By Andrew D. Harding, MS, RN, CEN, NEA-BC, FAHA, FACHE

Increasing the Use of 'Smart' Pump Drug Libraries by Nurses:

A Continuous Quality Improvement Project

One hospital's efforts to reduce the risk of medication errors.

Photo courtesy of Alaris.

Receiving IV therapy can be risky and dangerous for patients. In its 2000 report *To Err Is Human: Building a Safer Heath System*, the Institute of Medicine noted that the use of automated technologies such as "smart" technology IV therapy administration pumps (smart pumps) could potentially help prevent medication errors by reducing reliance on human vigilance.[1] Smart pumps are IV infusion devices with built-in computers containing electronic libraries of information on selected drugs and fluids, including predetermined volumes and concentrations with corresponding administration rate limits. Of course, the use of smart pumps alone isn't enough to guarantee patient safety; some risk from human error will always exist. But when these devices are well supported through proper programming, drug library development, limit setting, compliance reporting, follow-up reviews, and staff education, they can be useful tools in

ABSTRACT

The use of infusion pumps that incorporate "smart" technology (smart pumps) can reduce the risks associated with receiving IV therapies. Smart pump technology incorporates safeguards such as a list of high-alert medications, soft and hard dosage limits, and a drug library that can be tailored to specific patient care areas. Its use can help to improve patient safety and to avoid potentially catastrophic harm associated with medication errors. But when one independent community hospital in Massachusetts switched from older mechanical pumps to smart pumps, it neglected to assign an "owner" to oversee the implementation process. One result was that nurses were using the smart pump library for only 37% of all infusions.

To increase pump library usage percentage—thereby reducing the risks associated with infusion and improving patient safety—the hospital undertook a continuous quality improvement project over a four-month period in 2009. With the involvement of direct care nurses, and using quantitative data available from the smart pump software, the nursing quality and pharmacy quality teams identified ways to improve pump and pump library use. A secondary goal was to calculate the hospital's return on investment for the purchase of the smart pumps. Several interventions were developed and, on the first of each month, implemented. By the end of the project, pump library usage had nearly doubled; and the hospital had completely recouped its initial investment.

KEYWORDS: culture of safety, nursing leadership, patient safety, return on investment, smart pump, smart pump library, smart pump technology

creating what the Joint Commission has called a "culture of safety." Since nurses are the primary users of smart pumps, strong nursing leadership and support for implementing this technology,[2] along with education and training of nursing staff, are arguably even more important to this endeavor than the technology itself. There's also evidence that the use of smart pumps can be a cost-efficient way for hospitals to reduce the risks associated with IV therapies.[3]

What smart pump technology offers. The smart pump library is essential to the device's effectiveness. This electronic database of medications and fluids is instantly accessible to nurses via the smart pump at the point of care. At minimum, it should include all high-alert drugs and their standard concentrations, specified "soft" and "hard" limits for each therapy as determined by the institution, and individualized library subsets or "profiles" (databases devoted to specific patient populations or care areas).

Soft limits are dosages or administration rates of the drug or fluid that are out of range for typical therapy. When a soft limit alert is detected, the pump pauses the infusion, awaiting the nurse's review of the entered dosage. At this point the nurse must choose one of three options: cancel administration, change the dose or the administration rate to one below the soft limit, or override the soft limit by confirming the higher dose or rate. Only after the nurse confirms her or his decision will the pump resume functioning. In contrast, hard limits are doses or administration rates for a drug or fluid that are beyond any recommended amount. When a hard limit alert is detected, the smart pump stops the infusion and cannot be reprogrammed to override that limit. In such instances, the nurse must cancel administration or lower the dose or the administration rate into the acceptable range. This incorporation of soft and hard limits into the pump's software helps to prevent harm related to IV therapy administration errors.

The smart pump library's profiles can help in tailoring IV therapy administration to different patient populations or care areas (for example, oncology or neonatal ICU). Such profiles should be created based on data from the hospital pharmacy regarding IV therapies used in particular patient care areas or units; direct care providers may also be involved in selecting which therapies to include. The profiles can then be periodically updated by the pharmacy, based on reports generated by the smart pump software and the electronic medication administration record (eMAR), as well as on feedback from unit staff.

ONE HOSPITAL MAKES THE SWITCH, BUT . . .

In the spring of 2008, an independent community hospital in Massachusetts decided to replace its older, outmoded IV pumps after an adverse drug event (ADE) was found to be related to one pump's mechanical failure. The process of reviewing, selecting, and preparing for the use of smart pumps began in May 2008, and involved many departments. The hospital evaluated its systems and determined what changes were needed in order to implement smart pump technology. A product trial was conducted and several smart pumps

were evaluated with regard to their different features, vendor and technical support, and whether the software allowed usage reports to be generated. As the primary end users, nurses who provided direct care were involved in the pump evaluation and selection process.

The hospital's biomedical engineering and information technology departments then determined that the necessary support systems were in place. The hospital had already implemented the eMAR—a point-of-care process used to monitor bedside administration of medications—and installed automated medication dispensing cabinets on every unit. It also had the required computer server and wireless technology for the selected pump. Although some supplemental technologies, including computerized provider order entry (CPOE) and bar code medication administration (BCMA), hadn't yet been purchased, the hospital planned to add these within 10 months of smart pump implementation.

It was intended that nurses would use the smart pump libraries as a way to lower the risk of ADEs and ensure patient safety.

Shortly before smart pump implementation began, nurses on all units completed in-service education, which included a review of the different processes necessary to safely administer IV therapies and to troubleshoot typical pump displays (such as alarms) at the bedside. Additional education was offered to nurses on each shift during the first three weeks of implementation.

A flawed beginning. The hospital implemented the new smart pumps in January 2009. The clinical leadership team believed that interdisciplinary collaboration had occurred during the planning phase and was continuing during the implementation phase. Unfortunately, what no one recognized was that no "owner" had been assigned to oversee the entire smart pump implementation process.

Throughout implementation, each department addressed its own responsibilities. The information technology department set up the server and the wireless technology, the pharmacy entered medications into the smart pump drug library and specific profiles, and the nursing department educated the nurses on how to use the smart pumps. But the nursing quality team (NQT) made no provision for postimplementation monitoring to see if, when, and where the smart pump library feature was being used.

In June 2009, during a performance improvement meeting, the NQT representative asked, "Are we using the smart pump technology?" After the meeting, usage reports were run from the smart pump software. An analysis revealed that, for all infusions occurring between January and June, the smart pump library had been used in only 37% of these. The remaining 63% had been performed using rate-based programming, which involves manually entering an administration rate without identifying the drug being given, thus bypassing both the pump library and limit settings. The analysis also indicated that nurses weren't using the smart pump profiles for their particular patient care areas, since the only way to access the library is through a profile. And it revealed the lack of comprehensive interdisciplinary collaboration for smart pump implementation, smart pump library development, and monitoring. This set the stage for the quality improvement project, and the NQT and the pharmacy quality team (PQT) began collaborating to find ways to increase the pump library usage percentage.

A PROCESS OF CONTINUOUS IMPROVEMENT

Objectives. The smart pump quality improvement project had two stated goals. The primary goal was to increase nurses' use of the smart pump library for the administration of IV therapies. An arbitrary goal of 90% usage was chosen as an initial benchmark goal; that is, it was intended that in 90% of infusions or better, nurses would use the smart pump libraries as a way to lower the risk of ADEs and ensure patient safety. The secondary goal was to determine the hospital's financial return on investment (ROI) for the purchase of the smart pumps.

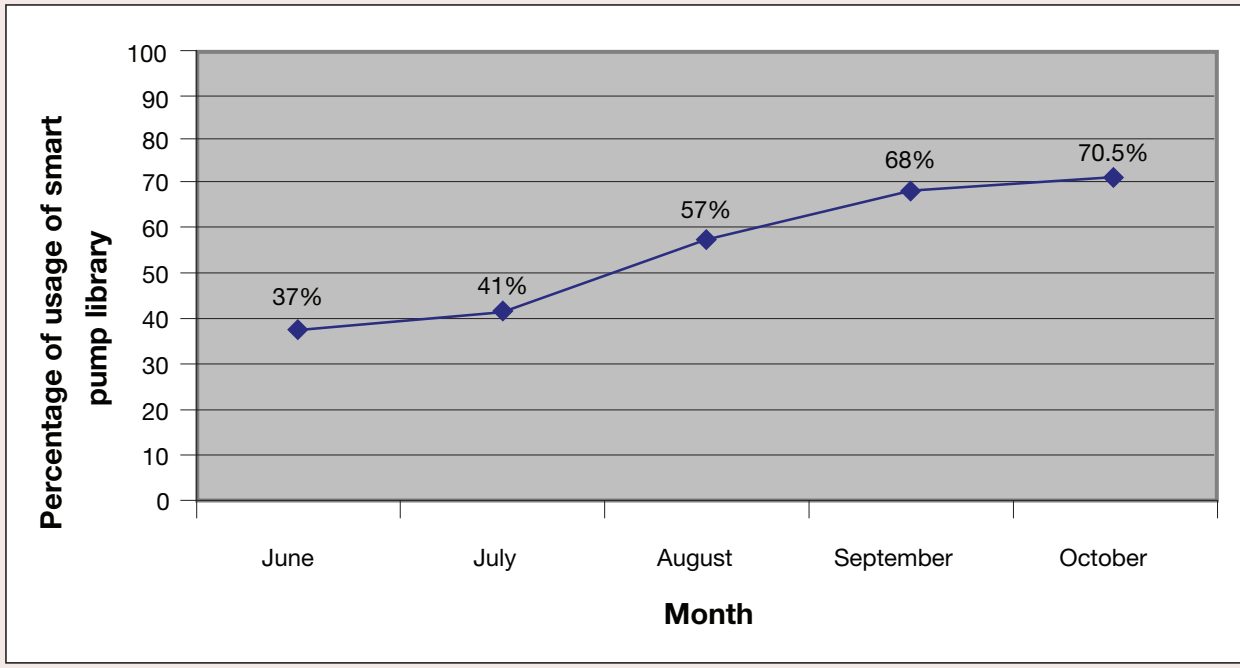
Setting. The hospital, an independent community hospital in suburban Massachusetts, is licensed for 140 beds and has 54,000 ED visits annually. Besides the ED, patient care units include an operating room, a postanesthesia care unit, an outpatient department, a surgical unit, a medical unit, a telemetry unit, an ICU, an elderly behavioral health unit, and a transitional care unit. Smart pumps are available for use on all units. Each unit is managed by a separate nurse manager and has a representative on the NQT. The hospital employs two nurse educators who provide education for the entire facility. About 30% of the nurses on staff have a bachelor of science in nursing or an advanced nursing degree.

Interventions. In order to increase nurses' use of the smart pump library, the NQT took actions and implemented several interventions from July through October 2009. These are described in detail below. (For a month-by-month list of these actions and interventions, as well as a graph showing monthly library usage percentage changes, see Figure 1.)

THE PROCESS AS IT UNFOLDED

July. In July, the NQT started to collect feedback from and communicate feedback to direct care nurses in every patient care area about smart pumps and pump library usage via e-mail, staff meetings, and one-on-one conversations. This included asking nurses why the

Figure 1. Smart Pump Library Usage Percentages and Interventions, June–October 2009



Month	Interventions[a]
June	• Identified clinical problem
July	• Collected feedback from and communicated feedback to direct care nurses via e-mail, staff meetings, and one-on-one conversations • Communicated with direct care nurses to determine why smart pump library profiles weren't being used • E-mailed nursing staff weekly with usage percentages for the smart pump library by profile
August	• Ran weekly usage and monthly limit override reports from the smart pump library database • Contacted the smart pump manufacturer's clinical representative regarding best practices • E-mailed nursing staff weekly with current library usage percentages by profile, any upcoming changes to the library, and a request for feedback • Added and amended therapies in the smart pump library • Added "IV fluid" and "IV antibiotic" to smart pump library choices • Updated and disseminated revised IV medication administration policy • Spoke with Institute for Safe Medication Practices vice president
September	• Updated profiles so that the first three screens reflected the most frequently used IV therapies • Reviewed and updated soft and hard limits in smart pump library using Lexicomp Online • Initiated reporting of stories of nurses' "saves" in weekly e-mail
October	• Added or amended smart pump library so that *all* IV medications on hospital formulary were included • Updated profiles based on nurses' feedback forms from medication rooms • Obtained nurse manager feedback from unit councils

[a]New interventions were implemented on the first of each month. New interventions were added to those of previous months, which were ongoing.

RESOURCES FROM THE INSTITUTE FOR SAFE MEDICATION PRACTICES

- *Proceedings from the ISMP Summit on the Use of Smart Infusion Pumps: Guidelines for Safe Implementation and Use*
  www.ismp.org/tools/guidelines/smartpumps/default.asp
  Guidelines address various areas, including equipment, staff education, specialized patient care areas, vendor support, and smart pump library development.
- *List of High-Alert Medications*
  www.ismp.org/tools/highalertmedications.pdf
- *Effective Approaches to Standardization and Implementation of Smart Pump Technology: A Continuing Education Program for Pharmacists and Nurses*
  www.ismp.org/profdevelopment/SmartPumpTechnologyforwebce.pdf

smart pump technology wasn't being used more regularly. The most frequent responses included some version of: "The pump is hard to use," "The profile doesn't have the medications I need," "The alarms keep going off," and, "It's just easier to use the rate-based programming feature."

Usage reports showing library usage percentages by profile—that is, for each patient care area—were also produced via the smart pump software, and the NQT began e-mailing nurses weekly with this data, as well as with any upcoming changes to the pump library. (Although the measured and reported outcome was total library usage percentage, the NQT also monitored usage by profile throughout the project, as a way to better assess efficacy of changes and demonstrate leadership's responsiveness to staff.)

July results and adjustments. At this point we didn't consider these initial communications to be an intervention. Yet, although no other changes had been made, the pump library usage percentage for total infusions rose from a baseline of 37% for the period from January through June to 41% for July, an 11% increase. It was suspected that this increase possibly reflected a Hawthorne effect (a form of reactivity in which people improve or modify some aspect of their behavior simply because they know they're being studied).

During July, the first formal interventions were being developed by the NQT and the PQT for implementation on August 1. It was decided that, thereafter, any new interventions would be implemented on the first day of each month. Previously implemented interventions were continued as well.

August interventions included the following: contacting the pump manufacturer regarding best practices; running weekly usage and monthly limit override reports from the pump library database; adding and amending therapies in the pump library; e-mailing nursing staff weekly with library usage percentages by profile, upcoming changes to the pump library, and requests for feedback; adding two new categories, "IV fluid" and "IV antibiotic," to pump library choices; updating and disseminating a revised IV medication administration policy; and speaking with a vice president from the Institute for Safe Medication Practices (ISMP).

The NQT contacted the pump manufacturer's clinical representative and asked for further support. Although the representative could provide only a few examples of best practices for smart pumps—such as standardizing drug concentrations in the pump library and providing ongoing staff education—these were in keeping with best practices cited in the ISMP's guidelines for the implementation and use of smart pumps.[4] The representative also provided an onsite lecture for staff, using various reports produced from our smart pump database. The discussion allowed nurses to hear about the increased patient safety risks and potential legal implications of administering IV therapies without using the smart pump library, as well as how using the library becomes easier with experience. The representative also solicited feedback for product improvement and answered questions.

From the smart pump database, weekly reports of pump library usage percentage by profile were generated. These reports allowed us to identify the most frequently administered therapies for that patient care area. Additional medications that unit nurses indicated were used in a given patient care area but were missing from the profile were also added. The NQT and the PQT also scrutinized the pump database for soft- and hard-limit warnings to see which medication limits had been challenged during the previous three months, and a limit override report was compiled. After careful review by the nursing, pharmacy, and medical leadership, some changes to the library were made. For instance, soft limits for which there was no pertinent indication were eliminated. (Per hospital protocol, any changes to the smart pump library were also reviewed by the pharmacy and therapeutics committee prior to implementation.) Such changes were made both to ease nurses' frustration and to reduce the potential for alarm fatigue.

The NQT continued to e-mail the entire nursing staff with the weekly library usage percentage by profile and planned changes to the pump library, as well as to request feedback from staff nurses. Information was also shared in order to increase awareness, spur collegial competition, and show staff nurses that the nursing leadership was attending to and using their feedback. One concern the nurse managers had was that nurses could choose *any* smart pump library profile for an infusion, regardless of whether the patient was in that patient care area. For example, a nurse on the medical unit could select the surgical unit's smart pump library profile. Since each library profile is tailored to a specific

patient care area or unit, it's important that nurses use the appropriate profile. The nurse managers sought to convey this in their communications.

A challenge nurses faced in using the smart pumps was the number of choices for a single IV therapy. For example, normal saline is available in only one concentration (0.9% NaCl) but in five different container sizes (volumes) (50 mL, 100 mL, 250 mL, 500 mL, and 1,000 mL). In reviewing total IV infusions given via the smart pumps for January through July, we found that approximately 30% of all infusions were of IV fluids (such as normal saline, half-normal saline, lactated Ringer's solution). Since the smart pumps didn't interface with the eMAR and the hospital hadn't purchased CPOE, the NQT and the PQT decided to provide a consolidated "drug" choice of "IV fluid" in the pump library. This consolidated choice included all therapies that would be classified as "IV fluid" in all volumes and many concentrations. This option allowed the nurse to quickly select the more frequently used therapies, while excluding IV fluids with any other additives (such as dextrose) and those given in concentrations requiring extra care to ensure safety (such as dextrose 10% and sodium chloride 3%). The review also showed that 20% of all infusions given via the smart pumps were of antibiotics. The teams decided to provide a second consolidated drug choice of "IV antibiotic" in the pump library. Exceptions were limited to antibiotics (such as vancomycin [Vancocin]) that can have potentially adverse side effects.

council. This policy explained how to use the smart pumps, described the various unique library profiles, indicated ISMP guideline and other evidence-based parameters, and detailed the expectations for use of the smart pumps.

The NQT and the PQT also spoke by telephone with Susan Paparella, MSN, RN, an ISMP vice president. The ISMP sends teams to hospitals to perform "proactive medication safety risk assessments" and we interviewed her to learn more about how hospitals utilize smart pumps. She stated that many hospitals aren't fully utilizing the range of database reports available on smart pump library usage, so it's unknown to what extent these libraries and their patient safety features are being circumvented. In some hospitals, nurses and nurse managers either aren't aware that such usage information is available or report that they can't directly access it themselves. Moreover, according to Paparella, many hospitals don't take a comprehensive approach to placing their facility's IV formulary into the smart pump library. Some hospitals report pump library usage percentages as high as 90%; but if those libraries fail to include much of the formulary, then some frequently infused or dangerous therapies could conceivably be routinely administered without involving smart pump safeguards (such as soft and hard limits).

August results and adjustments. During August, after the implementation of the new interventions, the hospital's total usage percentage of the smart pump library for all infusions that month was 57%. This represented a 39% increase over the usage percentage in July and a 54% increase from baseline.

Over the four-month period of the project (July 1 to October 31), smart pump library usage for all infusions involving the smart pumps nearly doubled.

On August 1 the "IV fluid" and "IV antibiotic" choices were added to the pump library on the first screen of each profile. By adding these options, the number of choices for the included IV fluids and antibiotics dropped from 53 to two. (Each of the 53 therapies was retained individually in the smart pump library; if need be, a comparison of the IV dosing with the eMAR could be made.) Initially the direct care nurses were concerned that the specific therapy being administered wasn't displayed on the pump. But the benefits of the consolidated options—improved ease of use, timelier selection of the correct therapy, reduced frustration for nurses, and improved workflow—helped alleviate these concerns.

A revised and updated IV medication administration policy was distributed and explained to the nursing staff via e-mail, staff meetings, and the nurse practice

Feedback from nurses indicated that changes made to certain soft limits helped to reduce their frustration with using the smart pump library.

During August, the NQT and the PQT also searched for industry benchmarks on usage percentages for smart pump libraries based on the total infusions provided, but were unable to find any such benchmarks. (This is probably owing to several factors, including institutional differences in percentages of formulary IV medications included in the pump library, in practice settings and library profiles, and in technological sophistication—for instance, some institutions we spoke with either didn't monitor pump usage or were unaware of smart pump reporting software.) This unsuccessful search further confirmed what the ISMP vice president had

told us. As a result, it was decided to change the goal for library usage from 90% to a trend of continuously improving usage percentages.

September interventions included updating profiles so that the first three screens showed the most frequently used IV therapies, reviewing limit settings against those in Lexicomp Online (an independent database) and amending the pump library accordingly, and including nurses' stories of "saves" in the weekly e-mails to staff.

It's been estimated that each preventable ADE adds $8,750 (in 2006 dollars) in costs to an inpatient stay.

One difficulty that nurses had in using the smart pump library was that the selected pump model doesn't permit easy alphabetical selection. The medications and fluids in a given profile are presented in alphabetical order by default, and there is no option for beginning selection from any letter other than A. Moreover, each profile screen shows only eight therapies at once. However, the profile does allow for manipulation of the first three screens. Thus, after it was determined which therapies were the most frequently administered in a given patient care area, these were added to the profile's first three screens. This allowed the nurse to locate the most frequently administered therapies with fewer keystrokes.

The NQT and the PQT also decided to compare the soft and hard limits set in the smart pump library with those in comprehensive databases searchable through the computer software Lexicomp Online. This software provides medication profiles, including acceptable therapy limits for most IV medications, and using it gave us an evidence-based approach to choosing smart pump limits. In most cases, the original limits in our smart pump library had been added either unnecessarily or without an evidence-based rationale. After review by nursing, pharmacy, and medical leadership, further changes to limit settings were made accordingly.

In September, the weekly e-mails to staff now began to include the number of total "saves" per profile. (A save was defined as any time that a programmed infusion met the hard limit. This stopped the infusion and prevented potentially catastrophic harm to a patient.) To help motivate nurses to use the pump library, this information was also posted in the unit break rooms. (See Figure 2 for the number of saves by month.) Direct care nurses' stories of how using the smart pump library had helped prevent an accidental overdose or the administration of the wrong drug were also included in the weekly e-mail. These stories were soon being discussed in casual conversation throughout the hospital.

September results and adjustments. In September, total library usage percentage rose to 68%, up from 57% in August.

October interventions included the addition of all of the IV medications on the hospital formulary to the main smart pump library. This took two months of data entry; review by the nursing, pharmacy, and medical staff; and approval by the pharmacy and therapeutics

Figure 2. Monthly Saves, June–October 2009

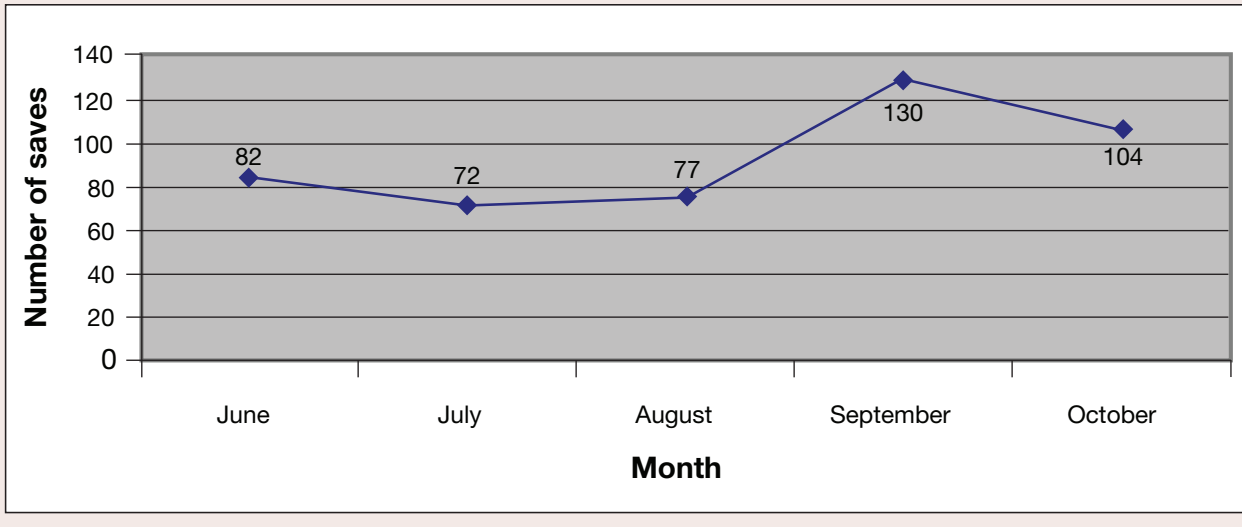
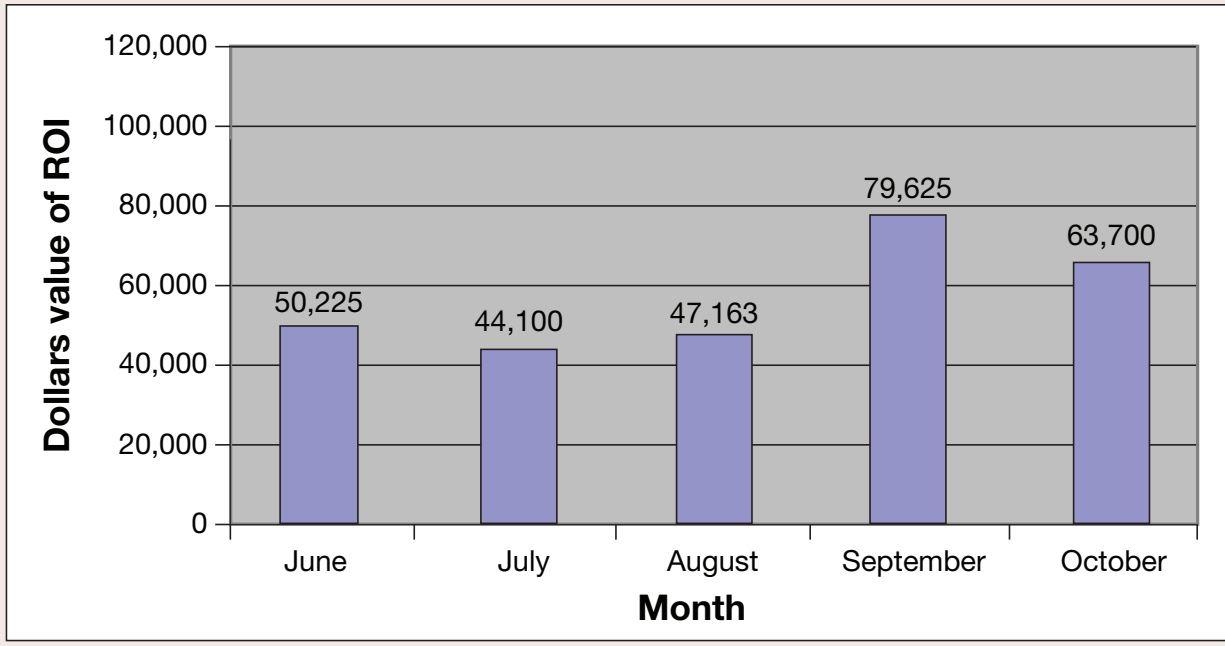


Figure 3. Return on Investment (ROI) by Month, June–October 2009



ROI formula calculations

	June	July	August	September	October
Number of saves	82	72	77	130	104
× 7% (%)	5.74	5.04	5.39	9.1	7.28
× $8,750 ($)	50,225	44,100	47,163	79,625	63,700

Total ROI (June–October)	$284,813
Total cost of implementation	$220,108
ROI (cost avoidance)	**$64,705**

committee before actual implementation on October 1. Relevant amendments to the individual library profiles were completed by this date as well.

Other October interventions included amending the profiles further, based on nurses' feedback solicited via paper forms placed in the medication rooms; and obtaining feedback from the unit councils. At unit council meetings, direct care nurses brought their experiences with the smart pumps to the nurse managers, who in turn brought that to the NQT.

October results and adjustments. Total library usage percentage in October rose to 70.5%.

RETURN ON INVESTMENT

As a way to measure the financial impact of implementing smart pump technology, the ROI was calculated monthly.

One large prospective study conducted in 36 institutions in two states found that approximately 19% of all doses were in error—and that 7% of all errors had the potential to cause harm to the patient.[5] It's been estimated that each preventable ADE adds $8,750 (in 2006 dollars) in costs to an inpatient stay.[6]

In order to calculate the ROI for the smart pumps, we multiplied the total number of hard-limit override attempts (saves) that the pumps prevented monthly by 7%. Each such override, if successful, could have led to a medication error; thus, multiplying the total number by 7% gave an approximation of the number of prevented ADEs. The 7% product was then multiplied by $8,750 to determine the monthly ROI. Using this method, we determined that the hospital had achieved complete cost avoidance ROI—that is, the costs so avoided completely covered the costs of implementation—within five months of tracking the data. See Figure 3 for a graph depicting these results.

DISCUSSION

Over the four-month period of the project (July 1 to October 31), smart pump library usage for all infusions involving the smart pumps nearly doubled. The greatest increase occurred in August, following the introduction of two initial screen options, "IV fluid" and "IV antibiotics," for the 53 most frequently administered therapies. This increase was likely due to the greater ease of use, as nurses administering any of those 53 therapies now had fewer pump screens to scroll through.

In evaluating a quality improvement project, it can be important to consider the resources and culture of the setting. At our hospital, factors that might have affected both nurses' usage of the smart pump libraries and the hospital's culture of safety overall included budgeted nurse staffing—the level of which placed it in the bottom 25th percentile for hospitals reporting to the oversight organization Massachusetts PatientCareLink (www.patientcarelink.org)—and recent, frequent turnover in the hospital's chief nursing officer position. It's unknown what effects these factors may have had on our results.

At the very least, the use of smart pumps should be the industry standard to provide for safer IV therapy administration.

Our findings in relation to other evidence. In a recent literature review, Hertzel and Sousa looked at nine articles that considered smart pumps and medication errors.[2] They found evidence that "bypassing the drug libraries was common among users of smart pumps." This lack of compliance was also felt to reduce the validity of the research studies evaluated. Hertzel and Sousa further noted, "Since smart pump technology is limited to detecting errors that exceed routine dosing and does not interface with medication orders"—that is, with processes and technologies such as CPOE and eMARs—"it is still vulnerable to the same failures that could occur without smart pump technology." Hertzel and Sousa called for "research designs that include measures of users' knowledge, skills, and compliance with the proper use of the smart pump technology as well as measures of leadership support." The results of our quality improvement project support that call, especially regarding the need for better understanding of how nurses use smart pumps.

A prospective study by Rothschild and colleagues at a large urban hospital emphasized the importance of taking user behaviors into account.[7] Although the researchers found that using smart pumps did not reduce medication errors, they concluded that this was because users often bypassed the library and overrode limits. They stated, "Improving medication administration safety requires not only well-designed technological tools but demonstrable institutional support and behavioral improvements."

An ISMP paper by Cohen and colleagues stressed the need for education and called for collaboration between pharmacy and nursing in "creating learning opportunities that ensure staff competency, focusing on key smart pump operations."[8] The authors also emphasized the importance of continuous vigilance in monitoring and improving processes related to smart pump use. Elias and Moss stated that for the full safety potential of smart pumps to be realized, direct care nurses must be involved in implementation and evaluation, and that such inclusion will increase nurses' confidence in using the pumps.[9]

Evaluating one hospital's intervention, Larsen and colleagues found that smart pumps, when used in conjunction with "human-engineered medication labeling" and the adoption of standardized medication concentrations, reduced the rate of reported infusion errors by 73%.[10] Breland described the continuous quality improvement processes used in implementing smart pumps at another hospital. He found that creating a customized library profile for each patient care unit helped to improve overall compliance with usage of the smart pump technology from 33% to 98% in 37 months.[11]

Finally, in an article for another publication, two colleagues and I considered the legal ramifications of failing to use smart pump technology when it's available.[12] We concluded that nurses could be found at fault in litigation if a patient were harmed as a result of such failure.

Limitations of our project. Beginning on August 1, new interventions were implemented only on the first day of each month, allowing us to compare the effects of new interventions with those of previous months. However, there were not enough data points for a statistical analysis. Furthermore, on the first of each month several interventions were implemented at once. This made it difficult to attribute increases in smart pump library usage to any one intervention. The NQT and the PQT acknowledged that other variables could affect pump library usage. Examples of such variables include direct care nurses' increased awareness of smart

pump safety features, including the library; differences in nurse managers' influence on different patient care units; differences in patient acuity; and differences in patient populations.

Our project was completed at one suburban acute care hospital; the results may not be replicable at or generalizable to other institutions.

There continue to be certain IV administration exclusions—those therapies that are provided without involving all of the smart pump's available safety features (for example, those given using a roller clamp or a "dial-a-flow" valve to regulate the flow rate). While this remained a concern, we decided to focus only on the data provided by the smart pump software (that is, only on smart pump–infused therapies).

Further implications. Smart pump technology is just one component in an institution's efforts to create safer medication practices. Integrating BCMA and other technologies into the process of selecting a therapy and programming the smart pump would further protect patients from receiving an incorrect dose.[4,13,14] BCMA requires the nurse to scan the bar codes assigned to the patient, the medication or fluid, and the pump. The integrated wireless network would then check the BCMA entries and the provider's order in the CPOE database and verify at the pump that the order is within the set standards for that therapy. It would also document in the EMAR, in real time, the actual dosage being administered. All of this further supports smart pump technology and adds extra safeguards. However, with or without BCMA and these other technologies, smart pumps with comprehensive libraries and limit settings for high-risk medications can prevent medication errors and help protect patients from potentially catastrophic harm.

At the very least, then, the use of smart pumps should be the industry standard to provide for safer IV therapy administration. As Gebhart noted in an article for *Drug Topics*, in an ideal system, "[t]he nurse would scan bar codes to verify pump, patient, drug, concentration, rate, and other factors, then start the infusion. Once the infusion was running, the pump would automatically report starting and ending time, rate, concentration, and other data to the medication administration record."[15] Another expert is quoted as saying, "That's the Holy Grail. . . . Everybody wants a seamless system with the fewest possible opportunities for error." Smart pumps are vital to creating such a system.

CONCLUSIONS

Nurses can and should be leaders in the implementation and use of IV smart pumps. Those who provide direct patient care must be involved with the planning of the smart pump library, especially the more specific library profiles used in specialized patient care areas. Nurse executives must champion the cause of patient safety in advocating the use of smart pump technology; indeed, nurse leaders should communicate to their nursing teams the idea that using the smart pump library for every infusion is a professional obligation. Improving the quality of nursing care, as well as the organization's culture of safety and its financial discipline, are each further reasons to support the use of smart pump technology. Resources are available to assist in the effective implementation and use of smart pump technology (see *Resources from the Institute for Safe Medication Practices*). ▼

For 29 additional continuing nursing education articles on the topic of drug therapy, go to www.nursingcenter.com/ce.

Andrew D. Harding is a clinical nurse specialist at Good Samaritan Medical Center in Brockton, MA. *He acknowledges Linda J. Curtin, PhD, RN, CCRN, and Kristen A. Sethares, PhD, RN, CNE, for their reviews of the manuscript.* *Contact author: adhardingrn@gmail.com.* *The author has disclosed no potential conflicts of interest, financial or otherwise.*

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