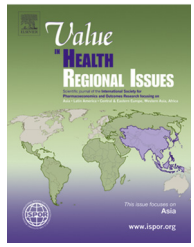
VALUE IN HEALTH REGIONAL ISSUES 6C (2015) 33–39

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/vhri



Incidence of Intravenous Medication Errors in a Chinese Hospital

Qian Ding, PhD[1,*], Kenneth N. Barker, PhD[2], Elizabeth A. Flynn, PhD[3], Salisa C. Westrick, PhD[2], Ming Chang, MS[4], Robert E. Thomas, PhD[5], Kimberly Braxton-Lloyd, PhD[6], Richard Sesek, PhD[6]

[1]Department of Pharmaceutical Sciences, Ferris State University, Big Rapids, MI, USA; [2]Department of Health Outcomes Research and Policy, Auburn University, Auburn, AL, USA; [3]Department of Pharmaceutical Outcomes & Policy, College of Pharmacy, University of Florida, Gainesville, FL, USA; [4]China Resources Purenhong Pharmaceutical Co., Ltd., Beijing, China; [5]Department of Industrial and Systems Engineering, Auburn University, Auburn, AL, USA; [6]Department of Pharmacy Practice, Auburn University, Auburn, AL, USA

ABSTRACT

Objectives: The purpose of this study was to explore intravenous (IV) medication errors in a Chinese hospital. The specific objectives were to 1) explore and measure the frequency of IV medication errors by direct observation and identify clues to their causes in Chinese hospital inpatient wards and 2) identify the clinical importance of the errors and find the potential risks in the preparation and administration processes of IV medications. **Methods:** A prospective study was conducted by using the direct observational method to describe IV medication errors on two general surgery patient wards in a large teaching hospital in Beijing, China. A trained observer accompanied nurses during IV preparation rounds to detect medication errors. The difference in mean error rates between total parenteral nutrition (TPN) and non-TPN medications was tested by using the Mann-Whitney *U* test. **Results:** A final total of 589 ordered IV doses plus 4 unordered IV doses as prepared and administered to the patients was observed from August 3, 2010, to August 13, 2010. The overall error rate detected on the study ward was 12.8%. The most frequent errors by category were wrong dose (5.4%), wrong time (3.7%), omission (2.7%), unordered dose (0.7%), and extra dose (0.3%). Excluding wrong time errors, the error rate was 9.1%. Non-TPN medications had significantly higher error rates than did TPN medications including wrong time errors ($P = 0.0162$). **Conclusions:** A typical inpatient in a Chinese hospital was subject to about one IV error every day. Pharmacists had a very limited role in ensuring the accuracy of IV medication preparation and administration processes.

Keywords: direct observation, intravenous, high-alert medications, medication errors.

Background

The medication use system for inpatients in hospitals usually contains prescribing, transcribing, dispensing, administration, and monitoring steps. The perspective of the medication use system for health care providers was to collaboratively promote efforts to achieve optimal therapeutic goals and encourage the enhancement of highly reliable and high-quality care [1,2].

Intravenous (IV) medication preparation is a very complex process including multiple steps: the selection of correct drugs, the dissolving of powder, and the transfer of injectable fluid from the original vial or ampoule into a base solution infusion bag [3]. Medication errors may be introduced during any of these steps of this complex process. IV medications are considered to be particularly dangerous because they usually go directly into the patient's vein via infusion, with immediate onset of systemic effects, low therapeutic index of many IV medications, and the difficulty of reversing the pharmacologic effects after IV administration [4,5].

Although errors can happen at any stage of the medication use system, the ultimate outcome of the medication use system from the patient's perspective is the rate of errors that actually reach the patient at the point of administration [6]. Many methods were used to capture medication errors, including direct observation, chart review, incident report, and so forth [7]. The direct observation method, which was developed by Barker and McConnell [8] in 1962, was confirmed to be able to detect more medication errors than did the other two methods: chart review and incident report [9]. Studies using the direct observational method found that error rates of IV medications admixed by nurses in hospitals varied largely from 26.9% to 49% in Europe [10–16]. Using the direct observation method, Flynn et al. [17] reported that the mean error rate of IV admixture compounding at five US hospital pharmacies was 9% [17].

Conflict of interest: The authors have indicated that they have no conflicts of interest with regard to the content of this article.

* *Address correspondence to:* Qian Ding, 220 Ferris Drive, Ferris State University, Big Rapids, MI 49307.

E-mail: qianding@ferris.edu.

2212-1099$36.00 – see front matter

http://dx.doi.org/10.1016/j.vhri.2015.03.004

China has an overwhelming usage of IVs than do other countries. In 2009, China used 10.4 billion infusion bottles annually [18]. This number of infusions was equivalent to approximately eight infusion bottles per capita for 1.3 billion Chinese people, much higher than the estimated three infusion bottles per capita at the international level [18]. Given that life-threatening IV medication error cases have been reported recently, the study of IV medication errors in Chinese hospitals is still rare [19,20]. If the error rate of 9% was applied to the Chinese hospitals in which IV infusions were administered, about 900 million errors involving IV infusions would have occurred annually in these hospitals.

The first objective of this study was to explore and measure the frequency of IV medication errors by direct observation and identify clues to their causes in Chinese hospital inpatient wards. The second objective was to identify the clinical importance of the errors and find potential risks in existing preparation and administration processes of IV medications.

Research Methods

Operational Definitions

An *IV medication error* was defined as any ingredient observed that was mixed in the IV bag and administered to the patients different from the interpretable physician's orders written on the patient charts. *Total opportunities for error* (TOEs) were defined as the IV ingredient doses ordered by the physician and interpretable by the observer, plus unordered IV ingredient doses observed to be given to the patient. The detected medication errors were divided by the TOEs and multiplied by 100 to obtain the medication error rate.

The IV medication errors were classified into the six categories listed below:

1. An unordered drug error: A dose that was not ordered for the patient was added in the IV solution and administered to the patient.
2. An omission error: An ingredient was not mixed in the IV solution and administered to the patient.
3. A wrong dose error: An ingredient was given more than 10% volume and concentration greater or less than the correct dosage, in the judgment of the observer.
4. An extra dose error: An ingredient dose given in excess of the total number of times ordered by the physician, such as an ingredient dose injected in the IV solution and given to the patient on the basis of an expired order, after a drug has been discontinued, or after an ingredient dose has been put on hold.
5. A wrong time error: The mixed IV solution was delivered more than 60 minutes before or after the scheduled administration time.
6. A wrong route error: The mixed IV solution was administered via a different location or site on the patient's body than was ordered.

The criterion for judging potential clinical importance was appearance in ISMP's list of high-alert medications in 2008 [21].

Study Site

The research protocol was approved by the hospital site in March 2010 and by the Institutional Review Board at Auburn University in May 2010. Two general (gastrointestinal) surgery patient wards at a teaching hospital with more than 1000 beds in Beijing were offered by the hospital as a convenience sample. The patient wards with 53 beds housed 50% of cancer patients, served by 13 physicians and 18 employed nurses. Most (90%) of the prescriptions for the patients on wards were IV medications. No clinical pharmacist was currently assigned to the wards.

A new Hospital Information System (HIS), an electronic prescribing system, was installed for inpatients in the hospital in July 2010. Physicians prescribed medications both in the computerized HIS and in the patient charts (handwritten). A medical nurse sent the medication orders through the HIS to the central pharmacy in the hospital after checking the consistency of medication orders between the HIS and the patient charts. Oral medications were supplied as unit doses and IV medications were dispensed in a bulk form to the wards once a day by the central pharmacy. The medical nurses transcribed handwritten medication orders to the medication inspection sheet for each patient. IV medications, including total parenteral nutrition (TPN) medications and non-TPN medications, were prepared by medical nurses in an IV preparation room.

TPN medications, which were usually given peripherally once daily, contained multiple additives such as vitamin C injection, sodium chloride injection concentrate (10%), compound amino acid injection (15-HBC) 250 ml, and so forth in the Kabiven TM PI fat emulsion bag (1440 ml). The TPN doses were placed on the counter aligned with the transcribed medication inspection sheet for each patient by an auxiliary worker. The medical nurses prepared TPN doses by injecting the prescribed volume of additives (lipids, protein, electrolytes, glucose, etc.) into the Kabiven TM PI fat emulsion bag. The patient's name and the bed number were written on the label using a marker pen on the Kabiven TM PI fat emulsion bag after the admixture process was completed.

Non-TPN medications usually contained one additive such as an antibiotic in a base solution of 5% glucose (250 ml) or 0.9% sodium chloride (100 ml). The handwritten label on the base solution bag included the name/volume of the ingredient and the administration time. No patient information was included on the label. The nurse injected the volume of the additive into the base solution and mixed them as an assembly line. The patient's name and the bed number were handwritten on the label when the nurses administered the non-TPN medications at the patient's bedside.

Data Collection Procedures

The direct observation method was used by a PhD candidate from the Department of Pharmacy Care Systems at Auburn University to detect IV medication errors. The observer was trained and certified in the direct observation method at the East Alabama Medical Center by Dr. Elizabeth Flynn in July 2008. Both preparation and administration processes were observed to detect wrong dose errors that may have occurred at the preparation process, but only medication administration errors were considered as the outcome at the end point of the medication use system.

The observer randomly picked up a nurse who prepared the IV medications and recorded the information of the admixing. When the nurse administered the IV medications to the patients, the observer accompanied the nurse as she delivered and administered the IV bags at the bedside. The observer recorded the information of the patient and the time and the label information on the IV bags administered. The observer's notes for preparation and administration processes were combined for each patient and later compared with the physician's orders for discrepancies.

The nurses who were 18 years or older were regularly employed for more than 1 year at the study site and regularly prepared and administered IV medications. The nurses provided their consent for observation. After the observed nurses were initially told the purpose of the study, the term "medication