



## Evaluating the Frequency of Errors in Preparation and Administration of Intravenous Medications in the Intensive Care Unit of Shahid-Sadoughi Hospital in Yazd

Seyed Mojtaba Sohrevardi<sup>1</sup>, Mohammad Reza Mirjalili<sup>2</sup>, Mohammad Hossien Jarrahzadeh<sup>2</sup>, Mahtabalsadat Mirjalili<sup>1</sup>, Ehsan Mirzaei<sup>1\*</sup>

<sup>1</sup> Faculty of Pharmacy, Shahid Sadoughi University of Medical Sciences, Yazd, Iran.

<sup>2</sup> Faculty of Medicine, Shahid Sadoughi University of Medical Sciences, Yazd, Iran.

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### ABSTRACT

**Background:** In most Iranian hospitals, the nurses in the wards prepare intravenous (IV) drugs and unfortunately pharmacists are not involved in this process. The severity of the patients in Intensive Care Unit (ICU) heightens the risk of errors. More over the frequency of using IV drugs in this unit is high, so we decided to determine the frequency and types of errors, which occur in the preparation and administration of commonly, used IV medications in an ICU.

**Method:** A prospective cross sectional study was performed from November 2013 to August 2014, in the intensive care unit in Shahid-Sadoughi hospital in Yazd. Medication errors occurred in the process of preparation and administration of IV drugs, were recorded by a pharmacy student and were evaluated by direct observation, according to the method established by Barker and McConnell.

**Results:** A total number of 843 intravenous doses were evaluated. The most common type of error (34.26%) was the injection of IV doses faster than the recommended rate followed by preparation (15.69%), administration (9.23%) and compatibility with doctor's order (6.24%). Amikacin was the most common drug involved in errors (41.67%). Most of errors were occurred at afternoon (8 p.m, 28.36%).

**Conclusion:** According to our study the rate of errors in preparation and administration of IV drugs was high in this ICU. Employing more nurses, using developed medical instruments and clinical pharmacists can help to decrease these errors and improve the quality of patient care.

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### Introduction

The goal of drug therapy is to improve the state of the patient and to heal with a minimum of medication misadventures. Some of these misadventures are inherent, associated with the therapeutic use of medicines, adverse drug events and adverse drug reactions (1). Medication

errors are defined as any avoidable happening that may result in improper use of medications or hazards for the patient for which the person responsible may be the health care professional, patient or consumer (2). Others, such as medication errors, are preventable. Medication errors include prescribing errors, dispensing errors, medication administration errors and patient compliance errors (3). Studies on medication errors dated as far back as the 1960s by Barker and McConnell who reported that medication errors occurred much more frequently than that could be obtained via event reports, with about 16 errors per 100

\* Corresponding Author: Dr Ehsan Mirzaei

Address: Professor Hesabi Blvd., Shahid Sadoughi University of Medical Sciences, Faculty of Pharmacy, Yazd, Iran. Tel/Fax: +983518203419.

Email: ehsan.mirzaei.1369@gmail.com

doses (4). In most cases, medication errors are generally undetected because clinical significance is often minimal, but in some cases, these errors result in increased patient morbidity or mortality and in increased costs (5-9).

In low- and middle-income countries, patient safety is still a neglected area, with little known about medication errors. Health system infrastructures are weak and there is a poor safety culture. Inadequate training of clinical staff and lack of protocols/ policy have been identified as important factors compromising patient safety (10-11). A considerable reduction in various types of medication errors was found after a multifaceted intervention was implemented, including the participation of a clinical pharmacist in clinical rounds, standardization of medication use, training, and the introduction of a medication error reporting system (12).

Intravenous therapy is associated with higher rates of medication administration errors compared to orally administered medications (13). Most intravenous medication administration errors occur during reconstitution and injection (14). Intravenous errors have been shown to be related to insufficient knowledge of practical procedures, deviation from protocols/ guidelines and nurses' experience (15-18). In an overview of IV related drug administration errors in Philadelphia during 5 years from 73769 reported errors %2.92 to %5.03 were associated with harms to patients. Hazardous errors primarily were those included incorrect concentration and calculations (19). In a research evaluating medication errors in UK, French and German hospitals, the incorrect diluents was utilized in 1%, 18% and 49% of medications used intravenously in each hospital respectively (20). It was shown that there is a direct relationship between hospital stay and risk of errors. Intravenous administration of medications is one of the most common routes in the hospitals in particular for those with a long length of hospitalization. Therefore, hospitalized patients are at high risk for adverse drug events (21). Taxis et al. study showed that perhaps one of the most serious adverse events that can happen as a result of medication error is one that involves the IV route of administration and about one half of medication errors occurred in IV preparations and administrations, %1 of which resulted in serious adverse events (22). Currently, in almost Iranian hospitals, the nurses in the wards prepare IV drugs and unfortunately pharmacists are not involved in the medication preparation process. Therefore, there are not any controls for preparations of medications in hospitals by pharmacists (23). There are a few reports about MEs in ICUs in Iran (24-27). In an observational study in the intensive care unit of a teaching hospital in Iran errors in preparation and administration of intravenous medications were evaluated and 380 (9.4%) errors were detected. Among all errors made, 66.4% were related to administration and 33.4% to preparation process (25).

Intravenous medications pose particular risks because of their greater complexity and the multiple steps required in their preparation, administration and monitoring. The ICU brings together high-risk patients and interventions in a complex environment (28). Critically ill patients are prescribed twice as many medications as patients outside of the ICU (29). Patients are prescribed these medications in an environment that is stressful, complex, changing, under the stewardship of multiple providers, and frequently managing patients in crisis (30). It is important to remember that critically ill patients have fewer defenses against adverse events than other patients do. They have limited ability to participate in their medical care and they lack the physiological reserve to tolerate additional injury. The ICU has been reported to be an error-prone environment due to critically ill patients, heavy workload and complex clinical care (31-32). The aim of this study was to assess the frequency and the type of errors in preparation and administration of common IV drugs which occurred in the medical intensive care unit in Yazd Shahid-Sadoughi Hospital.

## Methods

A prospective cross sectional study was performed from November 2013 to August 2014, in the 16-bed intensive care unit of largest teaching hospitals in Yazd with 450 inpatient beds. The study was approved by *ethics committee* of the Shahid-Sadoughi University of Medical sciences. Intensive Care Unit was selected because of having the highest rate of IV medication prescription. All IV drugs were prepared and administered by nursing staff and pharmacists had no intervention in this process .but nurses were not aware of the study's purpose. Twenty of the most commonly used drugs in the wards were selected for observational evaluation. A checklist for each selected medication was prepared based on the manufacturer leaflet and reference books by an expert clinical pharmacist (33-35). Observation days and rounds were alternated i.e. randomly selected from all rounds and during all working shifts. During each shift 8 nurses were involved. IV drug preparation and administration rounds were done at 8:a.m. (morning), 12:a.m. (noon), 8:p.m. (afternoon) and 12:p.m. (mid night). Medication errors were detected by direct observation, according to the method established by Barker and McConnell (36). Although different methods have been utilized to evaluate medication administration errors (MAEs), the observation-based method developed 40 years ago by Barker and McConnell, is commonly accepted as the most reliable (23). One observer (a pharmacy student) accompanied nurses giving medication and witnessed the administration of each dose. Observer wrote down exactly what nurses did when preparing and administering medicine. Observer paid particular attention to the following: correct time for injection, incorporating the compatible diluting agent, using the correct amount

**Table 1.** Types of errors and their definitions.

Types of errors	Definitions
Preparation error	Incompatible diluents, wrong amount of diluents and drug.
Wrong administration Technique	Inappropriate procedure or improper technique in the administration of a drug.
Wrong rate	Incorrect rate of administration of a medicine to the patient (intravenous route, whatever the technique: direct intravenous, perfusion by gravity or infusion).
Incompatibility with doctor's order	Preparation of a dose that is higher than, or less than, the amount prescribed.
Drug interaction errors	Interaction of IV drug with other prescribed drugs.

**Table 2.** Types of errors and their examples.

Types of errors	Example
Preparation error	Amikacin: For intravenous infusion 500 mg may be diluted in 100 to 200 mL of compatible infusion solution but in 66.67 % of prescribed doses were diluted less than 50 mL.
Wrong administration technique	It was observed that in some administrations, a little amount of drug was remained in the syringe or leakage of the drug from the Angiocath.
Wrong rate	Ranitidine: For direct intravenous injection given over at least five minutes (4 mL/min) but 88.24% of prescribed doses were infused less than 4 seconds.
Incompatibility with doctor's order	Infused dose was less or more than the prescribed dose by the doctor
Drug interaction errors	Furosemide and Amikacin According to drug interaction fact: Significance :1 Onset: Rapid Severity: Major Documentation: Suspected
Incompatibility with other IV drugs injected simultaneously	Furosemide and Metoclopramide Hydrochloride, Pantoprazole Sodium and Vancomycin Hydrochloride

of diluents, the compatibility of medications with each other in the same IV line, appropriateness of infusion rates and bolus injections, injecting the exact content of medication allocated for the patient as prescribed, evaluating interaction with other prescribed drugs, the way of administration and preparation of IV drugs. The notes were then compared retrospectively with the original physician prescriptions, the recommendations of the manufacturers and the data available on checklists.

According to table 1 the assessed errors in present study were defined.

The data was processed using SPSS software version 19 (SPSS inc. chigago, IL, USA). For the study of relationship between qualitative variables with each set of MEs data, we used chi-square and for quantitative variables independent sample t-test was used.

## Results

During the study period, a total number of 843

intravenous doses were evaluated. The most common type of error (34.26%) was the injection of IV doses faster than the recommended rate followed by preparation (15.69%), administration (9.23%) and compatibility with doctor's order (6.24%). In table 2, examples for each error are mentioned. Among these 20 medicines, Metronidazole had the highest percent of wrong infusion rate. Among 20 considered drugs, Meropenem (13.2 %), Ranitidine (10.39 %) and Furosemide (10.39 %) were prescribed more than others. Of the 20 most commonly prescribed medications each one had at least one error during preparation and/or administration. Table 3 shows the distribution of errors for each drug.

Amikacin was the most common drug involved in errors (41.67%), followed by Vancomycin (35.93%), Ranitidine (26.77%), Metronidazole (26.41%) and Metoclopramide (23.61%).

IV injections during four shifts were observed, most percentage of errors were occurred at afternoon (8 p.m)

**Table 3.** The distribution of errors for each drug.

	Drug names	Number of observed doses	Percent of Preparation error	Percent of Administration error	Percent of incompatibility with physicians' orders	Percent of Wrong Infusion/Bolus Rate
1	Meropenem	108	7.41	2.8	3.8	12.04
2	Ranitidin	85	5.89	10.59	2.36	88.24
3	Furosemide	85	2.36	1.82	0	5.89
4	Ceftriaxone	80	1.25	0	2.5	12.5
5	Clindamycin	67	25.38	10.45	10.45	25.38
6	Metronidazole	55	9.1	3.64	1.9	91
7	Morphine	44	25	27.27	9.1	12
8	Vancomycin	41	51.22	26.85	14.45	51.22
9	Pantoprazole	40	5	7.5	5	12.5
10	Hydrocortisone	37	5.41	2.71	5.41	21.63
11	Dexametasone	35	0	0	2.9	71.43
12	Imipenem	32	6.25	0	3.2	9.34
13	Phenytoin	30	20	16.3	6.7	23.4
14	Heparin	23	13.05	13.05	4.35	8.7
15	Metoclopramide	19	5.27	10.53	5.28	73.38
16	Dopamine	16	6.25	6.25	12.5	0
17	Amikacin	12	66.67	8.34	16.67	75
18	Cefazolin	12	8.34	16.67	8.34	41.7
19	Midazolam	10	30	20	10	10
20	Gentamycin	5	20	0	0	40

(28.36%), followed by midnight (12 p.m) (25.6%), noon (12 a.m) (24.3%), and finally morning (8 a.m) (21.74%). No significant correlation was found between the frequency of errors and workload ( $P > 0.05$ ).

15.7% of observed doses had important interaction with other prescribed drugs. Among evaluated intravenous doses, 28 cases (3.32%) did not have compatibility with other IV drugs which were injected simultaneously. Only 23.58 % nurses used gloves during injection.

## Discussion

Our evaluation of medication errors is derived from the well-known and "recognized disguised-observation technique", developed by Barker and McConnell (36). It is considered to be more efficient and more objective than incident reports (37). A small number of studies have examined the medication errors at the administration stage, especially in Asian hospitals. According to our results, a relatively high rate of errors in the preparation

and administration of commonly used IV medications were observed in an Iranian teaching hospital. Now should study the types of errors at each stage of the medication process should be studied in details. Most of errors were happened during 8:00 pm till 12 midnight. Changes in the shifts and nurses' exhaustion in this shift are the main reasons for errors. In this ward every nurse is responsible for two patients and nursing workload in this ICU is high. One solution for this problem is to increase the number of nurses. The most frequent type of error was the wrong rate of infusion. Among these 20 medicines, Metronidazole had the highest percent of wrong infusion rate. Metronidazole should be administered by continuous intravenous infusion or by intermittent intravenous infusion over one hour but 91% of prescribed doses were infused less than 20 minutes. One suggestion is using intravenous infusion pump. Drug allergy is a significant problem in medical practice especially in the case of antibiotics. No allergy testing was performed for patients. Nurses involved in our

study forget to monitor the site of injection for probable reactions which can lead to dangerous events. Since there is not a standard definition and research procedures to study medication error, comparing different study result is rather difficult. For instance some studies taking into consider some stages of medication process, while others consider on all parts including prescribing, transcribing, dispensing and administration (38).

The result of our study is almost consistent with that of Fahimi et al., who found that among 32 observed drugs, Amikacin was the most common drug involved in errors. Also in both studies Percent of wrong infusion/bolus rate is high. In our study most of errors were happened during 8:00 pm till 12 midnight which is different from Fatima's study in which the majority of errors were seen to occur during the 9:a.m. one reason for inconsistency is the difference in shift hours in the hospitals.

Our study focused on nurses' activity, it is a mistake to assume that all errors of preparation and administration originate in this area. The problem is multi factorial and its reasons could be medical, pharmaceutical, nurse-related and structural. However, this study was focused on preparation and administration of drugs; our observations show the following error origins:

**Lack of knowledge in use of drugs:** Nurses are not always knowledgeable regarding the nature and volume of diluents, administration techniques, rates and schedules of administration, physicochemical incompatibility, and specific form (e. g. extended-release tablets).

**Wrong preparation by nurses:** All medicines are prepared in the unit by the nurses. When the demand is intense, several nurses prepare the drugs for their own patients at the same time in cramped quarters. They are also frequently disturbed, which means they stop their preparations. The crowding and the interruptions increase the risk of error.

**Lack of standardization of protocols for preparation and administration:** Since each nurse prepares and administers, medicines according to his/her knowledge and habits, there is heterogeneity of practice.

**Inappropriate use of medical devices:** medical devices for intravenous administration are developing, and the lack of staff training and protocols in this area are also risk factors.

**Lack of the presence of a pharmacist:** Clinical pharmacists have been shown to improve the quality of patient care, for instance by reducing medication errors and (potential) adverse drug events (39-42). Our study strengthens the evidence for the relevance of clinical pharmacist. Lack of the presence of a pharmacist is true not just for our hospital, but for most other Iranian hospitals as well. The ideas that the pharmacist must have personal contact with the patients, and that she/he has a hand in training nursing staff, are new, and not accepted by the Iranian medical community as a whole. Neither

physicians nor nurses take advantage of the pharmacist as specialist, even though her/his impact on the quality of care has been extensively documented (43-46).

Also, hospitals should consider ways of incorporating pharmacy automated systems which can assist health care professionals to have more time for direct patient care since some of the labor-intensive tasks are reduced or eliminated by the automation (47).

In conclusion, this study indicates that the frequency of IV drug administration errors in this ICU were high. Medication errors have recently drawn significant attention, since they could cause considerable morbidity, mortality and unnecessary costs. This result again emphasizes on increasing nurses' knowledge, introducing standard protocols for preparation and administration of drugs, using developed medical devices and involvement of pharmacy department on drug preparation instead of preparation of drug admixtures by the nurses. Presence of a full- time clinical pharmacist at ICU is necessary in order to improve the quality of care in this ward.

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