

*Short Communication*

## **An Observational Study of Errors Related to the Preparation and Administration of Medications Given by Infusion Devices in a Teaching Hospital**

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### **Abstract**

Since there is no detailed hospital based incident reporting system, this study was designed to evaluate the medication errors associated with infusion pumps in intensive care unit (ICU). The investigation was conducted in a Teaching hospital in the form of a prospective, observational study. A sample size of 43 doses administered to ICU patients was chosen to enable reliable estimate of error rates. Any deviation in the IV pumps implication from the guidelines and/or doctor's order in the charts was measured as the main outcome.

Forty three doses with 258 opportunities for error were observed. Twenty (7.8%) errors were detected, of which 14 (20%) were incorrect dose, 4 (20%) labeling error, 2 (10%) unauthorized medication. From incorrect doses, 8 (57%) resulted in overdose. Benzodiazepines were the most common class of drug involved. We concluded that regarding the infusion pump usage for drug delivery, a large number of errors exist.

**Keywords:** Concentration calculation; Continuous infusion; Incompatibility; Infusion pump; Medication error.

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### **Introduction**

Medication errors are defined as any preventable event that may cause or lead to an inappropriate medication use or patient harm while in the control of the health care professional, patient or consumer (1). Approximately 1-2% of patients admitted to the United States hospitals are harmed as a result of medication errors (2). Several medication adverse events which led to deaths have been reported with infusion pumps (3). Administration by continuous infusion,

potentially, has a higher risk for medication errors. If calculations are required for drug administration, this added step in the use process can contribute to increased rates of errors (4).

Also, calculations for continuous infusion are more complex and can be more error prone than that of intermittent administration. Continuous Intravenous infusions are usually administered by infusion pumps. The scope of this problem is complicated, since infusion pumps are mostly being used for specific drugs e.g. high-alert medications (5) and ICU patients. Currently, no ICU floor-based pharmacist is available in the ICU of our hospital to get involved in IV admixture and/or administration.

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Errors are more common in intensive care units probably because of poly-pharmacy, a more stressful environment and unconsciousness of the patients who may not be able to verbalize symptoms. Medication adverse events involving critically ill patients can be potentially life-threatening (6, 7).

Failure to accomplish what was ordered and planned is a type of error that has been less identified and discussed compared to other types of medication errors. The topic is of high priority for clinicians. There is value to better understanding the issues surrounding intravenous infusion. Thus, the present study was performed to evaluate types, frequency, and severity of medication errors associated with infusion pumps in our ICU.

### Experimental

This investigation was conducted in the National Research Institute of Tuberculosis and Lung Disease between May to June 2006. The hospital is one of the largest teaching hospitals in Tehran with 446 inpatient beds. Only ICU was included in the study because of low infusion pump usage in the other wards. It is a multidisciplinary 12 bed ICU with a nurse:patient ratio of 1:2. There is no floor-based pharmacist currently available in ICU.

The study was approved by the ethical committee of the hospital. All IV medications were prepared and administered on the wards by nursing staff. We did not need informed consent from nursing personnel to perform this type of study. To decrease observer induced bias, the nursing staff were not aware of the purpose of this study. They were told that this is part of a clinical pharmacy training program, if they asked the observer about what he/she was recording.

A cross-sectional, prospective approach was used to identify any error related to medication administration via infusion pumps that could be assessed during the observation period. The process was verified by a clinical pharmacy resident. The observer intervened for errors likely to cause imminent harm, during the observation process.

A sample size of 43 doses was chosen. The pumps which employed for medication delivery

were "Atom syringe 1235N (made in Japan) for adult and neonates". Manual of the infusion pump, package insert of the medications, and nursing hospital guidelines for preparation were reviewed. A check list of potential errors was created for the observer to record details of each IV drug preparation and administration via infusion pump. The potential errors were listed as documentation of the order rate, patient identification, date, and time that the infusion was started or changed on the label of the infusing medication, unauthorized medication or change of order which was not found in the charts, the non-consistency of the concentration and rate with physician's order, the compatibility of the concomitant drugs, observation of any leakage from any part of infusion set, and detachment of patient from the pump.

Error was defined as any deviation in implication of the IV pump from the manual instructions and/or doctor's order in the charts.

NCC MERP Index for categorizing medication errors was used to determine the severity of errors (8). In categories B to D error but no harm occurred, and in categories E to H harm has been caused.

A new calculation for pump was made whenever the order changed. The accuracy of physician's order was not evaluated in this investigation.

### Results

We observed forty three doses which were administered via infusion pumps, with 258 opportunities for error (43 multiplied by 6 potential errors, which is mentioned below). Twenty (7.8%) errors were detected, including 14 (70%) incorrect dose, 4 (20%) labeling error, and 2 (10%) unauthorized medication. All the patients were attached to the pumps at the time of observation. Also, no leakage from infusion set monitoring was detected. We could not find any incompatibility in the solution (Table 1).

From incorrect doses, 8 (57%) could result in overdose if not corrected by the observer. Midazolam, which is a benzodiazepine, was the most common drug involved in the likely overdose (38%). This was prevented from reaching the patient, due to intervention the observer's.

**Table 1.** Types of errors, total number and severity rating.

Error type	Errors (n)	Total errors (%)	Total opportunities for error (%)	NCC MERP category No.
Labeling error	4	20	1.6	B
Unauthorized medication	2	10	0.8	B
Inconsistency of the concentration and rate with the order	14	70	5.4	B*
Total	20	100	7.8	-

\* This might be categorized as "F" if no intervention had been made.

Table 2 indicates drugs involved in concentration and/or rate of infusion error.

### Discussion

The result of this study shows that since medication errors with infusion pumps seem to occur mostly because of a lack of knowledge or precision in preparation and administration procedures, they could be easily corrected by educating the nursing staff.

Detachment of patient from pump was selected as a potential error, based on a previous experience in other wards where patients were mobile enough to detach themselves from the pumps. This was not seen during the observation period, due to the selected setting (ICU) of this study.

We found a number of error prone drugs, including those which are less routine such as sufentanil and those which are prepared for emergency reasons such as dopamine. Midazolam was the most frequent drug associated with errors, probably due to more frequent use of this drug. Calabrese et al observed the most frequent medication administration error in an adult ICU with vasoactive substances (9). Labeling error was seen in 20% of errors, despite the fact that all the diluents used were chosen correctly according to the hospital guidelines. Incorrect labeling and wrong diluents were reported to be up to 99% and 49%, respectively, of the doses administered in German hospitals (9).

Seventy percent of the errors were due to incorrect dose. Pre-calculated drug concentration charts, according to different routine rates, are useful tools and could be applied in wards like ICUs where nurses are overloaded with several

problems and in wards that there are not enough trained pharmacists to calculate and mix the IV preparation with the appropriate solutions. Palm and pocket PC software and computer-based database driven calculator (10) are now available to provide a spreadsheet with suitable rate, for dose calculations, in order to avoid errors. It has been shown that defining and classifying medical errors could help the reporting system of an institution to guarantee patient safety (11). Hence, we described different categorization in an effort to find better perception of the errors caused.

Since our health system is devoid of a well organized reporting system, errors are not detected and consequently not prevented. Le Grogneq and the colleagues have discussed similar issues in their system (12).

It was also shown that the most common reported reason for errors are performance deficit, which could be overcome by education (13). Performance level failures have been demonstrated as slips and lapses rather than knowledge-associated mistakes (14). Individual flaws were addressed as the main flaws in the medication delivery systems (15). Contributing factors to errors are lack

**Table 2.** Drugs involved in concentration and/or rate of infusion error.

Drug	Errors (n)	Total errors (%)
TNG	6	30
Midazolam	6	30
Dopamine	5	25
Insulin	1	5
Sufentanil	1	5
Propofol	1	5

of concentration, and distractions (nurses are vulnerable to several interruptions which may affect working focus). The goal of monitoring was to provide guidelines for nurses to decrease ICU medication errors regarding infusion pump drug deliveries. Protocols are more helpful for newly graduated nurses to promote their patient care services (16). This may contribute to a decreased prolongation of patient's stay, cost, resource consumption, adverse drug reaction, overdose, subtherapeutic dose, as well as an increased patient safety and efficiency of health care services in our ICU.

Alternative dosage calculation techniques should be applied to reduce the risk of errors (17). Improved training of nurses in calculating dosage is necessary to avoid risk associated with drug preparations.

In conclusion, medication errors have recently drawn significant attention, since they could cause considerable morbidity, mortality and unnecessary costs. The concept that clinical pharmacists can have a positive impact on patients' pharmaceutical care is becoming widely accepted (18).

Although no significant clinical outcomes have been encountered in the present investigation, possibly because the observer has intervened where needed, re-engineering of this high risk activity is suggested. Implementing a system with more active involvement of hospital pharmacists and/or clinical pharmacists in such activities can lessen the medication error related problems and thus enhance patient safety to a substantial degree. Data on frequency and type of medication errors is one of the several measures of patient safety which should be further completed with data on outcome measures.

The major limitation of this study was the small sample size. Although we claimed that nurses were unaware of this study's purpose, they might have guessed and, this could influence the rate of error if we had extended the study. Of course, our findings should further be verified by larger sample size and inclusion of wards with less pressured environment.

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