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STUDY ON THE INCIDENCE OF INTRAVENOUS MEDICATION-ADMINISTRATION ERRORS AT A TERTIARY CARE TEACHING HOSPITAL IN SOUTH INDIA

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ABSTRACT

Back ground: *A Prospective, Interventional study conducted from Jan 2011- August 2011 at a 600-bedded Multispecialty Tertiary care Teaching Hospital in South India.* ***Objective:*** *To find the incidence and severity of Intravenous (I.V.) drug administration errors and study the impact of pharmacist's intervention in reducing medication errors.* ***Methods:*** *Details of each IV drug preparation and administration were recorded on standard data entry form. In interventional phase type and severity of medication errors identified and guidelines on IV drug administration prepared and circulated to physicians and nurses. Pre-interventional phase nurses were accompanied daily during ward rounds from (February to April) 2011. The impact of pharmacist's intervention on intravenous medication errors was studied in the post interventional phase from (June to August) 2011.* ***Results:*** *A total of 1649 I.V. drug doses prepared and administered out of which preparation errors consisted of 221 doses, 1428 doses of administration errors and 129 doses both type of errors. 1169 different types of errors scored were of moderate severity. Preparation errors of 48 doses were associated with wrong preparation technique and administration errors associated with 305 dose omission errors. Significant reduction in number of errors was observed on counselling the paramedical staff by clinical pharmacist on IV drug administration and preparation guidelines. The error/dose was found to be reduced from 0.34 dose/error to 0.23 dose/error.* ***Conclusion:*** *I.V. drug errors are frequent, hence educating nurses on proper preparation & administration of I.V. drugs by clinical pharmacist found to be effective in reducing the incidence of I.V. error which reinforces the pharmacists' role in improving the health care system.*

KEY WORDS

I.V. (Intravenous), intravenous medications, intravenous drug, medication errors, administration errors, error per dose.

INTRODUCTION

Medication errors are serious problems in health care and can be a source of significant morbidity and mortality in the health care settings [1]. Medication error is an episode associated with the use of medication that should be preventable through effective control systems. Pharmacists have had a long-standing interest in improving medication safety and to reduce medication errors. The American Society of Health system Pharmacists (ASHP) definition of medication errors includes prescribing, dispensing, administration and patient compliance errors. An IV dose is defined as an administration of a drug directly into the vein via injection or infusion and included preparation of the drug dose [2].

I.V. therapy usually needs to be prepared immediately before administration. This 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 processes present multiple opportunities for errors. An Intravenous (I.V.) 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's prescription, which deviated from the manufacturer's instructions or the hospital drug policy [2].

Investigating the causes of error is the first step towards error prevention which is classified as:

Active failures are unsafe acts committed by people who are in direct contact with the patient. They take a variety of forms: slips, lapses, and mistakes. Slips and lapses are skill-based behaviour errors, when a routine behaviour is misdirected or omitted. Mistakes are knowledge-based errors (perception, judgment, inference, and interpretation) and occur due to incorrect thought processes or analyses. Situational factors (fatigue, drugs, alcohol, stress, and multiple activities) can divert attention and increase the risk of active failures [3].

Latent conditions are resident risks within the system. They can affect the rate at which employees execute active failures and the risks associated with active failures.

Risk factors for I.V. medication errors [4]

1. Pumps programmed incorrectly
2. Intravenous bolus medicines required to be administered by hand in a syringe were frequently administered too quickly and this practice is associated with phlebitis and loss of cannula potency
3. Drug injected through wrong type of access, oral medication injected
4. Similar labeling
5. Stressful situation
6. Wrong drug taken from drug dispensing machine
7. Wrong amount of fluid aspirated from drug vial containing more drug than ordered
8. Obtained drug from drug dispensing machine in advance, then order was changed but nurse not aware
9. Mixed up hanging IV bags changing dose rate on wrong drug.

The rate of administration of an I.V. bolus medication is usually determined by the amount of medication that can be given each minute, which varies for different medications [5]. One of the recommendations to reduce medication errors and harm is to use the "five rights": the right patient, the right drug, the right dose, the right route, and the right time [6]. Most important, it is time to recognize that health care is a team activity. Although the physician is still the leader of the team, helpful input from clinical pharmacists, nurses, and other health care professionals can provide invaluable assistance and improve the quality of care for the patient**.** Even though the literature reports a number of studies on identifying I.V. medication errors in various hospitals abroad, the data available on such situation in India is limited. This prompted the necessity of conducting this study.

Objectives of the study

- To monitor all the I.V. medications containing prescriptions generated in the hospital for its appropriateness in all the possible ways.
- To find out the I.V. drug preparation and administration errors by evaluating the prescriptions.
- To assess the severity of the I.V. drug errors using a validated scale (in order to evaluate their potential clinical significance).
- To develop I.V. drug administration guidelines, circulate it among physicians and nurses to achieve the therapeutic effect in order to educate the nurses on the proper preparation & administration techniques.
- To find the impact of educating the nurses in reducing the incidence of I.V. medication errors.

METHODOLOGY

A Prospective, Interventional study was carried out in a 600 bedded multi-specialty tertiary care teaching hospital located at Hyderabad. Appropriate permissions were taken before study initiation. Department selected was General medicine - Inpatient Patient Department (IPD) as a combination of disorders, which compels the physician to prescribe and generate high prescriptions with more categories of drugs that lead to possibility of errors in the management can be seen. The entire study was planned to be carried out for a period of 8 months from Jan 2011-Aug 2011. All patients who were being administered I.V. medications in the general medicine - IP department were included in the study. Exclusion criteria consisted of pregnant women, lactating mothers, Infants, terminally ill patients, Outpatients.

Data entry format was designed to note patient demographics and medication errors. Details of each I.V. drug prepared and administered were recorded. Information came from observation and talking informally to the nursing staff. Data were collected for three consecutive months from February to April 2011. The details obtained were checked and completed for each IV drug within 24 hours of leaving the ward. Each case of I.V. medication error was analyzed to identify the error. The details were then recorded in the form.

The study was divided into three sections as follows:

Pre-Interventional Study (January 2011 – April 2011)

Clinical pharmacists participated in ward rounds and interacted with physicians, nurses, patients compared with traditional role of centralized pharmacy drug monitoring. They also took medication history which enabled to know about drug-drug allergies, food-drug allergies in order to present any change in drug regimen changes. All the types of medication errors were documented as per Annexure-1.

ANNEXURE – 1

DEPARTMENT OF PHARMACY PRACTICE
Malla Reddy College of Pharmacy, Secunderabad. Case No. ____

DATA ENTRY FORM

Research Title: Study on Incidence of Intravenous Medication Errors at a Multispeciality Hospital in South India

PATIENT DETAILS									
Name	Age	Sex	Wt.	Ht	BMI	IP.No	Dept	DOA	DOD

REASON FOR ADMISSION

PAST MEDICAL HISTORY

PAST MEDICATION HISTORY

SOCIAL HISTORY	Known allergies:
Smoker : Y/N Tobacco in any form: Y/N Alcoholic: Y/N None:	Marital status:

LABORATORY INVESTIGATIONS														
Date											Blood sugar (mg %)			
Temp.											F.B.S (60-90)			
BP											P.P.S (80-150)			
Pulse											R.B.S (90-110)			

BLOOD COUNTS						
Haemoglobin (g/dl) M: 12-16 F:11-14	TLC (cells/cumm) (5000-10000)	ESR (mm/hr) (M<10; F<20)	Differential Leukocyte Count (%)			
			Polymorphs (40-60)			
			Lymphocytes(20-30)			
Platelets (1-3	Clotting Time(3-5min)	Bleeding Time(1-3min)	Basophils (0-1)			
			Eosinophils (1-4)			
			Monocytes (1-2)			

LIVER FUNCTION TESTS								RENAL FUNCTION TESTS			
Total bilirubin (<1mg %)				Alk. Phosphatase (84-306 U/L)				Urea (mg %) (15-45)			
								Uric acid (mg %) F-2-5, M-2-7			
P.T Time (14 sec)				SGPT (5-37 U/L)				Sr Creatinine (mg %) (0.6-1.4)			

ELECTROLYTES (m.Eq/l)					URINE EXAMINATION	
Sodium (130-150)					Colour	Sugar
Potassium (3.5 – 5.8)					Bile salts	WBC
Chloride (98-100)					Bile pigment	RBC
Bicarbonate (22-36)					Albumin	Casts
					Pus cells	Epithelial cells

C/S: Y/N **No. of organisms isolated: ☐**

Organism Isolated: **Sensitive to:**

Other Investigations:

DIAGNOSIS:

DRUGS PRESCRIBED

S.No	Drugs		Dose	Date of Treatment										
	T. Name	G. Name												
01														
02														
03														
04														
05														
06														
07														
08														
09														
10														
11														
12														
13														
14														
15														

OBSERVED INTRAVENOUS MEDICATION ERRORS

Error Category	
Dose Omission	
Extra Dose	
Unauthorized Drug	
Wrong Drug	
Wrong Dose	
Wrong Dosage Form	
Wrong Preparation Technique	
Wrong Route	
Wrong Time	
Wrong Rate	
Aseptic Technique	
Deteriorated Drug	
Wrong Diluent	
Wrong Diluent Volume	
Wrong Infusion Volume	
Wrong Patient	
Inappropriate Storage	
Drug Incompatibility	
Others	

DESCRIPTION OF OBSERVED ERRORS

PHARMACIST NOTE

Signature of the Investigator **Signature of the Supervisor**

3

ANNEXURE-2: ERROR SEVERITY ASSESSMENT SCALE WITH 5 SAMPLES OF SCORING

1.	Inj. Ceftriaxone (2gm) was administered in a minute rapidly.	Inj. Ceftriaxone (2gm) should be administered by slow iv injection over **2-4 minutes.**

0- - - - 1- - - - 2- - - -3 - - - -4 - - - -5✓- - - -6 - - - -7 - - - -8 - - - -9 - - - -10

2.	No drug for fever was prescribed in the medication chart.

0- - - - 1- - - - 2- - - -3 - - - -4 - - - -5✓ - - - -6 - - - -7 - - - -8 - - - -9 - - - -10

3.	Inj. Metronidazole was given one extra dose on a day.

0- - - - 1- - - - 2- - - -3✓ - - - -4 - - - -5 - - - -6 - - - -7 - - - -8 - - - -9 - - - -10

4.	During IV drug rounds nurse **omitted** Inj. buscopan doses on 2 days.

0- - - -1- - - - 2- - - -3 - - - -4✓ - - - -5 - - - -6 - - - -7 - - - -8 - - - -9 - - - -10

5	During IV drug rounds nurse **omitted** Inj. ceftriaxone doses on 2 days.

0- - - -1- - - - 2- - - -3✓ - - - -4 - - - -5 - - - -6 - - - -7 - - - -8 - - - -9 - - - -10

Signature of the Judge I:

ERROR SEVERITY ASSESSMENT SCALE WITH 5 SAMPLES OF SCORING

1.	Inj. Ceftriaxone (2gm) was administered in a minute rapidly.	Inj. Ceftriaxone (2gm) should be administered by slow iv injection over **2-4 minutes.**

0- - - - 1- - - - 2- - - -3 - - - -4 - - - -5- - - -6✓ - - - -7 - - - -8 - - - -9 - - - -10

2.	No drug for fever was prescribed in the medication chart.

0- - - - 1- - - - 2- - - -3 - - - -4 - - - -5 - - - -6✓ - - - -7 - - - -8 - - - -9 - - - -10

3.	Inj. Metronidazole was given one extra dose on a day.

0- - - - 1- - - - 2- - - -3 - - - -4✓ - - - -5 - - - -6 - - - -7 - - - -8 - - - -9 - - - -10

4.	During IV drug rounds nurse **omitted** Inj buscopan doses on 2 days.

0- - - -1- - - - 2- - - -3 - - - -4 - - - -5✓ - - - -6 - - - -7 - - - -8 - - - -9 - - - -10

5	During IV drug rounds nurse **omitted** Inj ceftriaxone doses on 2 days.

0- - - -1- - - - 2- - - -3✓ - - - -4 - - - -5 - - - -6 - - - -7 - - - -8 - - - -9 - - - -10

Signature of the Judge II:

SCORING INTRAVENOUS MEDICATION ERRORS

Error	Score by judge		Mean Score	Severity
	1	2		
1	5	6	5.5	Moderate
2	5	6	5.5	Moderate
3	3	4	3.5	Moderate
4	4	5	4.5	Moderate
5	3	3	3	Minor

Scores		Outcomes
0 to 3	–	minor outcome
3 to 7	–	moderate outcome
7 to 10	–	severe outcome
Minor	–	very unlikely to have any adverse effects
Moderate	–	likely to cause some adverse effects or interfere with therapeutic goals but very unlikely to result in death or lasting impairment.
Severe	–	likely to cause death or lasting impairment.

Education/Interventional Study (May 2011)

Clinical pharmacists intervened to reduce I.V. errors by preparing guidelines booklet for IV medications and circulated among healthcare professionals. The nurses were given in detail counselling on the drugs- use, administration, and preparation technique and risks associated with I.V. medication errors.

Post-Interventional Study (June-August 2011)

The impact of pharmacist's intervention on the incidence and severity of I.V. medication errors were studied in the post implementation phase. Patients were counseled regarding diet, disease, medications use and dosage at time of discharge. Telephonic follow up on medication adherence was done after discharge of patient and doubts clarified, if any.

Data analysis

The collected data were thoroughly analyzed and the prescriptions were checked for appropriateness. The data related to the drug were compared with the standards of Micromedex Medical Database, injectable drugs-hand book by Lawrence a Trissel, 13th Edition, Physicians' desk reference, 64th Edition.

Severity of the identified medication errors were assessed on the basis of potential patient outcomes using a reliable validated method of scoring. We used a validated scale to assess clinical importance of Intravenous drug errors. The two researchers participating in the study scored the potential clinical importance of each drug error on a visual analogue scale between Zero (no harm) and 10(death). The mean score was calculated for each drug error. Mean score below 3 suggested a minor outcome, scores 3-7 a moderate outcome and scores above 7 a severe outcome [7]. The severity table shown as in Annexure-2.

RESULTS

Pre- Interventional Study: February-April 2011.

A total of 153 cases sheets were observed in the study period of 3 months and the following evaluations were made from the observed data. The majority about 38.65% of subjects were in the age group (40-59)yrs followed by 30.71% of age-group from (19-39)yrs , followed by (60-74)yrs of old-age, 21.57% followed by children (1-12)yrs of 3.92% and with the least populated group being adolescents (13-18)yrs and old-age (≥75yrs) comprising of 2.61%.

The total drugs prescribed in the hospital as injections/infusions consisted a total of 4849 doses in 153 cases collected, where majority (56.85%) were Antibiotics given at a total of 1787 doses. The next commonly used drugs were Non-steroidal anti-inflammatory drugs (NSAIDs) that were administered at a total of 538 doses (11.09%), followed by Anti-ulcers/Antacids given a total of 534doses (11.01%). The less commonly used drugs comprised of anti-diabetics that was administered at a total of 05 doses (0.1%), followed by Cholesterol lowering agents given at a total of 06 doses (0.12%) and the least used drugs being anti-diarrheal given only 08 doses (0.16%). The number of medication IV drug errors identified in our study was 1649 out of 4849 doses that is 0.34 error/dose. The

categories were dose omission (305), wrong dose (285), and administering multiple drugs simultaneously resulting in drug incompatibilities (247), Inappropriate storage (194), administering more than prescribed dose: extra dose (172), wrong time (100), wrong route (73), wrong preparation technique (48) administering deteriorated drug (46) and other errors observed.

A total of 1649 I.V. drug errors were reported by a case-to-case analysis among the 153 cases observed during the study period, out of which, 480 medication errors (29.10 %) resulted in minor outcomes, 1169 medication errors (70.89%) with moderate outcomes, and none with severe outcome.

Post- Interventional Study: June-August 2011

After the interventions were made a total of 150 cases were observed for 3 months after intervention study period between June-August 2011 to assess the impact of educating the nurses on proper preparation and administration of commonly used drugs in the hospital. From the cases observed in the hospital during the study period it was found that old- adults comprised maximum amount of the population in the hospital of the age group (40-59) yrs of 35.33%.

The types of drugs prescribed in the hospital as injections/infusion comprised a total of 2962 doses, where the maximum administered drugs contained of antibiotics which were given at a total of 815 doses (27.51%). The number of IV drug errors identified in the post intervention study reduced to 692 out of 2962 doses that is 0.23 error/dose.

Significant reductions in the number of errors were observed in other categories including omission error, wrong time error and aseptic technique violation (Table-1). The results of the study suggest that there is a direct relationship between education and the incidence of medication errors, rather than an inverse relationship, wherein as education increased number of errors decreased.

Our study revealed that 8 categories of drugs were associated with the greatest number of IV medication errors (Table-2). A total of 692 errors were reported by a case-to-case analysis among the 150 cases observed during the study period, out of which, a marked reduction was seen in the number of moderate errors after intervention which were reported as 430 medication errors (62.13%) followed by a reduction in minor medication errors (262, 37.86%) and none (0%) with severe outcome as in Table-3.

Table-1: Types of errors comparison- pre-intervention & post-intervention

Error Category	Phase I (No. of Doses)	Phase III (No. of Doses)
Dose Omission	305	124
Wrong Dose	285	102
Drug Incompatibility	247	92
Inappropriate Storage	194	82
Extra Dose	172	63
Wrong Time	100	52
Wrong Route	73	48
Wrong Preparation Technique	48	25
Deteriorated Drug	46	34
Wrong Rate	41	26
Wrong Diluent Volume	42	17
Wrong Diluent	40	12
Aseptic Technique	27	08
Wrong Infusion Volume	23	07
Wrong Drug	03	00
Wrong Patient	02	00
Wrong Dosage Form	01	00
Unauthorized Drug	0	00

Table2: Types of drugs prescribed showing occurrence of errors

S. No	Drug classes	No. of Doses (N=2962)	Percentage Errors (%)
01	Antibiotics	815	27.51
02	Anticoagulants	428	14.44
03	Analgesic, antipyretic, anti-inflammatory	356	12.01
04	Diuretics	310	10.46
05	Antiulcerants /Antacids	238	8.03
06	Psychotropic drugs	123	4.15
07	Antiamoebics	110	3.71
08	Anti-emetics	98	3.30
09	Vitamins	74	2.49
10	Corticosteroid	72	2.43
11	Antispasmodics	71	2.39
12	Anticonvulsants	65	2.19
13	Antiallergic	55	1.85
14	Antiasthmatics	38	1.28
15	Antidepressants	22	0.74
16	Antihypertensives	18	0.60
17	Antifungals	16	0.54
18	Anxiolytics	12	0.40
19	Minerals	12	0.40
20	Anticholinergics	10	0.33
21	Antidiarrheal agent	08	0.27
22	Cholestrol lowering drugs	06	0.20
23	Anti-diabetics	05	0.16

Table 3: Severity Scale: Pre-intervention/Phase-I & Post-intervention/Phase-III

Severity	PHASE I Percentage (%)	PHASE III Percentage (%)
Minor	29.10	37.86
Moderate	70.89	62.13
Severe	0	0

DISCUSSION

Certain preparation errors of IV drugs observed, which were mainly due to wrong infusion volume, wrong diluents, wrong preparation technique, wrong diluents volume. 76 out of 180 dose preparation errors were seen with cefuroxime which showed the maximum errors and this was due to negligence and carelessness by nurses during preparation of the drug. This was in correlation with a study conducted a study at 3 different sites as: TBP (traditional British pharmacy service, n=77); TGP (traditional German pharmacy service, n=126) and GSP (German satellite pharmacy service, n= 134), where n= no. of preparation observed done by Veronika Wirtz et al. [8], also stated that the majority of them occurred at the study site with TGP and was mostly due to undissolved drug remaining in the vial. Other dose errors observed were due to foam, lower strength of the product chosen or smaller volume than required taken out of the vial. Calculation errors, which led to dose errors, were made in 6 cases (12%) out of 51 preparations where a calculation was required. In all of these cases the wrong solvent was selected.

The maximum I.V. drug administration error was seen with Ceftriaxone in 321 doses out of 1469. The medication administration errors in our study was found to occur due to various factors in our study such as dose omission, wrong dose, administering many drugs at a time resulting in drug incompatibilities, wrong route, wrong time, administering more than prescribed dose (extra dose), administering deteriorated drug and at a wrong rate or in a wrong patient varying from drug to drug. Most violations (n=153, 21.85%) were fast administration of bolus doses (injections administered faster than the recommended speed of 3-5 minutes). The dose was given in less than the recommended time. The majority of bolus dose errors were judged to be of

moderate severity. Interaction/communication with nurses showed that, they knew the correct speed of administration, but deliberately deviated from these guidelines.

A study conducted by Veronika Wirtz et al. [8], shows that the most common type of administration error on all wards (TGP< TBP< GSP) was the wrong rate error which resulted as the injections were given faster than recommended (usually three to five minutes for an IV push). Some nurses gave the drug dose in one single shot, others more slowly but still double or three times faster than the recommended time. The preparation and administration errors observed in our study is comparable to the study done by D H Cousins et al. [9], which was a multicentre audit trial conducted in UK, Germany and France where in German and French hospitals most frequent error was preparing the medicine with wrong diluents. Their study showed the use of wrong diluents which may cause a reduction in solubility of medicine powder being reconstituted that can lead to powder particles being administered to the patient who was in – line with our study of same observation.

Types of errors observed in this study majorly consisted of Dose omission, followed by Wrong Dose, Drug Incompatibility, Inappropriate storage, extra-dose and others such as wrong time, wrong route, wrong preparation technique, wrong rate etc. These findings are slightly varied from the study conducted by Diana C Alexander et al. [10], revealed that medication administration was the most frequently implicated phase of case, with improper dose being the most frequently cited type of error, followed by dose omission, extra dose and wrong drug and wrong time. In another study done by Veronika Wirtz, Katja Taxis and Nick D. Barber [8], showed that most common errors were wrong administration rates (73), omissions (36) and wrong dose (34).

This study showed high workload and distractions which were the reasons for IV medication errors. Patient related factors included a lack of venous access or unwillingness to co-operate with drug administration. Study findings included the failure to notice that a drug has not dissolved completely during reconstitution. A study conducted by P Y Han et al. [11], demonstrated that dose omission occurred as prescribers did not inform nursing staff of changes to a patients' fluid orders or prescription charts were not checked following specific surgical / medical consults. As per the study Julie Sakowski et al. [12], showed that the majority of errors reviewed (91%) were rated as having minimal severity potential and (9%) were rated as moderate to severe. However, the above studies showed slight deviation from our study where the severity of errors majorly consisted of moderate outcomes (77.09%), followed by minor outcomes (22.09%) and with severe outcomes observed to be nil in nature as there were no deaths or any life – threatening cases observed in our study period which is due to drug incompatibilities and adverse drug interactions associated due to administering many drugs at a time.

CONCLUSION

Limitations

The study was for short duration and small sample as it was from only one ward at the time of IV drug administration which may be similar in all other wards. Hence the results of our study cannot be generalized to other populations.

Medication error in healthcare setting is more common than we think due to the increase in complexity of diseases and the requirement for multiple medications at a time. Medication errors with IV administration can have instant detrimental effects due to immediate onset of action. Our study reveals that, medication – errors are common with antibiotics due to dose omission being the main reason. This leads to delay in resolution of infection and also increase in resistance to antibiotics which is of primary concern. Majority of observed errors were severity of errors, identified as moderate in nature. On intervention, by counselling the nursing staff about preparation, administration and use of IV drugs, there was a considerable decrease in medication errors seen. Carelessness during work, interruptions, distractions, performance-deficit, lack of technical knowledge from newly joined nurses, were the common risk factors contributing for medication administration errors. Hence, educating nurses on proper preparation & administration of IV medications reduces errors and needs to be regularly reinforced in order to maintain the error reduction.

CONFLICT OF INTEREST

Author declares that there is no conflict of interest to disclose.

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