intensive care nurses' knowledge & practices regarding infection control standard precautions at a selected Egyptian hospital in Egypt revealed that, more than half were with age from 20 to 30 years. Also, Issa, Elmadwah, Al Mosawi (2018) who conducted a study about evaluation of nurse's knowledge in management of premature baby at neonatal units in Basrah University, Iraq revealed that more than half were in age from 20 to 30 years. Also, the findings of current study showed that, the majority of the studied nurses were females. This may be due to the study of nursing in Egypt universities was exclusive for females only till few years ago; this fact attributes the high proportion of females, so the profession of nursing in Egypt was mostly feminine. This finding was similar with the study by Rahman, & Mu'taman Jarrar, (2015) who conducted study about Nurse Level of education, Quality of care and patient safety Malaysian private hospitals: A cross-sectional study that the majority of the study was female. In addition, present study showed that, more than two thirds of the studied nurses had a Bachelor of nursing, and the minority had a diploma. This point of view of this finding may clarify that the head nurse of NICU requesting large number of highly qualified nurses always and the governmental tendency for highly qualified nurses working in ICU. This aligns with Lan, et al, (2014) in this study about medication errors in pediatric nursing: Assessment of nurses' knowledge and analysis of the consequences of errors in Taiwan that more than half was Bachelor degree. On the contrary, Ammouri, et al, (2015) who conducted a study about patient safety culture among nurses in California State University; Los Angeles, USA reported in this study about that the minority was college graduate. The current study showed that, the minority of the studied nurses was head nurses. This finding was agreed with the view of Lan, et al, (2014) who conducted a study the minority was head nurses and more than half was bedside nurses. Also, Shamsuddin,

& Shafie, (2012) who conducted study about knowledge of nurses in the preparation and administration of intravenous medications that reported the minority of studied nurses was head nurses. This study carried in Kebangsaan University, Malaysia.

The findings of the current study illustrated that, the minority of the studied nurses had years of experience for more than fifteen years work at NICU (figure 1). According to the researcher opinion this finding may be related to large number of more experienced and trained nurses which had recently transferred to work in other places in hospital. The hospital policy of referring the most experienced and qualified nurses for supervision position in different hospital units according to their professionalism. In addition, more than one quarter of the studied nurses had years of experience from one to five years. On the contrary, **Alemu, Belachew, & Yimam (2017)** in their study about medication administration errors and contributing factors: A cross sectional study in two public hospitals in Southern Ethiopia that carried on Jimma, Ethiopia that stated more than half of the studied nurses had experience less than five years and more than quarter had experience more than ten years.

In relation to the studied nurses' attainment of previous training courses, the present study revealed that, near three fourths of the studied nurses didn't take any training courses before this study related to neonatal safety and medication administration (figure 2). This finding may be due to large number of nurses are recently experienced at the neonatal intensive care unit and they haven't had the opportunity to attain training programs. This finding was agreed with **Lan, et al, (2014)** who reported in their study that more than half of nurses don't taking training courses about medication errors. On the contrary, **Issa, et al, (2018)** who reported that the majority of nurses had a participation in training courses.

The current study showed that, more than half of the studied nurses had average practical knowledge about neonatal safety (table 2). This may be due to neonatal safety is a new area of study in Egypt. This is disagreeing with **Bari, Jabeen, Bano, & Rathore, (2017)** who studied about patient safety awareness among postgraduate students and nurses in a tertiary health care facility, which carried in The Children's Hospital and The Institute of Child Health, Lahore, Pakistan, showed that nurses had good knowledge towards patient safety. It is also observed in our study that, less than half of them had poor practical knowledge about medication administration. This may be due to lack of participation of staff in training programs. On the contrary, **Gonzales (2012)** who conducted study about assessments of safe medication administration in nursing education, which carried in College of Nursing, Nebraska Medical Center, Omaha, Nebraska, reported that, the majority of studied nurses had good knowledge about safe medication administration. This result was similar to **Alsulami, et al, (2015)** was conducted in Saudi Arabia, who made a study about evaluation of medication administration process in a Pediatric Ward reported that, the majority of studied nurses had good knowledge about medication administration process. The existing study illustrated that, the majority of all studied nurses had average practical knowledge about medication errors. This may be due to availability of experience nurses in every shift and continues monitoring of newly joined staff. On conversely, with the study carried by **Saundeeswari, & Muthamilselvi, (2018)** entitled nurses knowledge on prevention of medication error, which carried in Vinayaka Missions College of Nursing, Puducherry, India, stated that more than half of the studied nurses had poor knowledge about medication errors. The findings of the existing study illustrated that, more than half of all the studied nurses had average practical knowledge about methods of prevention of medications errors. This finding was similar with study by **Abdel-Latif (2016)** who conducted a study about Knowledge of healthcare professionals about medication errors in hospitals stated that, the majority of the studied nurses know methods of prevention of medication errors. this is disagreeing with **Saundeeswari, & Muthamilselvi, (2018)** found in their study that, the minority of the studied nurses had average level about methods of prevention of medication errors.

In our study, it is observed that, less than two thirds of the studied nurses had average practical knowledge about patient safety, medication administration process, medication errors and methods of prevention of medication errors. While, more than one third of them had good knowledge about patient safety, medication administration process, medication errors and methods of prevention of medication errors (figure3). These findings disagree with the study by **Mason, et al, (2014)** who conducted a study about patient safety, errors reduction, and pediatric nurses perception of smart pump technology who revealed that, the majority of nurses promoted safe and effective nursing practices about using of the pumps increased safe for medication administration, and reported had adequate training to use the pumps to decrease incidence of medication errors.

The results of the current study revealed that, there was no significant statistical difference between the total level of nurses' practical knowledge about neonatal safety, medication administration, medication errors by using intravenous devices and their characteristics table (3). This finding was similar with the study by **Stavroutis, et al, (2010)** who conducted study about NICU medication errors: identifying a risk profile for medication errors in the neonatal intensive care unit about there was no association between nurses', demographic characteristics and medication errors that resulted in harm. This finding disagreed with **Westbrook, Rob, Woods, & Parry, (2011)** who studied about errors in the administration of intravenous medications in hospital and the role of correct procedures and nurse experience that carried in Australian Institute of Health Innovation, University of New South Wales, Sydney, Australia stated that, there was relation between nurses' demographic characteristics and skill and knowledge deficiencies as reducing as clinical experience increases. Also, these findings were disagreeing with the study by **Montague, Asan, & Chiou, (2013)** about organizational and technological correlates of nurses' trust in a smart IV pump that carried in University of Wisconsin – Madison, USA about revealed that, the nurses who were bedside nurses reported higher trust about using intravenous devices in prevention of medication errors more than head nurses and was also found that, younger nurses than older nurses trust about using intravenous devices in prevention of medication errors. Also, this finding disagreed with **Mason, et al, (2014)**, they reported that younger nurses reported more practical knowledge about patient safety using intravenous devices for prevention of medication errors more often than did the older age nurses.

Limitations of study:

- Little number of nurses that the study applied on them so, results may be inaccurate when applying in all hospital or all country.
- It is not available a quiet and suitable place for interviewing the nurses.

V. CONCLUSION

Based on the findings of the current study, nearly two thirds of neonatal nurses had average level of practical knowledge about neonatal safety using intravenous devices for prevention of medication errors. There was a statistical significant difference between nurses' level of practical knowledge about neonatal safety and their gender. There was no statistical significant difference between nurses' level of knowledge about neonatal safety using intravenous devices for prevention of medication errors and their demographic characteristics.

VI. RECOMMENDATIONS

Based on the results of the present study, the following recommendations are suggested that:

1. Periodical in-service training programs for neonatal staff nurses directed toward all aspects of care provided to neonates on neonatal safety.
2. Provision of continuous supervision of nurses during their practices of medication administration and providing teaching on spot with motivation and feedback.
3. Establishing infusion alliance team should be available all time in NICU at Mansoura University Children Hospital

For further studies:

- Study the effect of nurses' knowledge and management on quality of life for children receiving intravenous medication.
- Improving nurses' knowledge and practices regarding patient safety and medication administration.

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