

Intravenous Smart Pumps

ABSTRACT

Intravenous (IV) smart pumps provide substantial safety features during infusion. However, nurses need to understand the requisite education necessary to fully benefit from and improve IV smart pump use and clinical integration. Failure to use IV smart pumps places the nurse and patient at increased risk.

Key words: culture of safety, infusion therapy, IV smart pumps, patient safety.

Smart pumps are intravenous (IV) infusion devices that provide computerized dose error-reduction software with IV therapy libraries and corresponding administration rate limits. If a rate is programmed outside of the predetermined volume of IV therapy (ie, medications, nutrients, blood products, and fluids) to be administered, a warning screen appears on the IV smart pump. If the rate is above the soft limit, the nurse administering the IV therapy has the option to override the warning and administer the dose. Soft limits are provided to tell the nurse administering the medication that the rate being programmed is potentially not safe and is outside of typical dose recommendations. If the programmed rate is above the predetermined hard limit, then the nurse cannot administer the IV therapy at that rate but may administer the IV therapy at a different rate within the predetermined limits. Hard limits are doses above any recommended dose or a dose known to be dangerous to patients. Nurses should be aware of IV smart pump

technology and functions. Nurses must also identify and understand the risks associated with not appropriately using IV smart pumps when administering IV therapy.¹

The benefits of IV smart pumps include an electronic IV therapy library, reduction of calculations, multiple functions (eg, syringe, large volume), warning and alarm systems, and data collection from the smart pump software. The data collected by the IV smart pump relate to the IV therapy selected, dose, time of day, date, alarms, warnings, and actions taken related to the alarms and warning, including overrides.² Overrides occur when the medication is administered at doses within the soft limit up to the hard limit, thus outside of the typical recommended range for the particular IV therapy. If a nurse harms a patient by not using the IV smart pump correctly or without using the safety tool of the therapy library, the nurse could be found at fault of negligence. Negligence has 4 components that the plaintiff (ie, injured patient) needs to prove in a court. The first is that the nurse (defendant) has a duty to provide reasonable care. Next, the nurse breached the duty of care, and the patient suffered harm (injury). Lastly, the harm was caused by the breach, and damages are necessary.

WHY ARE IV SMART PUMPS IMPORTANT?

IV smart pumps are a technology that truly functions at the patient's side. This tool is used as a safety device to measure and administer IV infusion therapy to patients. IV smart pumps should be used every time a patient receives IV therapy in the acute care setting.^{3,4} IV smart pumps directly affect patient care.

IV smart pumps are relatively low cost with a quick return on investment.⁵ Billions of dollars are spent on health care that never directly affect patient care. Billions of labor and thinking hours are spent in the health care system, although they never directly affect or improve safe patient care. Smart pumps, however, can improve patient safety by reducing medication administration errors.⁶

IV medication administration is a complex process. In fact, the ECRI Institute lists "medication administration errors using infusion pumps" as number 3 in their "Top 10 health technology hazards for 2012."⁷ Three studies

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found varying rates for error risk in the medication administration phase of treatment. In 1995, Leape and colleagues⁸ found that the risk of error in the medication administration (ie, nurse administering the medication to the patient) phase was 51% at a large urban academic medical center. In 2002, Barker and colleagues⁹ found that this step had a risk for error of 28% in 36 various health care facilities. In 2007, Buckley and colleagues¹⁰ were able to reduce the risk for error in medication administration to 6% in a neonatal intensive care unit. These 3 studies were very different, however. The reductions in risk were multifactorial and not directly attributed to the use of IV smart pumps in these studies. The settings and sample sizes do not compare well, although all 3 studies did use direct observation to obtain their data. However, the 3 studies make the case that since 1995, through the health care quality revolution in the United States, a tremendous amount of energy has been expended on improving the safety of the medication administration process. Automated dispensing cabinets, computerized provider order entry (CPOE), electronic health records (EHRs), electronic medication administration records (EMARs), wireless connectivity of medical equipment and technologies, computers on wheels, and efforts of interoperability and bar coding have all been used to reduce medication administration errors. The above-stated technology has helped, but nurses are necessary to ensure safe medication administration to patients. The “rights” of medication administration (ie, right patient, right medication, right dose, right route, right time, and right documentation) are still necessary, though fraught with the components of human error.¹¹

Until seamless CPOE through IV smart pump therapy administration can be fully automated, the best expectation of IV smart pumps is to reduce catastrophic patient injury with dose error-reduction software.¹² Some companies, however, have started to clinically institute IV smart pumps and software to begin the full integration of these medication administration systems.

STANDARD OF CARE

The risk to nurses of not using IV smart pumps when the technology is provided is immense. When IV smart pump technology is made available in the work setting, it becomes the standard of care for nursing within the institution.¹³ A story about a tugboat is a foundational law case typically referenced in medical malpractice cases for negligence.¹⁴ The story of the *Hooper* is described below.

Coal barges were lost in a storm while being towed by a petitioner’s 2 tugboats, the *Montrose* and *Hooper*. Trial court found the tugboats to be *unseaworthy*, an admiralty term comparable to *negligence* in ordinary

tort cases. The *Hooper* had no working radios that would have enabled its crew to hear about the coming bad weather and seek shelter. The tugboat company appealed.

It seems that the masters of the tugboats would have taken no undue chances had they received the broadcasts predicting the foul weather. Radios were typically the property of the tugboat captains, partly a toy and partly equipment. Neither was furnished or supervised by the tugboat owner. It is also not fair to say that there was a general custom among coastwise carriers to equip their tugs with radios. However, the court determined radios to be like a set of ears for the tugboat, as the master’s binoculars are the eyes to see a storm signal—precautions so imperative as a radio that even their universal disregard will not excuse omission. Compliance with the custom is no defense of a tort claim. The tugboat company was found negligent.¹⁴

The *Hooper* case demonstrates that technology that enhances safety must be used when available. The court ruled that even custom (eg, a hospital’s lack of a culture of safety) is not an excuse for not supplying the necessary technology. Subsequent case law has limited negligence liability for providers, in most cases, to instances in which the technology is provided in the workplace. Therefore, nurses should receive education and instruction to use new technologies as they become available in their places of work.

In tort cases, the expert witness describes the standard of care in accordance with what a “reasonable and prudent nurse”¹⁵ would have done in a similar situation as the defendant-nurse. The American Nurses Association¹⁶ sets the standard for nursing practice generally with their publication *Nursing: Scope and Standards of Practice*. The Infusion Nurses Society’s *Infusion Nursing Standards of Practice*¹⁷ describes what is expected of nurses when providing infusions.

WHAT IV SMART PUMPS CANNOT DO

There are many current limitations to IV smart pump technology. Smart pumps are not fully interoperable with the software and hardware used in the medication administration process and, therefore, cannot receive or provide feedback or direction to the EHR or EMAR. The pump cannot generally stop or start without human intervention unless the device alarms or the dose is out of therapeutic range and the hard-limit warnings are triggered. IV smart pumps cannot identify the patient; however, some do offer bar code identification. The ability to assess the patient and understand the medication’s appropriateness is not a function of the IV smart pump, but it can sense increased pressure from the patient side of IV tubing. The IV smart pumps will



Figure 1 Paper clip holding up an IV bag on a wall in an ED hallway bed. Abbreviations: IV, intravenous; ED, emergency department. (Courtesy of Andrew Harding, MS, RN, CEN, NEA-BC, FACHE, FAHA, FAEN).

typically increase the amount of pressure used to administer IV infusion. Smart pumps also cannot provide the rights of medication administration, which remain a standard of practice for registered nurses.¹¹ Although bar code verification is used to identify the medications and the patient at the point of care during medication administration, registered nurses continue to use workarounds if their work flow is affected by inefficient processes. The IV smart pump is connected to the patient's access device only by plastic connector. IV smart pumps are not able to assess patients. It remains imperative that nurses assess the patient's vital signs and recognize signs of phlebitis, infiltration, or extravasation, which cannot be accomplished by IV pumps.

WORKAROUND

A workaround is a process to circumvent a problem (eg, smart pumps or medication administration), but it does not eliminate the problem (Figure 1). The figure shows an IV bag hanging by a paper clip, which is taped to a wall. The nurse working in the emergency department did not have an IV pole available and used the tools she had to create a workaround. Nurses are very creative and have the ingenuity to accomplish what needs to be done in a timely manner. However, the number one legal risk for the nurse and patient is non-compliance by either not using the IV smart pump as a whole or not using the smart pump IV therapy library.^{13,18} The next leading concern is overriding soft-limit settings and warning alarms.¹⁸

There are many instances in which nurses do not use smart pumps when they are available. Three typical examples include when nurses need to administer

limited IV fluid to a healthy patient, when nurses administer an antibiotic to a patient before the patient enters the operating room, or in the trauma room, when nurses need to administer fluids and blood products rapidly to the patient. The need to use the smart pump is not withdrawn in these circumstances, but work flow and clinical presentations require action or speed that is not provided easily with smart pumps. Therefore, nurses choose a workaround to accomplish what they feel needs to be done for patients in a compressed time period. The direct care providers are keenly aware of what is needed to improve smart pumps and, therefore, should be directly involved in the implementation and improvement of IV smart pumps. If a patient is harmed while a workaround is being used, however, the nurse will be in jeopardy of litigation.¹³

HOW TO INCREASE USE

The Institute for Safe Medication Practices (ISMP)¹⁹ details how to implement and standardize the use of IV smart pumps. They suggest first analyzing the scope of the implementation, then identifying the stakeholders. Implementation issues such as developing standardized concentrations, creating drug library subsets, and setting dosing limits are among the interdisciplinary efforts discussed. Providing appropriate education for the stakeholders is necessary. Conducting regular maintenance and monitoring ensures continued quality assurance.

This author described in a recent publication an implementation effort to increase nurses' use of IV smart pumps.⁵ The ISMP identified the same themes to be effective in this effort: establishing a team, providing education, and modifying the technology. Among the specific interventions used to increase use of the IV smart pump library were requesting feedback from staff; communicating with direct care staff regarding library use by nursing unit, library amendments, or changes in IV administration policy; and adding all IV medications on the hospital formulary to the IV library. The institution's efforts to increase the culture of safety should not be discounted.²⁰ However, staff accounts of how the IV smart pump was able to prevent devastating medication errors were powerful tools.²¹

Stories were solicited from direct care providers who had been stopped from an incorrect administration by IV smart pumps, which generated alarms when hard limits were met. Nurses would tell these accounts at staff meetings, during lunch, and by e-mail. Stories described instances in which the IV smart pump technology prevented catastrophic overdoses of chemotherapy or heparin. Having direct care nurses describe how the safety technology affected actual patients had an emotional (ie, affective) impact on other nurses.

OVERSIGHT

The need for oversight of this patient safety activity in the use of IV smart pumps is vital to its continued effectiveness.^{5,17,22} Education about how to use the IV smart pumps should be provided during orientation and annually through competency assessment (ie, cognitive knowledge and psychomotor skills). Follow-up is necessary for the IV smart pump program. This consists of drug library tailoring, reviewing alarm reports, creating usage reports, and quality assurance/quality improvement activities. The data collected in the IV smart pump software can be powerful if monitored quickly and analyzed to seek out near-miss events that encourage changing the drug library (eg, medications or limits) and workaround activity.

Someone has to be responsible for reviewing the data reports. If necessary, contact the pump's manufacturer, and they will provide a representative from the company to help your team determine strategies for reviewing the data. Reach out to colleagues in your local area to learn their best practices and to benchmark your competition. Direct care providers must receive communication and feedback about the reports and analysis. Obtaining feedback from the direct care providers is the best way to understand their work and how to integrate the use of IV smart pumps into the care of patients more effectively.

CONCLUSION

IV smart pumps benefit nurses by reducing the mathematical calculations used in high-pressure circumstances of patient care. There are low barriers to entry for nurses to use the IV smart pump with minimal education. The smart pumps are available for a variety of infusion modalities, including large-volume, syringe, epidural, and patient-controlled analgesia. Secondary infusions can also be coordinated with IV smart pumps but can pose risks.²³ Patients benefit from the use of IV smart pumps through a reduction in medication errors. Most important for patients, IV smart pumps are a means to prevent catastrophic injury from an IV dose out of the normal range when nurses make use of the IV smart pump therapy libraries.

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