

The Safety of Intravenous Drug Delivery Systems: Update on Current Issues Since the 1999 Consensus Development Conference

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Abstract

This review was prepared in advance of the Second Consensus Development Conference on the Safety of Intravenous Drug Delivery Systems that was held at Hotel Sofitel in Rosemont, Illinois, from August 7 to 9, 2008. The purpose of this conference was evaluation of the safety of intravenous (IV) infusion systems used for medication administration. Specifically, the purpose was to build on the work from the initial Consensus Development Conference that convened in 1999. At that time, an interdisciplinary expert panel of physicians, nurses, and pharmacists reviewed 6 IV drug delivery systems (IV push systems, volume-control chambers, augmented IV push systems, point-of-care activated systems, pharmacy-based IV admixture systems, and manufacturer-prepared products) with regard to safety, cost, simplicity of use, and amount of education and training required for proper use. The Second Consensus Development Conference expanded on the initial conference findings through presentations regarding the impact of medication errors, a review of related standards and guidelines released since 1999, and analyses and perspectives on the different IV drug delivery systems. The invited faculty and audience provided comments on a preliminary report issued during the meeting. The interdisciplinary expert panel produced a final report, which will be published at a later date, by the end of the one-and-a-half-day conference.

Key Words—drug delivery, intravenous systems, safety

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ence on the Safety of Intravenous Drug Delivery Systems was convened to evaluate the relative safety of the nonelectronic IV drug delivery systems then available.² An interdisciplinary expert panel consisting of pharmacists, physicians, and nurses reviewed the existing literature and listened to presentations regarding the safety, cost, and simplicity of use of these systems. These included manufacturer-prepared products, pharmacy-based IV admixture systems, point-of-care activated systems, IV push systems, augmented IV push systems (such as syringe pumps), and volume-control chambers. The systems were ranked using a decision-analysis methodology based on 4 domains: safety, cost, simplicity of use, and education and training needed for operation. In the final report from the conference, 3 drug delivery systems had higher overall scores and were deemed superior systems by the expert panel: manufacturer-prepared, point-of-care activated, and pharmacy-based IV admixture programs. Manufacturer-prepared products were considered the safest IV drug delivery systems overall because of quality assurance during the production process.

INTRODUCTION

Although 10 years have passed since the publication of the landmark 1998 report by the Institute of Medicine, *To Err Is Human*, medication errors continually re-

main a universal problem in health care institutions.¹ One area of potential concern for hospitals is the safety of intravenous (IV) drug delivery systems. In 1999, the first Consensus Development Confer-

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Point-of-care activated admixture systems offered rapid preparation of less stable drug products, and pharmacy-based IV admixture systems offered the advantage of dosing flexibility. However, these systems required additional preparation steps that could potentially lead to a medication error.

Although it was determined that manufacturer-prepared, point-of-care activated, and pharmacy-based IV admixture drug delivery systems were the “safer” options of the 6 delivery systems evaluated, the panel recognized that most hospitals have need of a combination of delivery systems because there is a limited availability of manufacturer-prepared and point-of-care activated products.² In addition, none of the data presented at the conference led to a definitive recommendation from the expert panel stating that the safety of any of the IV drug delivery systems was “inherently unacceptable.”

Since the initial Consensus Development Conference, there have been no major changes in existing IV drug delivery systems; however, significant changes have occurred regarding new standards and guidelines that affect the use of these systems. These changes include the United States Pharmacopeia (USP) Chapter <797> on compounding sterile preparations, The Joint Commission (TJC) medication management standards, and the Centers for Medicare and Medicaid Services (CMS) rule on hospital-acquired conditions. The use of automation for syringe and IV admixture compounding and the continuing debate over standardized versus individually customized parenteral nutrition (PN) are other areas that have affected discussions regarding the safety of IV drug delivery systems. Furthermore, the prevalence of IV admix-

ture outsourcing has continually increased. In 2005, over 30% of hospitals outsourced IV admixture, which was double the amount of facilities outsourcing in 2002.³ This increase in outsourcing may affect the overall utilization of specific IV drug delivery systems. The purpose of this “white paper” is to provide an overview of these evolving issues before the Second Consensus Development Conference.

GUIDELINES AND STANDARDS

In January 2004, the initial version of USP Chapter <797>, *Pharmaceutical Compounding: Sterile Preparations*, became official, and it immediately had a significant impact on health care institutions.⁴ The intent of the chapter was improvement of patient safety and quality of care by establishing standards for pharmaceutical compounding of sterile preparations. Over the years, there have been multiple reports of problems associated with compounded products, many of which have resulted in recalls, patient injuries, and even fatalities. When addressing this serious issue, the initial version of USP Chapter <797> classified IV products into risk levels, outlined the responsibilities of personnel involved in compounding sterile preparations, ensured the ongoing competence of compounding personnel with regard to aseptic technique, verified compounding accuracy and sterilization, described appropriate equipment and facilities needed for pharmaceutical compounding of sterile preparations, and addressed the issue of maintaining product quality and control once a product leaves the compounding facility or hospital pharmacy.

In June 2008, revisions to USP Chapter <797> became the official, enforceable standard.⁴ Because of

feedback from health care providers and institutions, new sections were added to the chapter and revisions were made to existing sections to further efforts in preventing patient harm as a result of inaccurate or contaminated compounded sterile products. Implementing these standards improves the safety profile of pharmacy-based IV admixture systems by mandating proper preparation, labeling, storage, dispensing, and delivery of compounded sterile products. Implementing USP Chapter <797> also represents a significant monetary investment for many health care institutions. Although all institutions must update existing sterile compounding facilities to comply with the standards, the required financial commitment has prompted some institutions to move toward other IV drug delivery systems—such as manufacturer-prepared, point-of-care activated, or outsourced compounding systems—during this modernization. This shift toward systems that minimize the number of steps from preparation to administration likely will affect patient safety. The USP exemption of proprietary bag and vial systems also may drive facilities toward the utilization of these types of devices because use of these systems allows that caregivers activate various medications while only necessitating that they meet TJC requirements for clean, organized areas for medication preparation in their facilities.⁴

New standards of medication management released in 2004 from TJC have also had an impact on use of IV drug delivery systems.⁵ These new standards not only placed a greater emphasis on patient safety than previous editions of the standards, but they were more detailed and prescriptive. Standard 2.20 encompassed the safe and proper storage of medications throughout

an organization and the incorporation of standard concentrations, and standard 2.30 covered the use of emergency medications. Together these standards emphasized the need for use of the “most ready-to-administer” form of medication available from the manufacturer to improve safety in patient care areas. Standard 4.20 detailed TJC requirements for the safe preparation of medications and promoted the preparation of all sterile compounded products within the pharmacy, most notably for medications used 24 hours after preparation. Standard 4.40 emphasized the need for dispensing the most ready-to-administer form of medication available from the manufacturer but also stated that organizations must be consistent in their use of a drug delivery system to reduce medication errors and improve safety. Any switch in a drug delivery system (ie, from manufacturer-prepared products to point-of-care activated systems) should be accompanied by staff education or instruction. Finally, standard 8.10 stated that all health care organizations must continually evaluate their medication management system for risk points that may result in a medication error. Organizations also must remain current on new technologies and practices that enhance patient safety.⁵

TJC medication management standards promote the use of manufacturer-prepared IV drug delivery systems when feasible because the standards emphasize the need for use of the most ready-to-administer form available from the manufacturer. The use of this IV drug delivery system helps improve medication-use safety by eliminating preparation errors, which is one of TJC’s 2008 National Patient Safety Goals (NPSGs) for hospitals.⁶ In addition, with these stan-

dards, the organization recognizes the continued importance of pharmacy-based IV admixture programs by stressing that all compounded sterile products should be prepared within the hospital pharmacy. In doing so, TJC acknowledges the pharmacy’s expertise in the preparation of compounded sterile preparations for individual patients. Evaluation of risk points in the medication management system also directly affects the choice of an IV drug delivery system. Systems such as IV push, volume-control chamber, and augmented IV push are associated with increased potential for a risk point that may result in patient harm, as evident by the results from the initial Consensus Development Conference. Health care organizations must continually assess improvements made to IV drug delivery systems to reduce these risk points along the medication delivery pathway.

In 2008, CMS proposed a new rule regarding withholding additional Medicare payments for hospital-acquired conditions.⁷ Essentially, CMS no longer pays health care institutions for certain preventable conditions or errors that develop during the hospital stay of a patient who is using Medicare.^{8,9} The 8 selected conditions included in this rule are foreign object retained after surgery, air embolism, blood incompatibility, pressure ulcers, falls and trauma, catheter-associated urinary tract infections, surgical-site infection, and vascular catheter-associated infection. The choice of a particular IV drug delivery system may have an impact on vascular catheter-associated infection. Pharmacy-based IV admixture programs may be associated with an increased potential risk of microbial contamination because of multiple manipulations during the compounding

process. Manufacturer-prepared or point-of-care activated systems may reduce the potential for contamination and, thus, diminish the risk of hospital-acquired catheter-associated infections.

STANDARDIZED VERSUS CUSTOMIZED PARENTERAL NUTRITION

Parenteral nutrition formulations are complex pharmaceutical dosage forms. Compounding PN formulations involves multiple manipulations of various chemical entities and, thus, an increased chance of error.¹⁰ Because of this complexity, the Institute for Safe Medication Practices has designated PN as a high-alert medication.¹¹ In 2006, TJC’s NPSGs emphasized the importance of using standardized concentrations to reduce the occurrence of medication errors.¹² Clinical data on the practicality and potential for improvement in patient outcomes using standardized versus individually customized PN have become available only fairly recently, with existing viewpoints being divergent.¹³⁻¹⁶ Although the routine use of standardized PN is not explicitly required by TJC, evaluation by organizations for the potential transition from customized to standardized PN solutions is encouraged in anticipation of the future inclusion of these IV products in TJC’s NPSGs.

In 2007, the American Society for Parenteral and Enteral Nutrition (ASPEN) published a statement on PN standardization.¹⁶ After reviewing the literature associated with standardized PN formulations, ASPEN recommended the following:

- The process for PN management should be standardized throughout health care facilities and among clinicians.

- The clinical evidence on patient safety does not currently support the use of standardized PN formulations in all situations.
- Select patient populations may benefit from standardized PN.
- A mechanism for compounding customized PN formulations for medically complex cases should be in place in organizations that adopt the use of standardized PN.
- Implementation of a standardized PN process should include input from clinicians with expertise in nutritional support.
- PN compounding practices should adhere to recommendations promulgated by national professional organizations.

Although the general conclusion of the ASPEN statement regarding patient safety is that current evidence does not support the widespread adoption of standardized PN formulations, the use of a manufacturer-prepared PN formulation may reduce the chance for compounding errors and microbial contamination. In addition, there are some clinical data available that suggest that standardized PN solutions may not only prevent incidents in which sterile water for injection and dextrose are improperly administered, but also may provide better control of serum electrolyte values.¹³⁻¹⁵ However, the pervasive uptake of standardized PN formulations across health care organizations may not occur until the availability of specific outcome data linking the use of standardized formulations with improved efficacy and safety outcomes compared with individually customized PN formulations.

COMPOUNDING AUTOMATION

In the final report of the initial Consensus Development Conference, IV push and augmented IV

push systems were not listed among the safer IV drug delivery systems.² Although these systems have advantages regarding preparation and ease of administration, safety concerns abound, particularly with regard to steps taken when nurses prepare medications for IV push at the bedside. Such a system is often missing many safeguards and quality checks that are prevalent in other drug delivery systems. This lack of checks and balances may lead to medication errors.

Automated devices recently have become available that can compound batches of standardized doses or patient-specific doses of IV medications in syringe form.¹⁷ Devices are being developed for the production of IV admixtures and chemotherapy. The fill process for these devices begins with a pharmacist check of the list of ingredients to ensure accuracy of the compounded medication. The automated device either fills a batch of medications or fills patient-specific doses using information from orders in the pharmacy information system, which interfaces with the automated device's onboard systems. The automated device then selects and dilutes the appropriate medication and withdraws the needed amount. Before dispensing the medication, a patient-specific or batch label is attached to the filled IV product. Finally, a pharmacist verifies the information on the label and visually checks its content. If properly maintained, automated IV preparation devices not only ensure sterility and accuracy of dispensed doses, but they also can ensure that an institution is compliant with TJC standards.

SUMMARY

Since the initial Consensus Development Conference on the Safety of Intravenous Drug Deliv-

ery Systems in 1999, no major changes have occurred in the available systems. However, the policy and regulatory realms encompassing these systems have changed. Specifically, the USP Chapter <797> on compounding sterile preparations, the TJC medication management standards, and the CMS rule on hospital-acquired conditions have improved the safety of medication delivery. In addition, there is continued debate over the position of standardized versus customized PN formulations and whether or not standardized PN products may improve patient safety. Finally, the introduction of automated devices that safely and accurately compound IV syringes and bags may be another useful tool in the ongoing discussion regarding safe IV drug delivery systems.

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EDUCATIONAL OBJECTIVES

Upon completion of this activity, participants will be able to:

- Explain the results from the original Consensus Development Conference on the Safety of Intravenous Drug Delivery Systems (1999).
- Compare recent standards, including the United States Pharmacopeia (USP) Chapter <797>, The Joint Commission (TJC) medication management standards, and the Centers for Medicare and Medicaid Services (CMS) rule on hospital-acquired conditions.
- Describe the American Society for Parenteral and Enteral Nutrition (ASPEN) statement on standardization of parenteral nutrition solutions.



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