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The Relationship between Nurses' Pharmacological Knowledge and Medication Administration Errors

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Abstract: **Background: Health care systems around the world are under pressure to reform and improve the quality of service delivery. Care should be safe, effective, patient centered, timely, efficient and equitable. One of the important stages in promotion of safety level is identification of medication errors and their causes. Aim: To examine the relationship between nurse's pharmacological knowledge and medication administration errors, at Damanhour chest and Kafer -El Dawar General Hospital. Methods: A descriptive, correlational research design was utilized for all staff nurses in coronary care, neuro-surgery, ICU, burn ICU, Eclampsia ICU, and Neonatal general Intensive Care at Damanhour chest and Kafer El Dawar General Hospital, El-Beheira, Egypt. Tools: two tools were used: Tool I: Pharmacological Knowledge Questionnaire (PKQ) and a demographic characteristics data sheet; Tool II: Medical Intensive Care Units (MICU) Data from Observation Check List. Results: There is a gap between nurses' pharmacological knowledge as compared to the standard guidelines about medications administration, uses, side effects, documentation, patient education and awareness. The medication administration total score was unsatisfactory. Conclusion: This is first study conducted in Beheira Governorate at Damanhour chest and Kafer El Dawar General Hospital using the first tool (Tool I) to measure all dimensions of nurse's pharmacological knowledge. There was a negative highly significant correlation between total nurses' Pharmacological Knowledge and all its dimensions and total nurses' Medication Administration Erros and all its dimensions. Recommendations: A list of all medications and medication safety policies and procedures are strongly needed and emphasized. Arranging continuous educational programs for nurses, construction of training endeavors based on teaching about pharmacokinetics, pharmacodynamics, dosage administration, therapeutic use, how to calculate, side effects and adverse events of all medication is urgently required.**

Keywords: **Medication Errors, Nurses-& Intensive Care Unit; Nurses' pharmacological knowledge; adverse drug events; Safe medication.**

1. INTRODUCTION

Preservation and promotion of health are considered as main goals of care in health care systems.(1) Patient safety is one of the main concepts in the field of health care provision and a key factor in maintaining the quality of health care services.(2) Preservation of patient safety is a major concern in health care provision systems.(3) According to Zarea et al, (2018)(4) one of the important stages of raising the safety level of patients is identification of medication errors and their causes to improve

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patient safety[5] Medication errors are among the most prevalent health errors threatening patients' safety and are regarded as an index for determining patients' safety in hospitals.[6] These errors are one of the five medical errors classified by the National Institute of General Medical Sciences.[7] Medication errors, the most common type of medical error[8-12] , result in negative consequences, including long hospital stays, increased economic burden and threat to patients' lives .[9] Medication errors can cause serious harm to patients in several settings, particularly hospitals.[13]

A Medication error has been defined by the National Coordination Council for Medical Error Reporting and Prevention (NCCMERP)(2020)[14] as: 'An avoidable event causing medication to harm a patient or a patient to take an inappropriate medication, despite its being under the control of health workers, the patient or the manufacturer'. Medication administration is an important part of nursing practice and an important responsibility for nurses.[15] Medicine is usually prescribed by the doctor and dispensed by the pharmacist, but the primary responsibility rests with the nurses, as they spend 40% of their time administering medication.[16]

Because of the complexity in the drugs administration, in order to safety medication administration and clinical decision making and professional role in managing drug therapy and reducing the adverse effects and common drug errors, nurses need to be pharmacological knowledge.[17] Thomas et al, 2019[16] stated that Factors causing or contributing to the occurrence of medication errors are knowledge deficits regarding knowledge of medication and medication monitoring requirements, dose calculation, facility policy and procedure, use of equipment/technology, interpretation of the medication administration and medication packaging.

Lack of pharmacological knowledge is the leading cause of medication errors by nursing staff.[18] Nurses experience insufficient medication knowledge where the nurses' involvement in medication management is quite simple: giving the right patient the right drug in the right dose and right administration form at the right time. However, the nurses' responsibilities include more than just carrying out the orders from the physicians.[19] In order to ensure a safe storage, dispensing and administration of the drugs, the nurses must know the pharmacological principles for each drug; the Regulations of drug management; precautions for preparation; and considerations concerning administration to patients. Errors may be caused by either lack of knowledge, routine failure, and insufficient practical skills or as a result of an accidental happening.[20]

Nurses must maintain competence in practice and continually update their education In order to practice safely and avoid errors. This includes the acquisition of a broad knowledge of anatomy and physiology, an understanding of pharmacology and the impact of culture, gender and age on medication effectiveness.[21] Nurses must have adequate pharmacology knowledge behind the drugs they commonly administer.[22]

In Egypt, fewer studies were conducted to assess nurses' pharmacological knowledge and Medication Administration Errors (MAEs). Hence, the current study will be conducted to explore the relationship between nurses' pharmacological knowledge and medication administration errors.

Aim of the Study:

This study aims to assess the relationship between nurses' pharmacological knowledge and medication administration errors.

Research question:

What is the relationship between nurse's pharmacological knowledge and medication administration errors?

2. MATERIALS AND METHODS

I. Materials

1- Research Design:

A descriptive, correlational research design was be used in this study.

2- Setting:

This study was conducted at two hospitals affiliated to the Ministry of Health and Population. Damanhour Damanhour chest and Kafr El Dawar General Hospitals, which are considered the main hospitals at El Beheira Governorate in delivering

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critical care. **Kafr El Dawar General Hospital**, consist of 8 units (with 250 bed capacity), namely: general Intensive Care Unit ICU (old and new); coronary care unit; neuro-surgery ICU; burn ICU; pediatrics ICU; Eclampsia ICU; Toxicology ICU and Neonatal ICU, ***Damanhour Chest Hospital***, (N=1) (with 16 bed capacity), namely: general Intensive Care Unit.

Subjects:

All nurses (N=200), *Damanhour Chest Hospital* (N=80), and Kafr El Dawar General Hospital (N=120), who are working at the previously mentioned settings and was available at the time of data collection, and who are responsible for providing direct patient care , with at least one year of experience, will be included in the study.

Tools of the study

Two tools were used in this study:

Tool 1: Pharmacological Knowledge Questionnaire (PKQ):

This tool was developed by the researcher based on review of related literature,[23-29] to assess nursing pharmacological knowledge. In addition, a demographic characteristics data sheet which developed by the researcher for the study subjects and included data such as age, gender, marital status, educational level, and years of nursing and unit experience….etc.

It consisted of (50) questions ; Multiple Choice Questionnaire(MCQ) and (1) open ended question , to assess nursing pharmacological knowledge and open ended question .It used for measuring nursing knowledge, medication calculation, and medication administration and medication preparation. The response was measured through in a dichotomous scale right=1 and wrong=zero. The overall score ranged from zero to 50. The scoring systems were: less than 25 (50%) was poor knowledge; from 25 to 40 (50% to less than 75%) was moderate knowledge, and finally; from 40 to 51 (more than 75%) was good knowledge. (Appendix I)

Tool (II): Medical Intensive Care Units (MICU) data from observation check list:

It was developed by Pedersen and Schneider (2007).[30] it was used for assessing the occurrence of medication administration errors through observation of nurses during medication administration. It includes: observer initials, nurse identification number, date, patient ID number, patient room number, page number, drug name, dose, dosage form, route, rate, scheduled time, time of administration, dose preparation, administration technique, wash hands, maintain package integrity, check armband before administration ,not borrowing medication from another patient, double checking the medication in the Medication Administration Record (MAR), documenting after administering the dose, transcription from orders to MAR, comments, omitted medications, Patient weight, Patient restraints, Time of vital signs, and time of turning. Responses were measured in a dichotomous scale (Yes=1, No=0), not applicable for items that not applied for certain patients. Frequency and percentage of MAEs was calculated (Appendix II)

II. Methods

1. An official written permission was obtained from the Dean of Faculty of Nursing, Damanhour University, and the responsible authorities of the study settings after an explanation of the purpose of the study.

2. Tool I was translated into Arabic, and distributed to five experts in the field of the study, and tested for their content validity. The necessary modifications were done based on their comments. (Appendix III)

3. A pilot study for the questionnaires was conducted on 10% of the study subjects (n= 20) who were working in the previous mentioned units at Damanhour Chest and at Kafr El Dawar General Hospital who were not included in the study subjects after obtaining an official permission to check and ensure the applicability, feasibility of the tools, identify the obstacles, the problems that may be encountered during data collection, and to estimate the time needed to fill the questionnaires (answering the questionnaires took about 10-15 minutes). The subjects who included in the pilot study were excluded from the main study group.

4. The reliability of the two tools was tested statistically using Cronbach's Alpha Coefficient test to measure the internal consistency of the items composing each dimension of the tools. The results of Cronbach's Alpha Coefficient test proved to be strongly reliable (0.78) for nurses pharmacological knowledge scale and (0.72) for medication administration errors scale..

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5. Tool I Data was collected from the identified subjects, by the researcher through a hand-delivered questionnaire at their working setting after explaining of the aim of the study and the needed instruction was provided to them.

6. Tool II Individualized observation was conducted by the researcher through the following steps:

i. Arrived to the unit that planned to be observed at 8.00am, explained the aim of the study to nurse who are working a 12-hour-day shift to be observed on this day while they prepare, and give medications to patients.

ii. Determined with each nurse at the beginning of shift "when each nurse will administer medication to patients" because some units administered the medication in times rather than it was documented in their patients' records.

iii. Observed each nurse during each trail of preparation and administration of medication for all patients.

iv. Documented nurse performance of each medication administration trail in the medication from checklist as it observed.

v. reviewed physicians' medication prescription ordered records to identify the prescribed medication to each patient, and then the researcher compared nurse performance against the predetermined medication form checklist, and the prescribed medication record.

vii. When the researcher observed any errors occurring in medication administration such as name, dose, rate, route, and an omitted drug. the researcher informed each nurse about errors to save the patient' life (ethical consideration) and documented it as it was occurred.

7. The data collection took about two months from 1-7-2020 to 30-8-2020.

8. Data obtained was analyzed using the appropriate statistical tests.

3. STATISTICAL ANALYSIS

Statistical analysis was conducted by Mr. Ibrahim Sehsah at Pioneers Statistics Office, Egypt.

1. The collected data was coded and entered in a special format to be suitable for computer feeding. Following data entry, checking and verification process were carried out in order to avoid any errors.

2. Data was analyzed using the statistical package for social science SPSS (version 20).

3. The following statistical analysis measures were used:

a. **Descriptive statistical measures**, which included numbers, percentages, and averages (Minimum, Maximum, Arithmetic mean (X), and Standard deviation (SD).

b. **Statistical analysis tests**, which included: Chi square (X^2), student T test and ANOVA test.

4. RESULTS

The present study is mainly concerned with determining the relationship between nurse's pharmacological knowledge and medication administration errors.

Demographic characteristics of staff nurses working at Damanhour Chest and Kafr El Dawar Genral Hospital (n=200).

This table shows that, slightly more than half (60%) of staff nurses were in the age group from 20 to 25 years, While (40%) was in the age group from 25 to 30 years at both hospitals with a mean age (25.13 ± 2.51) at Damanhour Chest Hospital, and (25.34 ± 2.62) at Kafr El Dawar Hospital . Concerning nurses' gender, slightly more than half (60%, 60.8%) of staff nurses were females; while (40%, 39.2%) were males at Damanhour Chest and Kafr El Dawar general hospitals respectively.

According to their level of education, 77.5% of them had a bachelor's degree of nursing science, distributed as (68.8%, 83.3 %) at Damanhour Chest Hospital, Kafr El Dawar general hospital respectively. On the other hand, 22.5% of them had a diploma of technical health nursing institute distributed as (31.3%, 16.7%) at Damanhour Chest Hospital, Kafr El Dawar general hospital respectively. Regarding the most frequently working hours, 73.5% of them are working (night 12 hrs). 71.3

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% at Damanhour Chest Hospital and 75% at Kafr El Dawar General Hospital, while 26.5% of them are working (morning/ evening 6 hrs), 28.8% at Damanhour Chest Hospital and 25% at Kafr El Dawar General Hospital

Table (1): Demographic characteristics of staff nurses working at Damanhour Chest and Kafr El Dawar Genral Hospital (n=200)

Demographic Characteristics	Damanhour Chest Hospital (N=80)		Kafr El Dawar general Hospital (N=120)		Total (N=200)		Total X^2 P
	No	%	No	%	No	%	
Age							
From 20-25	48	60	72	60	**120**	**60**	**0.000 1.00**
25 to 35 and more	32	40	48	40	**80**	**40**	
Mean ± SD	**25.13 ± 2.51**		**25.34 ± 2.62**				
gender							
Male	32	40	47	39.2	**79**	**39.5**	**0.014 0.9020**
Female	48	60	73	60.8	**121**	**60.5**	
Educational qualification							
Bachelor of Nursing Science	55	68.8	100	83.3	**155**	**77.5**	
Diploma of Technical Health Nursing Institute	25	31.3	20	16.7	**45**	**22.5**	**5.85 0.01***
Diploma of Technical Secondary Nursing School	0	0	0	0	**0**	**0**	
Most frequently working hours							
Morning /evening (6hrs)	23	28.8	30	25	**53**	**26.5**	**0.34 0.55**
Night &long shift (12hrs)	57	71.3	90	75	**147**	**73.5**	
Years of unit experience							
<1	12	15	18	15	**30**	**15**	**2.80 0.24**
1-	41	51.3	74	61.7	**115**	**57.5**	
5-	27	33.8	28	23.3	**55**	**27.5**	
≥ 10	0	0	0	0	**0**	**0**	
Mean ± SD	4.26 ± **2.6**		3.95 ± **2.38**				
Years of nurse experience							
<1	34	24.5	32	26.6	**66**	**55**	
1-	22	27.5	45	37.5	**67**	**33.5**	
5-	14	17.5	25	20.8	**39**	**19.5**	
≥ 10	10	12.5	18	15	**28**	**14**	
Mean ± SD	4.03 ± **3.94**		4.85 ± **3.88**				
Patients ratio : nurse							
1:1	17	21.3	34	28.3	**51**	**25.5**	**2.30 0.31**
2:1	52	65	76	63.3	**128**	**64**	
3:1	11	13.8	10	8.3	**21**	**10.5**	
≥ 3:1	0	0	0	0	**0**	**0**	
Marital status							
single	20	25	32	26.7	**52**	**26**	**2.19 0.53**
Married	56	70	86	71.1	**142**	**71**	
Divorced	3	3.8	1	0.8	**4**	**2**	
Widow	1	1.3	1	0.8	**2**	**1**	

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Correlation Matrix between nurses' pharmacological knowledge and nurses' medication administration errors at Damanhour Chest and Kafr El Dawar General Hospitals (n=200).

Table (2) states that there are positive highly statistical significant correlations between total Nurses pharmacology knowledge and its dimensions and there are positive highly statistical significant correlations between total medication administration and its dimensions, where (P=0.000). However, there are negative highly statistical significant correlations between total Nurses pharmacology knowledge and all its dimensions and total medication administration and all its dimensions, where (P=0.000).

Table (2): Correlation Matrix between nurses' pharmacological knowledge and nurses' medication administration errors at Damanhour Chest and Kafr El Dawar General Hospitals (n=200).

Nurses pharmacology knowledge dimensions/medication administration dimensions		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
ICU High Alert Medications(1)	R	1	0.572	0.764	0.762	0.81	0.864	-0.522	-0.57	-0.619	-0.717	-0.655
	P(2-tailed)		0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**
Medication administration (2)	R		1	0.654	0.961	0.958	0.985	-0.715	-0.427	-0.52	-0.609	-0.499
	P(2-tailed)			0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**
General Pharmacology (3)	R			1	0.986	0.958	0.977	-0.684	-0.379	-0.471	-0.542	-0.442
	P(2-tailed)				0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**
Calculation& measurement (4)	R				1	0.954	0.975	-0.685	-0.347	-0.44	-0.53	-0.423
	P(2-tailed)					0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**
Medication preparation& Medication order, storage and documentation (5)	R					1	0.981	-0.683	-0.396	-0.481	-0.548	-0.459
	P(2-tailed)						0.000**	0.000**	0.000**	0.000**	0.000**	0.000**
Total Nurses' Pharmacological Knowledge (6)	R						1	-0.691	-0.44	-0.527	-0.613	-0.514
	P(2-tailed)							0.000**	0.000**	0.000**	0.000**	0.000**
Deviation From Order (7)	R							1	0.398	0.472	0.514	0.422
	P(2-tailed)								0.000**	0.000**	0.000**	0.000**
Preparation and Administration (8)	R								1	0.934	0.785	0.889
	P(2-tailed)									0.000**	0.000**	0.000**
Process Variation (9)	R									1	0.861	0.922
	P(2-tailed)										0.000**	0.000**
Documentation (10)	R										1	0.963
	P(2-tailed)											0.000**
Total Medication Administration Errors (11)	R											1
	P(2-tailed)											

5. DISCUSSION

Medication errors (MEs) are major public health issues in hospitals because of their consequences on patients' morbidity and mortality [31, 32]. It's having been identified as the most common type of error affecting the safety of patients.[33] Medications may be very dangerous if improperly used, moreover medication safety is one of the highest priorities of nursing practice, a matter of considerable concern for all health team members.[32] Medication errors produce a variety of problems for patients ranging from minor discomfort to substantial morbidity that may prolong hospitalization or lead to death and risk of litigation. [34]

In this respect the results of the present study revealed that the all intensive care nurses with different educational levels, irrespective of their years of experience or area of work had unexpectedly poor knowledge scores about pharmacological knowledge of medication administration, dosage forms, routes of administration, Calculating dosages, medication order, preparation, storage, documentation, patient education, adverse drug event and package information. The findings of current study results revealed that the age of more than half of the ICU nurses was ranged between twenty to twenty five years. From the researcher point of view; nursing knowledge increased with the increase in years of experience because

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experienced staff nurses are more skillful, have more knowledge related to the medication administration. That agreed with studies done by Štrbová et al, (2019)[35] who mentioned that many research studies are generally considering that more experienced and highly educated nurses are more knowledge and provide higher quality of care.

So, it isn't surprising that, the present study revealed that there was a negative correlation between nurses' pharmacological knowledge and medication administration errors. This study sought to explore the relationship between nurses' knowledge, specifically pharmacology knowledge, and medication error occurrence. Most research studies that have investigated medication errors have focused on causes, antecedents and systems factors. For the nurse, who is at the sharp end of a medication error, the basis of medication competence lies in the knowledge that begins with their basic education and training and is a lifelong pursuit. The current study result was agreed with, studies done by Kumar (2015)[36] who state that, there is an inverse relationship between knowledge and the incidence of error such that more knowledge is related to little error. Nurses have a low level of knowledge of the drugs they use the most and with which a greater number of medication errors are committed in the ICU so nurses must have pharmacological knowledge.

6. CONCLUSION AND RECOMMENDATIONS

CONCLUSION

The result of the present study concluded that there was highly statistically significant negative correlation between nurse's pharmacological knowledge and medication administration error at Chest and Kafr El Dawar General Hospitals. In addition to that, the majority of the study participant had moderate level of knowledge .So these results showed that there is a wide gap between nurse's knowledge regarding medication administration errors. There was a gap between nurses' pharmacological knowledge and skills so these results showed that there is a wide gap between nurse's knowledge regarding medication administration errors.

RECOMMENDATIONS

Based on the findings of the present study, the following recommendations are suggested

1. The hospital administrators should:

- Continuous in-service training programs for all ICU nurses at different hospitals regarding the suggested medication safety guidelines for decreasing the frequency rate of medication errors.
- Implementation and dissemination of comprehensive, systematic, and continuous educational programs in order to enhance the knowledge and practices of nurse's on medication administration practices which will decrease the medication administration errors and using interactive teaching methods and technology in order to increase the efficiency of in-service trainings.
- Arabic booklet about medication safety guidelines should be available for all ICU nurses at all settings.
- Collaboration between pharmacists and nurses is paramount to improve the quality of drug supply chain and decrease the risk of medication errors.
- Publishing posters containing medication safety guidelines in all ICUs in different health care setting.
- Periodical assessment of the ICU nurses knowledge and practice to detect the areas to be covered in training education courses to improve their practice regarding medication management and medication errors.

2. Head nurses should:

- Assign nurse to check all prescribed medication with nurse that will administer medication.
- Inform nurse about standardized precautions during the administration.
- Inform nurses that they must carefully check patient name, name of medication, dose, route…..ect.
- Supervise nurse during administering medication.

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- Create incentives for nurses to report errors and demonstrate positive responses for them when reporting medication error.

1. Staff nurses should:

- Checked prescribed medications by assigned nurse who will administer medication.
- Follow steps of medications administration for each medication prescribed.
- Inform patient about his/her treatment plan, time, names, dose……ect

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