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# A Clinical Study on Audit of Intravenous Drug Administration in Various Departments of a Tertiary Care Hospital

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**ABSTRACT**

**Background:** Life threatening errors have been associated with intravenous (IV) medications but there is limited evidence of error severity. The objective of this study was to investigate the cause of errors which is the first step towards error prevention and to evaluate the practice of parenteral medication preparation, administration among nurses in various departments of a tertiary teaching hospital in India. **Methods:** The audit was performed at various departments of hospital. The pilot study was done by taking 21 commonly administered drugs through intravenous route and nurse incharges of all the departments were invited to participate and were informed about the objective of the study as they prepared and administered medications. Data was collected from each location and documented in to a structured case record form. **Results:** Majority of drugs administered in all departments were appropriate with their diluents and their volume (Category-I). Although some drugs like Amoxicillin/Clavulanic acid, Pantoprazole and Azithromycin, Meropenem which are diluted in less volume and majority of them were from ACU, ICU and GW-2 (Category II). General wards were reported to be administering drugs with volume more than recommended (Category III). Diclofenac and Torsemide in general wards were diluted with incorrect diluents (Category-IV). The drugs like Mannitol, Ofloxacin and Paracetamol are given as premixed forms (Category-V). GW-5 was the only location where nurses were unaware of diluent/ dilution procedure for the drugs such as Ofloxacin and Vancomycin (Category-VI). ICU was the only location where nurses were aware of appropriate dilutions for large number of drugs. **Conclusion:** Intravenous drug errors are frequent hence raising nurses awareness of the high intravenous administration errors is also likely to be helpful in reinforcing compliance with correct procedures. It is recommended that checklist should be introduced inwards to encourage monitoring dilutions and administration rate of I.V infusions.

## INTRODUCTION:

Medication errors are serious problems in healthcare and can be a source of significant morbidity and mortality in healthcare settings.[1] The American society of health system pharmacist (ASHP) definition of medication errors includes prescribing, dispensing, administration and patient compliance errors. An IV dose is defined as administration of a drug directly into the vein via injection or infusion and included preparation of the drug dose. [2] IV therapy usually needs to be prepared immediately before administration. These may involve dissolving of powder, dilution, or transfer of injection fluid from the original vial or ampoule into a container (a syringe or an infusion bag). These process present multiple opportunities for errors. An IV medication error is defined as any deviation of preparation or administration of an IV dose from the original prescription or any act in the preparation or administration of a medicine from doctor prescription, which deviate from the manufacturer's instructions or the hospital drug policy.[3]

Intravenous therapy is a complex, potentially dangerous and error prone, thus the need for strategies to reduce the risk and complications. [4] Infusion therapy through IV access is a therapeutic option used in the treatment of many hospitalized patients. [5]

Intravenous medications pose particular risks because of their greater complexity and multiple steps required in their preparation, administration and monitoring. Relatively few studies have specifically focused on intravenous medication administration errors, but those available confirm their high error rates (49% 48% 81%), with the exception of one Australian study which reported an intravenous error rate of 18% of continuous infusion among surgical patient.[6]

The preparation and administration of intravenous drugs is a series of complicated technical skills. The consequences of medication preparation and administration errors can be anything from relatively harmless to lethal.[7] In IV therapy, fast dilution of injected solutions in bloodstream allows for a greater tolerance of the drug product component with blood component which enhance the pharmacological effect of the drug to patient or its used when barrier to oral drug administration exist in hospital settings. The choice of IV drug administration has risk which leads to incompatibilities between the administered drugs Adverse drug events are most common type of health care errors.[8]

The study of Taxis and Barber described the different stages in which error occurs and also the clinical importance of these errors. There are 2 types of errors reported *i.e.* Preparation errors and administration error of IV drug doses. Preparation error occurs in 7%, Administration error occurs in 36% and both type of errors were found in 6% of all cases.

Examples of errors observed in practice and described under the study are:

- Quick administration of bolus dose(Reduces contact time)
- No evaluation of expiry date of drug.
- No double checking the prescribed drug, doses and corresponding patient by colleague.
- Negligence of hygiene regulations. [9-11]

**Drug-therapy problems in intravenous administration**

Drug -therapy (related) problems can be defined as an event or circumstance involving drug treatment that actually or potentially interferes with the patient experiencing an optimum outcome of medical care.[12] It may lead to substantial morbidity and mortality as well as increase the health care expenditure, thus affecting both patients and society.[13]

**Complications of intravenous therapy**

Intravenous therapy presents a potential risk to patient safety with associated risks varying from minor complications to death. As more number of patients are becoming acutely ill, the numbers of patient requiring IV therapies are increasing. Maintaining the patient vascular access throughout treatment is difficult because a number of complications including phlebitis, infiltration, extravasations, and infections may occur. [14]Complication increase hospital stays duration of therapy, and can also put the patients at risk of other medical problems. [15]

**Pharmacist role in intravenous administration**

The mission of profession of pharmacy is to improve public health through ensuring safe, effective, and appropriate use of medications.[16] 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 DRPs could be considering pharmacy services in IV

product preparation by implementing protocol prepared by clinical pharmacist and establishment of reporting error systems. [17]

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. [18]

The objective of this study was to investigate the cause of errors which is the first step towards error prevention and to evaluate the practice of parenteral medication preparation, administration among nurses in various departments of a tertiary teaching hospital in India.

**METHODOLOGY:**

The study was undertaken at private corporate hospital, India. The audit was performed at various departments of hospital. The study centers were General wards (GW-1, GW-2, GW-3 GW-4, and GW-5) and Intensive care units such as Acute medical care unit (AMCU), Acute care unit (ACU), Intensive care unit (ICU), Intensive cardiac care unit (ICCU), and Cardio-thoracic intensive care unit (CTICU). Patients from pediatric department and oncology department were excluded from the study. The selection of centers was based on willingness to participate without any attempt at selecting a representative sample. The pilot study was done by taking 21 commonly administered drugs through intravenous route and nurse incharges of all the departments were invited to participate and were informed about the objective of the study as they prepared and administered medications. Data was collected from each location and documented in to a structured case record form. The most commonly administered drugs via intravenous route were Amoxicillin or Clavulanic acid, Azithromycin, Amikacin, Cefpirome, Ceftriaxone, Dexamethasone, Diclofenac, Furosemide, Mannitol, Meropenem, Metronidazole, Multivitamins (MVI), Ofloxacin, Ondansetron, Potassium chloride, Pantoprazole, Piperacillin/Tazobactum, Paracetamol, Tramadol, Torsemide and vancomycin. These drugs administered intravenously were analyzed with the standard diluent and its volume obtained from Micromedex as categorized in Table 2. Confidentiality of the entire patient data was maintained. Furthermore, these drugs were simplified in to 6 categories depending on their diluents and volumes as shown in Table 1.

| Table No. 1: Categories assigned for various dilution processes observed | |
|---|---|
| Category I | Appropriate diluents and their volume |
| Category II | Appropriate diluents but volume less than recommended |
| Category III | Appropriate diluents but volume more than recommended |
| Category IV | Incorrect diluents |
| Category V | Premixed dilutions used |
| Category VI | Unawareness of the diluents or dilution technique |

**RESULTS:**

Majority of drugs administered in all departments were appropriate with their diluents and their volume (Category-I). Although some drugs like Amoxicillin/Clavulanic acid, Pantoprazole and Azithromycin, Meropenem which are diluted in less volume and majority of them were from ACU, ICU and GW-2 (Category II). General wards were reported to be administering drugs with volume more than recommended (Category III). Diclofenac and Torsemide in general wards were diluted with incorrect diluents (Category-IV). The drugs like Mannitol, Ofloxacin and Paracetamol are given as premixed forms (Category-V). GW-5 were the only location were nurses were unaware of diluent/dilution procedure for the drugs such as Ofloxacin and Vancomycin (Category-VI).ICU was the only location were nurses were aware of appropriate dilutions for large number of drugs.

Based on our observation and results, IV drug administration standard was prepared in order to enhance the rational use of IV medications and patient safety (Table-2).

A detailed diagrammatic representation based on the percentage distribution of categories among various departments of hospital is shown in Fig.1.

Based on the percentage distribution of total drug dilutions in each category is shown in Fig.2.

**Table No. 2: Comparison of standard dilutions with dilutions in various departments of Hospital.**

| S. NO | Drug Name and Dose | Standard Dilutions | AMCU | ACU | ICU | ICCU | CTICU | General wards | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | GW-1 | GW-2 | GW-3 | GW-4 | Gw-5 |
| 1 | Amoxicillin/Clavulanic acid 1.2gm | 100ml NS | 30ml NS | 50ml NS | 30ml NS | 30ml NS | 50ml NS | 10ml NS | 50ml NS | 100 ml NS | 100 ml NS | 100 ml NS |
| 2 | Azithromycin 500mg | 250ml D5W, NS | 500ml NS | 500ml NS | 500 ml NS | 500ml NS | 500ml NS | 50ml NS | 500 ml NS | 500 ml NS | 500 ml NS | 500 ml NS |
| 3 | Amikacin 500mg | 100ml NS | 100ml NS | 50ml NS | D | 100ml NS | D | D | 100 ml NS | 100 ml NS | D | D |
| 4 | Cefpirome 1gm | 50ml NS | 50ml NS | 50ml NS | 50ml NS | 30ml NS | 50ml NS | 10ml NS | 30ml NS | 100 ml NS | 100 ml NS | 100 ml NS |
| 5 | Ceftriaxone 1gm | 50ml NS | 50ml NS | 50ml NS | 50ml NS | 50ml NS | 50ml NS | 10ml NS | 10ml NS | 10ml NS | 50ml NS | 50ml NS |
| 6 | Dexamethasone | 100ml NS | 100ml NS | 100ml NS | 100 ml NS | 100ml NS | 100ml NS | 10ml NS | 100 ml NS | 100 ml NS | 100 ml NS | 100 ml NS |
| 7 | Diclofenac 75mg | 100ml NS | D | 100ml NS | 100 ml NS | D | 100ml NS | D | 100 ml NS | 100 ml NS | 100 ml NS | D |
| 8 | Furosemide 20mg | 10ml NS | D | D | 10ml NS | D | D | D | D | D | D | 10ml NS |
| 9 | Mannitol | 250-1000ml PMW | D | D | D | D | D | D | D | D | D | D |
| 10 | Meropenem 1 gm | 50ml NS | 50ml NS | 100ml NS | 50ml NS | 100ml NS | 100ml NS | 10ml NS | 100 ml NS | 100 ml NS | 100 ml NS | 100 ml NS |
| 11 | Metronidazole 500mg | 100ml NS | 100ml NS | D | 100 ml NS | 100ml NS | 100ml NS | 10ml NS | 100 ml NS | 100 ml NS | 100 ml NS | 100 ml NS |
| 12 | MVI (Multi vitamin) 5ml | 500-1000ml NS | 500ml NS | 100ml NS | 100 ml NS | 500ml NS | 500ml NS | 100 ml NS | 500 ml NS | 500 ml NS | 500 ml NS | 100 ml NS |
| 13 | Ofloxacin 200mg | 100ml PMW | D | D | D | D | D | D | D | D | D | DK |
| 14 | Ondansetron 4mg | 50ml NS | D | D | 50ml NS | D | D | D | D | D | D | D |
| 15 | Potassium chloride | 500ml NS | 500ml NS | 500/1000ml NS | 500 ml NS | 500ml NS | 500ml NS | 500 ml NS | 500 ml NS | 500 ml NS | 500 ml NS | 500 ml NS |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **16** | Pantoprazole 40mg | 100ml NS | 10ml NS | 10ml NS | 10ml NS | 10ml NS | 5ml NS | 10ml NS | 10ml NS | 10ml NS | 10ml NS | 10ml NS |
| **17** | Piperacillin/Tazobactum 4.5gm | 100ml NS | 50/100 ml NS | 100ml NS | 30ml NS | 100ml NS | 100ml NS | 100 ml NS | 100 ml NS | 100 ml NS | 100 ml NS | 100 ml NS |
| **18** | Paracetamol | 100ml PMW | D | D | D | D | D | D | D | D | D | D |
| **19** | Tramadol 50mg | 100ml NS | 50ml NS | 100ml NS | 100 ml NS | 100ml NS | 100ml NS | 100 ml NS | 100 ml NS | 100 ml NS | 100 ml NS | 100 ml NS |
| **20** | Torsemide 10 mg | 10ml D5W | D | D | 30ml NS | D | D | D | D | D | D | D |
| **21** | Vancomycin 500mg | 100ml NS | 100ml NS | 100ml NS | 100 ml NS | 100ml NS | 100ml NS | 100 ml NS | 100 ml NS | 100 ml NS | 100 ml NS | DK |

**Note: NS- Normal Saline, PMW-Premixed water, D5W-Dextrose 5% Water, D-Direct, DK-Don't know

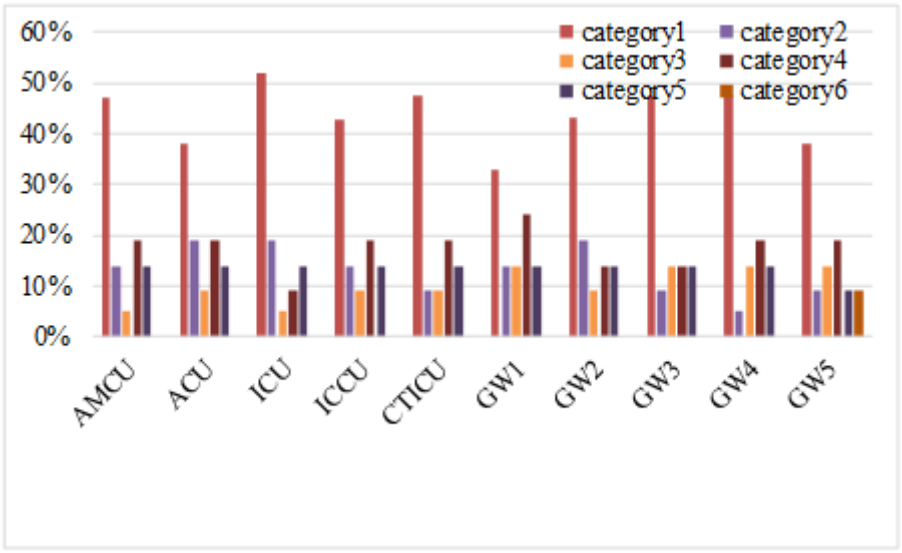


**Figure No. 1: Based on the percentage distribution of categories among various departments of hospital.**

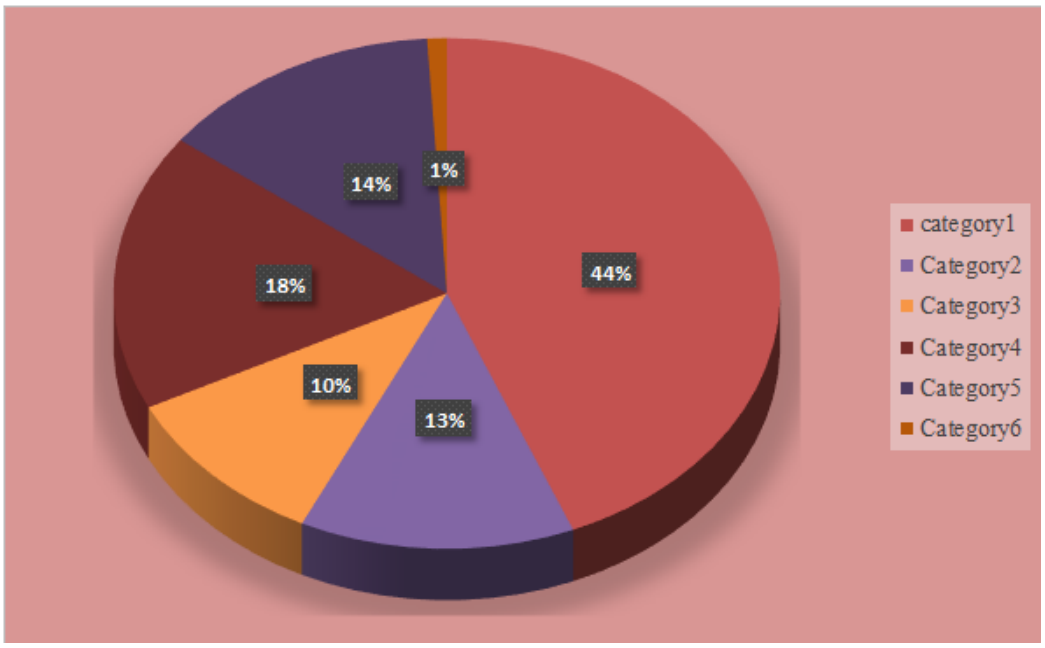


**Figure No. 2: Based on the percentage distribution of total drug dilutions in each category**

**DISCUSSION:**

Methods for detecting medication error include anonymous self-reports and direct observation method. The observation-based method employed in this study provides the most accurate mean of detecting medication error.[19] In a comparative study conducted in 2 Australian hospitals, about one third of drug administrations were detected to contain error using the observation method. [20]

In this study, overall, 44% of parenteral medications were prepared and administered correctly with appropriate diluents and their volume and 18% of the IV medications were administered incorrectly *i.e.* by direct administration without dilutions. When compared to other European studies, [21] it was observed that our study results indicated a smaller number of DRPs.

Dexamethasone and potassium chloride are the only drugs administered according to the standard dilutions in all the wards of the hospital. Torsemide and combination of Piperacillin and tazobactam were also administered according to the standards except in ICU where they were diluted in 30ml NS instead of 10ml D5W and 100ml NS respectively. Similarly, Metronidazole was administered properly in all the locations except in ACU where it was administered directly instead of administering with 100ml NS, Whereas Tramadol was given

with 50ml NS instead of 100ml NS in AMCU. The administration of vancomycin is appropriate in all the locations except in GW-5, where its administration was not known by the nurses.

Mannitol, Paracetamol are given directly in all the wards as they were available as premixed dosage forms. Though Ofloxacin was available as premixed dosage form, its administration was not known by the nurses of GW-5. Amikacin was correctly administered only in 4 locations (AMCU, ICCU, GW-2 and GW-3). In other locations it was either given directly (ICU, CTICU, GW-1, GW-4 and GW-5) or given with 50ml NS (ACU).

The combination of Amoxicillin and Clavulanic acid was administered with 100ml NS (GW-1,3,4&5) whereas it was diluted in just 30ml NS in AMCU, ICU and ICCU and only in 50ml NS in ACU, CTICU and GW-2.

Ceftriaxone and Cefpirome was administered in less than recommended volumes in all the general wards. ICU and GW-5 are the only locations where Furosemide was administered correctly with 10ml NS, while in other wards it was given directly. Similarly, AMCU and ICU were seen to be administering Meropenem correctly with 50ml NS, in other locations it was administered with 100ml NS. Diclofenac was given directly in AMCU, ICCU, GW-1 and in GW-5 instead of administering in 100ml NS.

All the locations in the hospital followed standard dilutions in administration of Multivitamin except in ACU, ICU, GW-1 and GW-5 where it was administered using volume less than the recommended. The administration of Azithromycin and Pantoprazole was altered in all the locations.

We found a significant relationship between failing to check a patient's identification and making an intravenous administration error. While failing this check does not cause a clinical error, we hypothesize that it is an indicator of a general failure to follow correct administration protocols, whether this is because the nurse is under stress, time pressures, or selects to not comply. This finding suggests that this variable could be used as a proxy measure for increased risk of clinical error, and interventions which reinforce compliance with administration protocols may be effective in reducing clinical errors. The poor compliance found with checking patients' identification (47.9%) suggests that this is a routine violation performed by a large proportion of nurses. [22]

We observed nurses generally do not practice double-checking during preparation/administration of medications in the GICU. Although healthcare professionals are advised to practice double checking during prescribing, dispensing, and administering medications[23,24,25,26], time pressure and lack of staff causes nonadherence in this good practice. [27]Lack of double-checking either by the same person or a second person has been found to cause medication errors. This is a routine violation performed by a large proportion of nurses. The risk is greater in high alert medications, such as potassium chloride, which are often used in the critical care setting. Implementing a double-checking system into the hospital's policy, especially for high alert medications, could provide an additional safeguard. Involving a medication expert, such as a pharmacist, to witness the drug administration process may also reduce medication error.

## CONCLUSION:

Intravenous drug errors are frequent hence raising nurses awareness of the high intravenous administration errors is also likely to be helpful in reinforcing compliance with correct procedures. It is recommended that checklist should be introduced inwards to encourage monitoring dilutions and administration rate of I.V infusions. Thus, permanent supervision and involvement of clinical pharmacist will improve the quality of preparation and administration of I.V medications and will also reduce the incidence of I.V error thereby improving the health care system.

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