



An Audit on Intravenous Drug Preparation and Administration in Various Departments of a Tertiary Care Hospital

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Authors' contributions

This work was carried out in collaboration between all authors. Author RS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors SAS and MM managed the analyses of the study. Author MSA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Background: Intravenous administrations have a high incidence of errors but there is limited evidence of associated factors or error severity.

Objective: To evaluate and categorise the attentiveness and negligence of nursing staff during the administration of intravenous drugs to the patients in order to reduce the medication errors.

Methodology: This was a prospective, descriptive audit done in a hospital setting where 19 intravenous drugs were taken into consideration and their dilution parameters like the name and volume of diluents used were collected in a data collection form by verbally interviewing the nurse in-charge of preparing and administering their dilutions to patients admitted in eight different wards of the hospital. The results were categorised into 6 categories and compared to the standard dilution parameters.

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Results: Emergency was the only location where nurses reported that they were aware of all the dilutions involved in the study. Nurses from wards were not aware of many dilutions while very few drugs were out of nurses knowledge in ICUs. Majority of drugs were administered in a proper way i.e. appropriate volume and diluent type as well. Diluents and their volumes were appropriately (category I) administered to patients in ICU's when compared to general wards.

Conclusion: There is a need to formulate a standard dilution protocol and training programmes to acknowledge the staff regarding volume and proper diluents to minimise the haphazard dilution techniques and medication errors in the hospital.

Keywords: Appropriateness; dilutions; intravenous administration; medication errors.

1. INTRODUCTION

National Coordinating Council for Medical Error Reporting and Prevention (NCC MERP) defines "A medication error is any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer. Such events may be related to professional practice, health care products, procedures, and systems, including prescribing, order communication, product labelling, packaging, and nomenclature, compounding, dispensing, distribution, administration, education, monitoring, and use" [1].

Infusion medications are associated with high risk of harm. Once injected, reversal is almost impossible unless an antidote exists [2]. Infusion therapy through IV access is a therapeutic option used in the treatment of many hospitalized patients [3]. A study has reported that there is a probability of 19 to 27% of administration errors in hospitals [4]. Medication errors are represented to be largest single cause of deaths with a mortality of more than 7000 cases annually [5]. The use of medications can be a benefit for patients only if the principles of their safe use are followed by both health care professionals and patients. Errors can occur in any phase of drug management: prescription, preparation, dispensing, or administration of the drug. There have been reports of deaths and harm following medication errors such as wrong drug, dose, diluents, and cross contamination with intravenous therapy [6].

To Err Is Human [7], the report from the National Academy of Sciences, Institute of Medicine (2000), estimated that as many as 98,000 people die every year in the US because of mistakes committed by medical professionals in hospitals.

1.1 Pharmacist role in Intravenous Administration

The mission of the profession of pharmacy is to improve public health through ensuring safe, effective, and appropriate use of medications [8]. Clinical Pharmacist can play a significant role in nurse training as an effective method to reduce the rate of errors in the hospital. One obvious solution to aid in the process of drug related problems (DRP's) could be considering pharmacy services in IV product preparation by implementing protocol prepared by Clinical Pharmacist and establishment of reporting error systems [9]. Pharmacist role to provide expert advice on compatibility and stability for the use of multiple drugs if required for IV administration, update staff on new clinical practice guidelines and help to interpret guidelines as they apply to patients with advanced illness. Thus, permanent supervision and involvement of Clinical Pharmacist is important [10].

This study is carried out in order to reduce the medication errors by evaluating and categorising the attentiveness and negligence of nursing staff during administration of intravenous drugs to the patients.

2. METHODOLOGY

2.1 Inclusion Criteria

In-patient departments like intensive care units (ICUs), general wards (GW) and Emergency unit of the hospital were taken into consideration.

2.2 Exclusion Criteria

The Dialysis unit was excluded considering it to be an out-patient unit and there was limited usage of the intravenous dilutions.

The study was performed in various departments of a tertiary care hospital that include Intensive care units, General wards and Emergency unit. A list of 19 commonly administered drugs through intravenous route was formulated on the basis of a pilot study which was done prior to the main study in the Aster Prime Hospital located at Hyderabad, India. The pilot study was done by taking the sample size of 3 nurses of the general wards. The main study consist a total of eight different wards were present excluding dialysis unit where 8 nurses were interviewed and the data was collected within the hospital. Nurse in charge was interviewed and information related to preparation and administration of drugs was collected. The eight locations where broadly put into three departments. Intensive care units such as Cardio-thoracic intensive care unit (CTICU), Cardiac intensive care unit (CICU) and Medical intensive care unit (MICU) were clubbed under the department 'ICU's'. Similarly, general ward 1, 2, 3 and 4 were clubbed under 'Wards' and 'Emergency unit' was taken as the third department. Data collection form was designed with components such as name of the diluents, its volume of drug administration. The parameters taken into account were categorised as shown in Table 1. The commonly used drugs in the hospital were found to be Amikacin, Amoxicillin/ Clavulanic Acid, Cefpirome, Ceftriaxone, Diclofenac, Diltiazem, Furosemide, Mannitol, Meropenem, Metronidazole, Multivitamin, Ofloxacin, Ondansetron, Pantoprazole, Paracetamol, Piperacillin/ Tazobactam, Torsemide and Tramadol.

Table 1. Categories assigned for various dilution processes observed

Category I	Appropriate diluents and their volume
Category II	Appropriate diluents but inappropriate volume
Category III	Appropriate diluents but volume more than recommended (acceptable)
Category IV	Incorrect diluents but proper volume
Category V	Premixed dilutions used
Category VI	Unawareness of the diluents or dilution technique

2.3 Statistical Analysis

Collected data were entered in the Microsoft excel worksheet (2010) and analysed with the

standard [11] as given in Table 2 which was obtained from Micromedex to compare with the test data

3. RESULTS

Amikacin, Mannitol and Paracetamol were reported to be administered directly without dilution in all the locations with an exception of GW-3 where nurse was unaware of Amikacin dilution.

Combination of Amoxicillin and Clavulanic Acid was administered with 100 ml of normal saline in six locations where as it was diluted in just 10 ml of normal saline in CICU and CTICU. Dilution approach used for Cefpirome was almost similar to that of Amoxicillin and Clavulanic Acid combination with a difference in GW 4 where it was administered directly.

While Ceftriaxone and Pantoprazole were administered with 10 ml of normal saline in all the eight locations of the hospital, Metronidazole and combination of Piperacillin + Tazobactam were administered with 100 ml of normal saline in all the locations. Diclofenac and Tramadol were also administered in the similar manner in seven of the eight locations while in CICU these drugs were directly administered.

Furosemide and Ondansetron were administered without diluent in all locations except CTICU where 10 ml of normal saline was used. Nurse from GW 3 was not aware of dilutions for Diltiazem, Meropenem and Ofloxacin. Similar results were obtained from GW1 and GW2 but they were diluting Meropenem in 100 ml of normal saline.

Ofloxacin was reported to be administered directly in half of the locations while the rest of the locations were not aware of the dilution. Diltiazem was administered with either 10 ml or 45 ml of normal saline in ICUs and emergency. However, nurses from general wards were not aware of the dilution except for GW 4 where it was administered directly.

Multivitamin was administered in either 100 ml or 500 ml of normal saline in all locations included in the study. Meropenem was administered with 100 ml of normal saline while Torsemide was administered directly in majority of the locations as shown in Table 2.

Table 2. Comparison of standard dilutions with dilutions observed in hospital

Drug name dose	Std	CICU	CTICU	MICU	GW-1	GW-2	GW-3	GW-4	Emergency
Amikacin 500 mg	100 ml NS	D	D	D	D	D	Don't Know	D	D
Amoxicillin/ Clavulanic Acid 1.2 gm	100 ml NS	10ml NS	10ml NS	100ml NS	100ml NS	100ml NS	100ml NS	100ml NS	100 ml NS
Cefpirome 1 gm	50 ml NS	10ml NS	10ml NS	100 ml NS	100ml NS	100ml NS	100ml NS	D	100 ml NS
Ceftriaxone 1 gm	50 ml NS	10 ml NS	10ml NS	10ml NS	10ml NS	10ml NS	10ml NS	10ml NS	10 ml NS
Diclofenac 75 mg	100 ml NS	D	100ml NS	100ml NS	100ml NS	100ml NS	100ml NS	100ml NS	100 ml NS
Diltiazem 25 mg	20 ml NS	45ml NS	45ml NS	10ml NS	Don't know	Don't know	Don't know	D	45ml NS
Furosemide 20 mg	10 ml NS	D	10ml NS	D	D	D	D	D	D
Mannitol	250 ml to 1 L PMW	D	D	D	D	D	D	D	D
Meropenem 1gm	50 ml NS	100ml NS	100 ml NS	100 ml NS	100 ml NS	100 ml NS	Don't know	100 ml NS	D
Metronidazole 500 mg	100ml NS	100 ml NS	100 ml NS	100 ml NS	100 ml NS	100 ml NS	100 ml NS	100 ml NS	100 ml NS
Multi vitamin 5 ml	500 ml to 1 L NS	500ml NS	100/500 ml NS	100 ml NS	500ml NS	100/500ml NS	100/500 ml NS	100 ml NS	100 ml NS
Ofloxacin 200 mg	100 ml PMW	D	D	Don't know	Don't know	Don't know	Don't know	D	D
Ondansetron 4 mg	50 ml NS	D	10ml NS	D	D	D	D	D	D
Pantoprazole	100 ml	10 ml	10 ml	10 ml	10 ml	10 ml	10 ml	10 ml	10 ml

Drug name dose	Std	CICU	CTICU	MICU	GW-1	GW-2	GW-3	GW-4	Emergency
40 mg	NS	NS	NS	NS	NS	NS	NS	Water	NS
Paracetamol	100 ml	D	D	D	D	D	D	D	D
1 gm	PMW								
Piperacillin/ Tazobactam	100 ml	100 ml	100 ml	100 ml	100 ml	100 ml	100 ml	100 ml	100 ml
4.5 gm	NS	NS	NS	NS	NS	NS	NS	NS	NS
Torsemide	10 ml	D	10 ml	100 ml	D	D	D	D	D
10 mg	D5W		NS	NS					
Tramadol	100 ml	D	100 ml	100 ml	100 ml	100 ml	100 ml	100 ml	100 ml
50 mg	NS		NS	NS	NS	NS	NS	NS	NS

** Std- Standard dilutions, NS- Normal Saline, PMW- Premixed Water, D5W- Dextrose 5% water, D- Direct, GW- General Wards (1,2,3,4)

Majority of drugs were administrated in a proper way i.e. appropriate volume as well as diluent type (category I). Among these, general wards were slightly better than the emergency ward and ICUs. Most of the drugs administrated in ICUs were associated with proper diluents type but improper volume of diluents (category II). Emergency department was reported to be administrating drugs with proper diluents but volume more than recommended (category III). ICUs were the only locations where few drugs were diluted with inappropriate diluents but correct volume (category IV).

Emergency was the only location where nurses reported that they are aware of all the dilutions involved in the study. Nurses from wards were not aware of many dilutions while very few drugs were out of nurses knowledge in ICUs as shown in Fig. 1.

Detailed diagrammatic representation of individual locations and their categories can be seen in Fig. 2.

Percentage of total drug dilutions at all the eight location is shown in Fig. 3

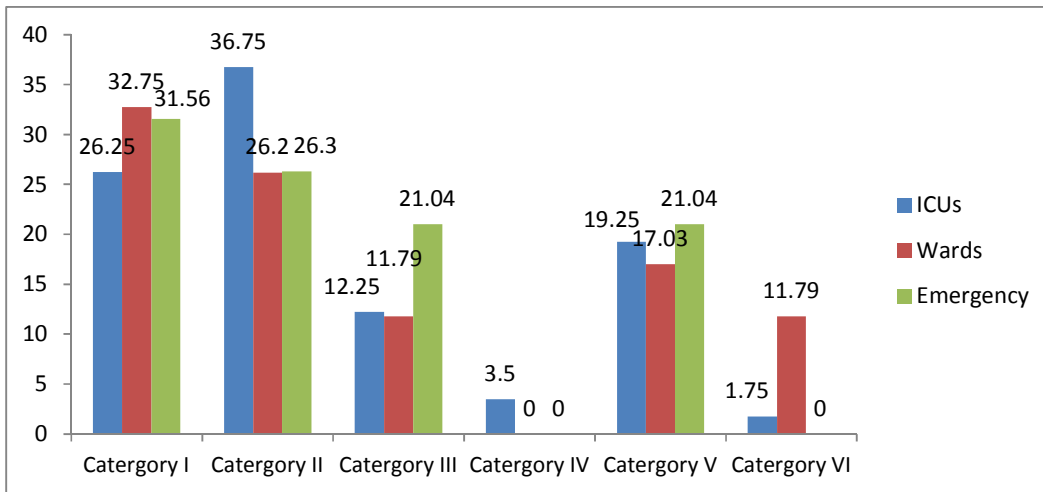


Fig. 1. Percentage distribution of various categories among locations

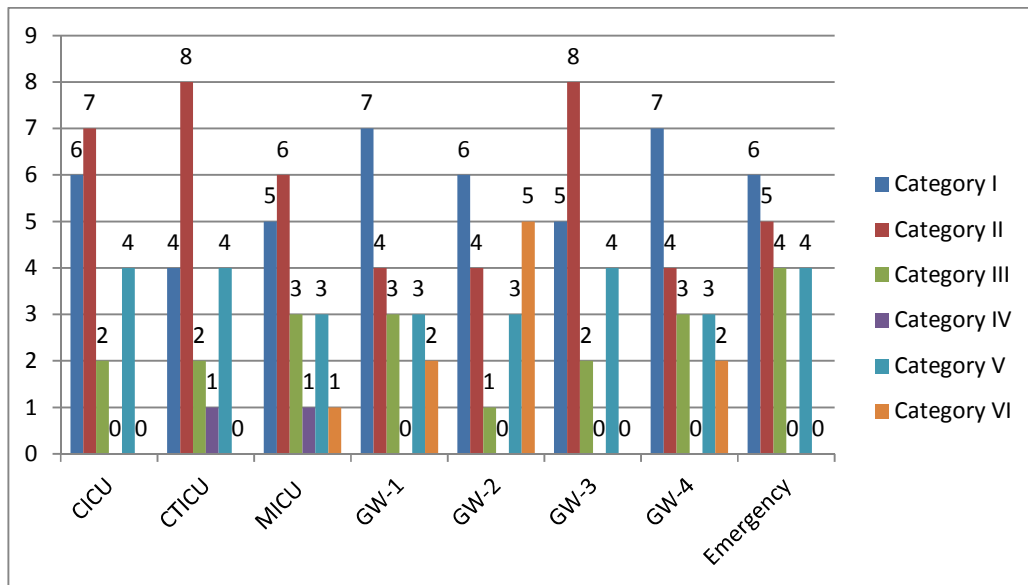


Fig. 2. Percentage distribution of categories among individual departments

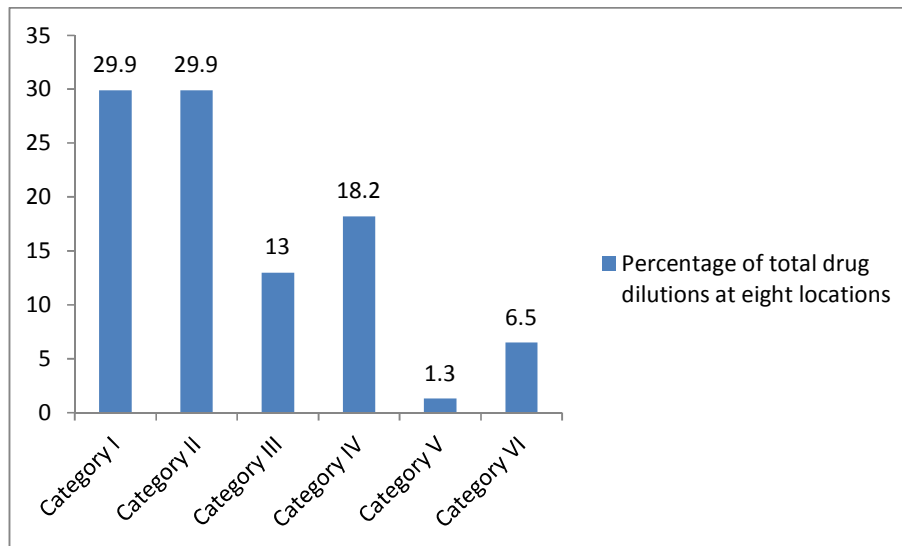


Fig. 3. Percentage of total drug dilutions at eight locations

4. DISCUSSION

Metronidazole and combination of Piperacillin + Tazobactam were administered as per the recommended guidelines in all locations of the hospital. Diclofenac and Tramadol were also administered according to the recommended guidelines in all locations except CICU where no diluent was used.

Mannitol and Paracetamol were available in premixed dosage form and therefore it was administered directly at all locations. Ofloxacin was also available in premixed form but nurses from general wards were not aware about the administration. Amikacin was administered directly in this hospital, but it is supposed to be administered with 100 ml of diluent.

Combination of Amoxicillin and Clavulanic Acid was administered properly in six locations whereas CICU and CTICU followed dilution with 10 ml of normal saline instead of recommended volume of 100 ml. Cefpirome is recommended to be diluted with 50 ml of normal saline. However, five out of eight locations followed dilution of 100 ml which is double the recommended diluent. CICU and CTICU used 10 ml of diluent whereas GW 4 used no diluent.

Ceftriaxone and Pantoprazole were administered in less than recommended volume of diluent. While the former was administered in 10 ml of diluent instead of 50 ml, the latter was diluted in 10 ml instead of recommended volume of 100

ml. Further, Pantoprazole was administered with sterile water as diluent instead of normal saline in GW4.

Furosemide was administered directly instead of 10 ml of diluent in all locations except CTICU where proper diluent and volume was used.

Administration of Ondansetron was improper in all locations. It is recommended to be given with 50 ml of diluent but all locations followed direct administration except CICU where 10 ml of diluent was used.

Diltiazem was diluted with more than recommended diluent in Emergency and ICUs except MICU where lower than recommended diluent was used. Most of the general ward nurses were unaware of the dilution with an exception to GW4 where no diluent was used. Meropenem was administered in more than recommended diluent at all locations but emergency where no diluent was used and nurse from one of the four general wards were unaware of the dilution. CICU and GW1 followed administration of Multivitamin in recommended way but rest of the locations used lower than the recommended volume of diluent.

CTICU was the only location that followed proper diluent volume for administration of Torsemide. MICU followed 10 times higher than recommended volume of diluent whereas rest of the locations used no diluent. Despite using recommended volume of diluent, CTICU also

failed in adhering to the actual policy of Torsemide dilution as they used Normal Saline as diluent instead of recommended 5% Dextrose.

5. CONCLUSION

There is a necessity for awareness among nurses in general ward regarding the appropriate diluents and volume. It was alarming to witness more errors in ICU's than general wards as the former were considered as one of the vigilant locations of hospital. Nursing staff does not give much importance on compatibility of diluents with drugs and they prefer NS in nearly all drugs even if it is incompatible. Despite efforts from patient safety departments, there is not much improvement in the safe intravenous practice by the nursing staff.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. NCCMERP, National Coordinating Council for Medication Error Reporting and Prevention, About Medication Errors: What is a Medication Error? Available:<http://www.nccmerp.org/about-medication-errors> (Accessed April 13, 2017)
2. Cousins DH, Upton DR. Medication error 79: How to prevent IV medicine errors. Pharm Pract. 1997;7:3101.
3. Summa Sorgini C, Fernandes V, Lubchansky S, Mehta S, Hallett D, Bailie T, et al. Errors associated with IV infusions in critical care. Can J Hosp Pharm. 2012;65:1926.
4. Westbrook JI, Rob MI, Woods A, Parry D. Errors in the administration of intravenous medications in hospital and the role of correct procedures and nurse experience. BMJ Qual Saf. 2011;20:1027-34.
5. Ong WM, Subasyini S. Medication errors in intravenous drug preparation and administration. Med J Malaysia. 2013; 68(1):52-7.
6. Cohen MR. Medication errors. 2nd ed. Washington, Wash, American Pharmacists Association; 2007.
7. Kohn LT, Corrigan JM, Donaldson MS, editors. Washington: National Academy Press. To err is human: Building a safer health system; 2000.
8. Council on credentialing in pharmacy, Albanese NP, Rouse MJ. Scope of contemporary pharmacy practice: Roles, responsibilities, and functions of pharmacists and pharmacy technicians. J Am Pharm Assoc (2003). 2010;50:e35-69.
9. Majid AK. The roles of clinical pharmacy in reducing medication errors. Int Res J Pharm. 2012;3:7683.
10. Abbasinazari M, Zareh Toranposhti S, Hassani A, Sistanizad M, Azizian H, Panahi Y. The effect of information provision on reduction of errors in intravenous drug preparation and administration by nurses in ICU and surgical wards. Acta Med Iran. 2012;50:7717.
11. Micromedex® Healthcare Series [Internet database]. Greenwood Village, Colo: Thomson Micromedex. Available:<https://www.micromedexsolution.com/micromedex2/librarian/ssl/true>

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