

## The Time of Standardisation Comes: Devising Dilution to Drill Nurses Mind

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**ABSTRACT:** Medication errors are the stumbling block of patient safety in hospital and leading cause of morbidity and mortality among patients. Among medication errors, intravenous medication administrations are especially important. The lack of medication information can be one of the causes of medication error. Nurses have the most important role among health care workers in each hospital. Nurse's education can lead to improvement of nursing care if it implemented and designed based on nurses needs and proper principle. We aim to evaluate the role of nurse's education via installation of informative dilution pamphlet in reducing the errors in preparation and administration of intravenous drugs in a tertiary care teaching hospital in Tamilnadu, India. 4 Clinical Pharmacist had been stationed in different departments in the hospital. We recorded nurse's practice regarding the preparation and administration of IV drugs and examined their knowledge before and after education. A total of 75 nurses are educated by using informative dilution pamphlet regarding the correct preparation and administration of IV drugs to reduce the number of errors.

### I. INTRODUCTION

Medication safety becomes a major concern and a global issue related to quality and safety of patient care(1). Medication Administration error is defined as any differences between what the patient received or was supposed to receive and what the prescriber intended in the original order(2). The administration of intravenous medications in hospital is a common practice. Although it may seem almost insignificant, the practice remains no less an act which involves risks, due to many factors identified(3). Consequences of the mistake that occur during the

process of IV drug administration may be more serious than in drugs delivered by other routes of administration(4). Several areas of particular concern emerged including the nurses confusion regarding the definition of drug errors, the appropriate actions to take when they occurred, their fear of disciplinary action, their loss of clinical confidence, the variation in managerial response and a possible lack of nurses mathematical skills(1).

Nursing is a dynamic profession that is subject to rapid changes in health care profession. Hence there is a need for in-service training program(5). The National Patient Safety Agency of UK revealed that medication administration error is most common and this occurs in 50% of all drug administration in hospitals(2). So it clearly shows the necessity of educating the nurses regarding proper drug administration. Malpractice in preparation and administration of intravenous (IV) medications has been reported in recent years(6). It is therefore important to gather, clarify and communicate the updated information on the modalities of the administration of these injections in order to facilitate and secure the work of the teams of care with a view of an optimal and standardized administration of intravenous medications(3). In addition, several characteristics of IV dosing and administration, such as variability in available concentrations for the same drug during transitions within the same institution and among facilities and settings, can increase the likelihood of errors. The multifarious roles of nurses in Pharmacotherapeutics include accurate and appropriate drug administration. The need to perform calculations to guide extemporaneous preparation or to calculate administration rates also creates opportunities for errors(7). Many medication errors were found to be due to lack of

pharmacological knowledge, proper attitude and skill in medication administration. Gerry and Helen (2003) have shown that 5.41% of medication error that occurred due to failure in following the prescription and poor skill in administering the drugs. It is recommended that all of these issues are addressed as a matter of urgency for the sake of both patient and nurses(1).

## II. METHODOLOGY

### AIM

The aim of the study is to identify the dilution errors made and to access the outcome after educating the nurses by the introduction of dilution pamphlets

### OBJECTIVE

The objective of the study is to evaluate the progress towards the goal of standardizing the IV infusion concentration of commonly used medications and to evaluate the quality of IV drug administration.

To determine the frequency of medication errors that occurred during the preparation and administration of IV drugs.

### METHOD

An interventional study was carried out at a tertiary care teaching hospital of a major Trauma care Centre in the month of April to September 2021. The study was conducted among the nurses to evaluate their knowledge in IV infusion and dilution. The standardization of injectable drugs have been made on several occasions in the past and distributed in the care units. The latest version of these documents was reviewed and updated in the light of the recent editions from several sources (Dilution Protocol BPF, Dilution guidelines for Injectable drugs, medicines.org.uk, Medscape, US FDA). Education of nurses by preparation of pamphlets and handing out this pamphlet to the nurses were used as an educational method in this study.

The study consists of four different phases:

Phase 1- Designing the dilution pamphlet and questionnaires

Phase 2- Pre-intervention; observation of IV drug preparation and administration by nurse before education

Phase 3- Interventional phase; education of nurses regarding correct process of IV drug preparation and administration

Phase 4- Post-interventional phase; observation of IV drug preparation and administration after nurse education

### INCLUSION CRITERIA

Nursing staffs in ICU, ward, pre-operative and post-operative wards

### EXCLUSION CRITERIA

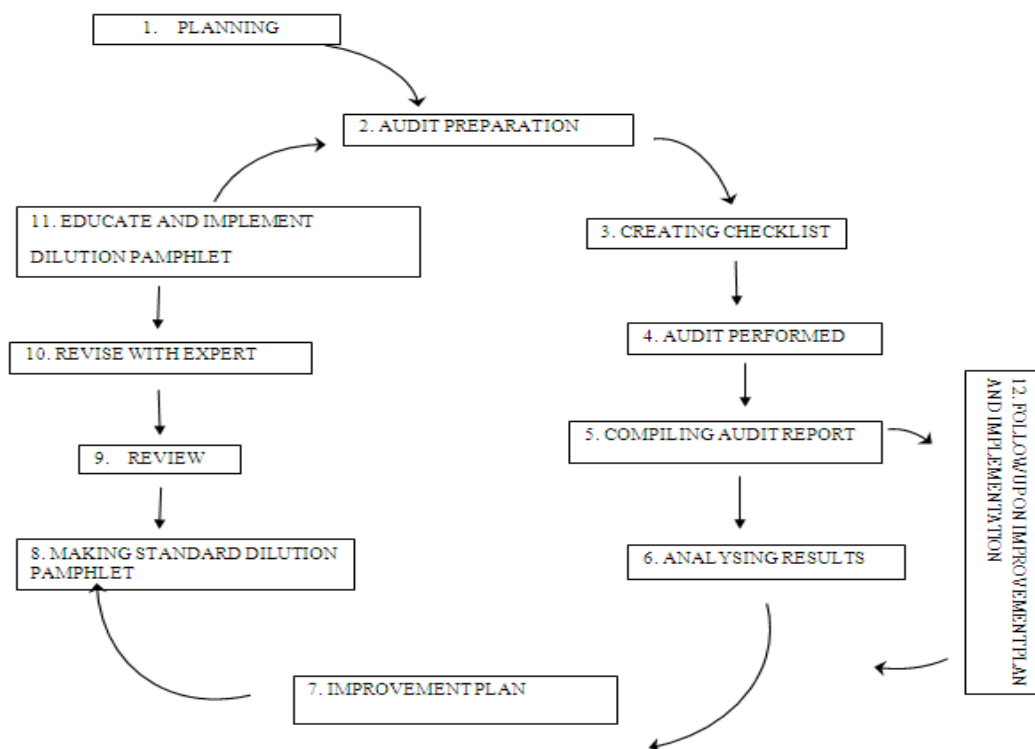
Nursing students

### DATA COLLECTION

During the study period, we prepared a checklist for evaluating the quality of IV infusion and dilution administration within the hospital by enquiring with the nurses. The total number of nurses included in the study was 75. A standardized dilution pamphlet of 40 commonly used drugs have been created and designed in the format of a table. In each row, there was information about appropriate preparation and administration of each commonly used drug in the hospital which had underwent peer review and had been circulated among the nurses in the hospital. With this standardized pamphlet we educate the nurses about the dilution and administration of IV drugs.

The clinical pharmacist asked the nurses to read and refer to it when they prepare and administer IV drugs. After 3 month of the introduction of dilution pamphlet the knowledge of the nursing staff was again assessed.

### STUDY DESIGN



### III. RESULTS AND DISCUSSION

Multiple concentrations of IV medications are most common practice in hospital care settings. IV route provides rapid action when compared with other drug delivery methods. (6) Errors involving IV medications long have been known to carry high risks of patient harm and death. Several factors contribute to the danger of IV medication errors, including the rapid onset of effects and narrow therapeutic indexes of infused drugs. Global error rates in preparation and administration of IV drugs have been reported 7% and 36% respectively by Taxis

et al., (8) The dilution itself can take different forms. Rationing by dilution refers to a situation where a service continues to be offered but its quality decline as cuts are made of staff members and equipments (9).

A total of 40 questionnaires were distributed to nurses working in tertiary care teaching hospital. The accepted number of respondents (n=75). Here we recorded the nurse's practice regarding the preparation and administration of IV drugs before and after the education process.

**Table1. Background of nurses (n=75)**

VARIABLE	n (%)
Age	
<25	42 (56%)
25-30	24 (32%)
>30	9 (12%)
Education	
Degree	50 (66.66%)
Diploma with post basic	17 (22.66%)
Diploma	8 (10.66%)
Position	
Head nurse	12 (16%)
Ward nurse	63 (84%)
Experience	
<2years	49 (65.33%)

2-5 years	20 (26.66%)
>5years	6 (8%)

Wards/ Units	
ICU/HDU	14 (18.66%)
General ward	52 (69.33%)
Post-operative	4 (5.33%)
Pre-operative	3 (4%)

In this study the knowledge level is not influenced by age group. The degree holders were found to have more knowledge in dilution of drugs. Head nurse is more familiar with dilution than ward nurse. The nurses who had greater than 5 years of experience tend to be accurate in dilution of drugs. The ICU nursing staffs are more

legitimately responding than ward nurse. From the table 1 the majority of the respondents (66.66%) were degree holders, 16% were head nurse and 84% were staff nurse. 65.33% had less than 2 years' experience while 8% had 5 years or more experience.

**Table 2. Response from nurses during Phase 2 (before nurse's education)**

STATEMENTS	n (%)
Correct dose	43 (57.33%)
Correct diluent	48 (64%)
Correct dilution	39 (52%)
Correct route of administration	61 (81.33%)
Correct time duration	59 (78.66%)

**Table 3. Response from nurses during Phase 4 (after nurse's education)**

STATEMENTS	n (%)
Correct dose	58 (77.33%)
Correct diluent	62 (82.66%)
Correct dilution	54 (72%)
Correct route of administration	70 (93.33%)
Correct time duration	66 (88%)

Checklist was prepared based on the practice of IV drug dilution and administration mentioned on the above table (Table 2 and Table 3). The knowledge of nurses in selecting the correct diluent in Phase 4 had improved to 82.66%. The correct response on dilution of drugs from nurses before phase 3 was found to be 52% which shows a tremendous increase in Phase 4 by about 72% .

A survey of 10 true/ false/optional statement was used to measure the knowledge bases of the nurses on administration of IV medications was listed in table 4 and 5. This is to evaluate the basic knowledge of nurses based on Injectable drugs.

**Table 4. Knowledge of nurses on IV medications before Phase 3**

SI. No	STATEMENT	TRUE\FALSE\OPTIONAL	CORRECT RESPONSE	INCORRECT RESPONSE	DON'T KNOW
1.	Medication administered intramuscularly act rapidly than if administered intravenously	False	51 (68%)	11 (14.66%)	13 (17.33%)
2.	Slow bolus IV injection means administration of intravenous medication in 1 minute	False	47 (62.66%)	8 (10.66%)	20 (26.66%)
3.	Colour code of High alert medication is blue	False	56 (74.66%)	11 (14.66%)	8 (10.66%)
4.	Test dose of a drug is 3ml	False	64 (85.33%)	5 (6.66%)	6 (8%)
5.	Missed dose can be administered as double dose	False	59 (78.66%)	7 (9.33%)	9 (12%)
6.	Amphotericin should only be diluted in dextrose 5%	True	41 (54.66%)	15 (20%)	19 (25.33%)
7.	Fentanyl should be given in ICU under observation	True	70 (93.33%)	0 (0%)	5 (6.66%)
8.	Tramadol must be administered with Ondansetron	Optional	68 (90.66%)	2 (2.66%)	5 (6.66%)
9.	Therapeutic drug monitoring should be done for phenytoin	True	38 (50.66%)	4 (5.33%)	33 (44%)
10.	Patient's arm hand and IV catheter should be inspected for phlebitis or extravasations during IV administration	True	74 (98.66%)	0 (0%)	1 (1.33%)
TOTAL			568 (75.73%)	63 (8.4%)	119 (15.86%)
MEAN			75.72	8.39	15.86

It was found that in Phase 2 respondents managed to obtain a high level of correct responses (>60% response) for most of the statements posted except for statement 6: Amphotericin should only

be diluted in dextrose 5% (54.66%) and statement 9: therapeutic drug monitoring should be done for phenytoin (50.66%).

**Table 5. Knowledge of nurses on IV medications after Phase 3**

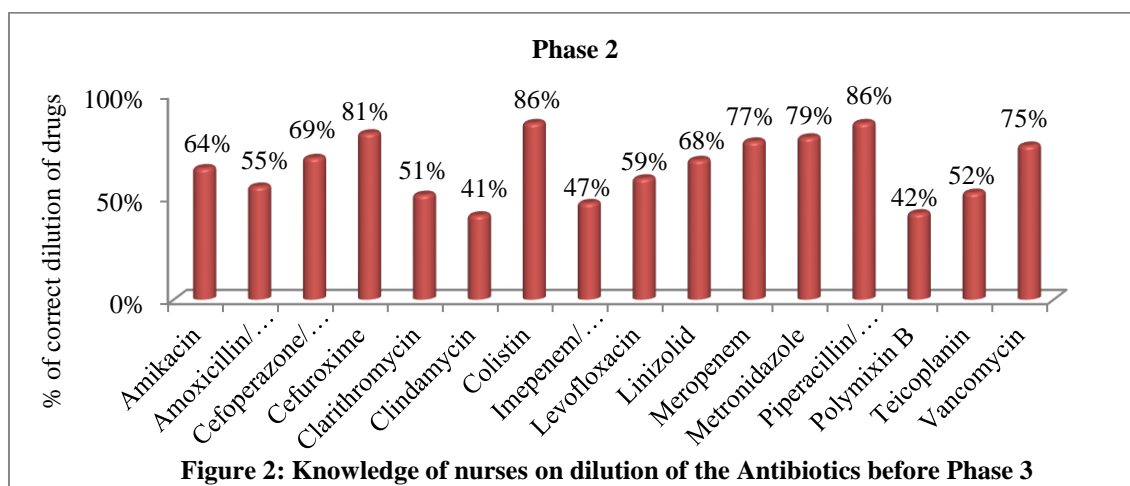
SI. No	STATEMENT	TRUE\FALSE	CORRECT RESPONSE	INCORRECT RESPONSE	DON'T KNOW
1.	Medication administered intramuscularly act rapidly than if administered intravenously	False	69 (92%)	1 (1.33%)	5 (6.66%)
2.	Slow bolus IV injection means administration of	False	62 (82.66%)	6 (8%)	7 (9.33%)

	intravenous medication in 1 minute				
3.	Colour code of High alert medication is blue	False	65 (86.66%)	7 (9.33%)	3 (4%)
4.	Test dose of a drug is 3ml	False	72 (96%)	2 (2.66%)	1 (1.33%)
5.	Missed dose can be administered as double dose	False	68 (90.66%)	3 (4%)	4 (5.33%)
6.	Amphotericin should only be diluted in dextrose 5%	True	58 (77.33%)	11 (14.66%)	7 (9.33%)
7.	Fentanyl should be given in ICU under observation	True	74 (98.66%)	0 (0%)	1 (1.33%)
8.	Tramadol must be administered with Ondansetron	True	71 (94.66%)	3 (4%)	1 (1.33%)
9.	Therapeutic drug monitoring should be done for phenytoin	True	49 (65.33%)	15 (20%)	11 (14.66%)
10.	Patient's armhand and IV catheter should be inspected for phlebitis or extravasations during IV administration	True	75 (100%)	0 (0%)	0 (0%)
TOTAL			663 (88.4%)	48 (6.4%)	40 (5.33%)
Mean			88.39	6.39	5.33

In Phase 4, the respondents managed to obtain a high level of correct responses (>60% response) for all the statements posted. The mean differences of the correct response before and after Phase 3 had increased from 75.72 to 88.39 respectively, that is by a difference of 12.67. The mean of incorrect and don't know responses before

and after Phase 3 had reduced by a difference of 2 and 10.53.

A checklist of 40 commonly used IV drugs was prepared and the knowledge of nurses had been assessed before and after Phase 3. Out of the 40 drugs, 16 were Antibiotics and the other 24 IV drugs are commonly used in this hospital.



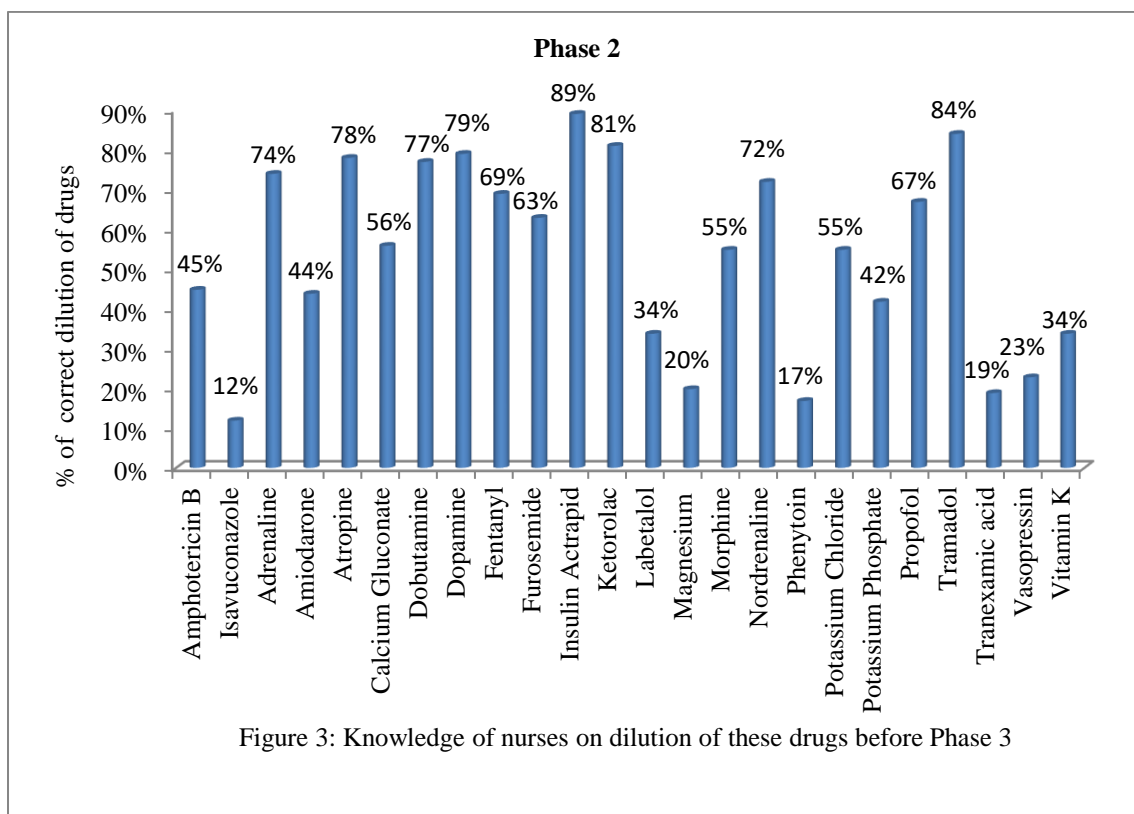


Figure 3: Knowledge of nurses on dilution of these drugs before Phase 3

In Phase 2 (before nurse's education) the knowledge of nurses about the dilution of antibiotics and other commonly used drugs was listed in figure 2 and 3 respectively. One of the possible factor for the lower percentage (<30%) for

some of the drugs like Isavuconazole, Magnesium, Phenytoin, Tranexamic acid and Vasopressin since these drugs are not frequently used in the hospitals as its major trauma care center

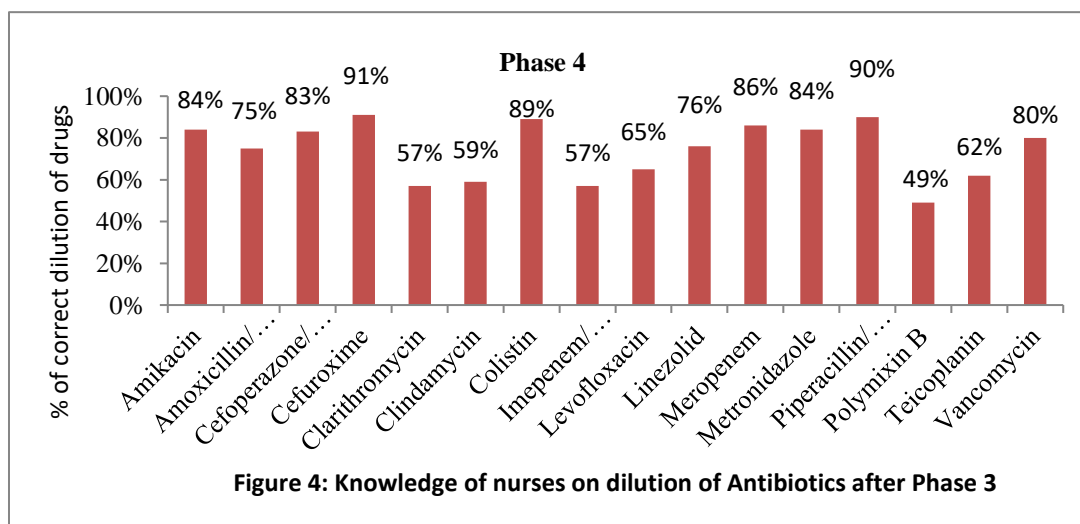


Figure 4: Knowledge of nurses on dilution of Antibiotics after Phase 3



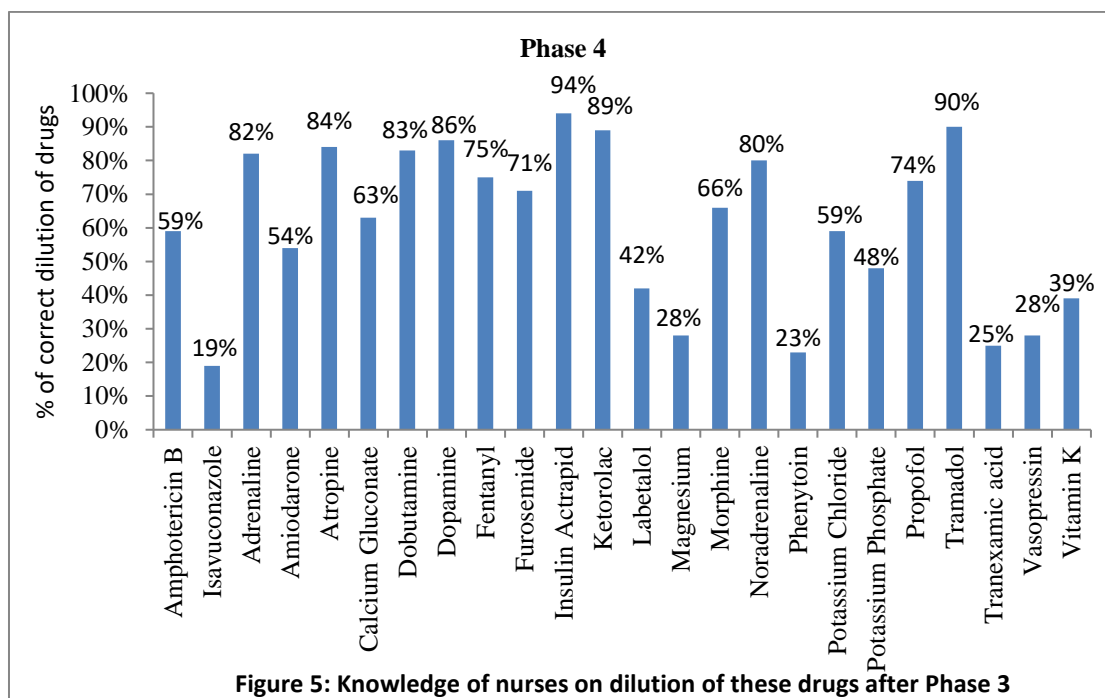


Figure 5: Knowledge of nurses on dilution of these drugs after Phase 3

In Phase 4 (after nurse’s education) the knowledge of nurses about the dilution of antibiotics and other commonly used drugs was listed in figure 4 and 5 respectively. When comparing the Phase 2 and Phase 4 it was found that the nurse’s education had an impact on improving the proper drug dilution and administration.

Finding of this study showed that nurses from the selected ward had an average level of knowledge in preparation and administration of IV medications. The knowledge level of the nurses in this study was influenced by the experience, working department and working position. It seems that several factors contribute in occurrence of these types of errors. Increased work load as measured by a low nurse to patient ratio is a risk factor for adverse events. Different diluents for a single drug cause uncertainty about the exact diluent selection and preparation. A study shows that nurses consider heavy work as a contributing factor in 37% of medication errors(10). Another factor that may be responsible in occurrence of errors is the knowledge deficiency of nurses regarding IV preparation and administration.

For future research this study of similar nature can be done in other hospitals. Qualitative research could be conducted on this so that the preparation of the nurse on the knowledge-practice gaps could be explored in-depth. It is also

recommended that the nursing students and new graduates who enter the practice setting take responsibilities as adult learners. They should have the interest to learn the things of their own to improve the knowledge and confidence. It is also necessary to revise dilution pamphlet every year.

#### LIMITATION

The heavy work load of nurses creates a barrier for proper communication.

The day and night shift of nurses makes them unavailable and this causes the long study period.

The diluent preference varied according to Doctor’s choice which makes hesitancy for nurses.

#### IV. CONCLUSION

Building a better educated workforce with the cognitive capability and know how to make effective, evidence based decisions delivers better health outcome for patient, families and population. The purpose of the study was to investigate if nurses have adequate knowledge and skill in drug dilution and administration. Nurse’s education by using informative pamphlets regarding the correct preparation and administration of IV drugs reduces the number of errors. All of the information relating to the methods of preparation and administration have been gathered and clarified in order to facilitate and secure the work of the teams of care and thus enable optimal administration of intravenous medications.



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