

Implementation of Wireless “Intelligent” Pump IV Infusion Technology in a Not-for-Profit Academic Hospital Setting

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Abstract

Purpose: This paper describes the implementation of wireless “intelligent” pump intravenous (IV) infusion technology in a not-for-profit academic, multicampus hospital system in the United States.

Methods: The process of implementing a novel infusion system in a multicampus health care institution (main campus plus three satellite campuses) is described. Details are provided regarding the timelines involved, the process for the development of the drug libraries, and the initial implementation within and across campuses.

Results: In early 2004, with the end of the device purchase contract period nearing, a multidisciplinary committee evaluated potential IV infusion pumps for hospital use. In April 2004, the committee selected the *Plum A+* infusion system with Hospira *MedNet* software and wireless capabilities (Hospira Inc., Lake Forest, IL). Implementation of the single-channel IV infusion system took place July through October 2005 following installation of the wireless infrastructure throughout the multicampus facility. Implementation occurred in July, one campus at a time; the three smaller satellite campuses went “live” before the main campus. Implementation of the triple-channel IV infusion system took place in March 2006 when the wireless infrastructure was completed and fully functional throughout the campuses, software was upgraded, and drug library revisions were completed and uploaded.

Conclusion: “Intelligent” pump technology provided a framework to standardize drug concentrations used in the intensive care units. Implementation occurred transparently without any compromise of patient care. Many lessons were learned during implementation that explained the initial suboptimal compliance with safety software use. In response, the committee developed strategies to increase software utilization rates, which resulted in improved acceptance by nursing staff and steadily improving compliance rates. Wireless technology has supported remote device management, prospective monitoring, the avoidance of medication error, and the timely education of health care professionals regarding potential medication errors.

Key Words — medication errors; safety software; safety management; risk management; quality improvement

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Infusion pump technology has revolutionized the administration of intravenous (IV) medications, with programming features such as intermittent and bolus dosing, preprogramming, and standby mode. Many of these medications in the drug library are “high alert” agents likely to cause injury if misused.¹ An estimated 90% of hospitalized patients receive IV medications, most being delivered by an infusion pump.² Although IV infusion pumps improve the accuracy and continuity of IV drug administration, these devices are involved in 35% to 60% of the 700,000 adverse drug events (ADEs) that occur annually in the United States.²⁻⁴ These ADEs, in turn, are costly and can result in significant morbidity and, occasionally, mortality.

The key steps in the process of IV infusion medication administration where potential errors can occur include reading the actual order, obtaining the medication, preparing the infusion, and programming the infusion pump. Major types of errors include misinterpretation of the order, obtaining the wrong medication or wrong concentration of the correct medication, using the wrong diluent or drug to prepare the infusion, and entering the wrong concentra-

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tion and/or infusion rate into the pump.^{5,6} Errors relating to programming of the infusion pump have the greatest likelihood of causing patient harm.⁵ Hence, investigation and actions to reduce these errors should receive priority.

As a result, a new generation of IV infusion pumps, known as “intelligent” or “smart” pumps with wireless technology, has entered the marketplace. The terms “smart” and “intelligent” are often used interchangeably to refer to this infusion pump technology. For the purposes of clarity, this article will use the word “intelligent” when discussing infusion systems with medication safety software. Safety Software is a server-based suite application designed to connect data from a hospital’s drug information library to infusion devices throughout the hospital to monitor, control, and provide reports at the device, group, or system-wide level.

These devices have the potential to prevent the majority of administration-related ADEs. The key feature of the intelligent pump technology is comprised of software that can be used to develop customized drug libraries or rule sets that are assigned to specific clinical care areas (CCA) representing all of the major patient care areas or specific patient populations using “high-alert” medications administered by IV infusion within that institution. Multiple classes of medications are easily incorporated into the drug libraries; next-generation devices can even calculate oncology medication dosages according to body surface area. The intelligent pump will alert the programmer if institution-defined parameters such as drug dose, dosing unit, dosing rate, or drug concentration are outside of pre-established limits.² This type

of pump also has free-flow protection, a safety feature that prevents unintentional over-delivery of fluids or medications.⁷

When used in conjunction with bar code technology, intelligent pumps help support the five “rights” of medication administration: the right drug to the right patient by the right route in the right dose at the right time.⁸ Several studies have identified reductions in pump-related errors subsequent to the implementation of intelligent pump technology. After implementation in a five-hospital health care system, only 2.6% of infusions resulted in programming alerts/overrides and 0.3% in alerts/programming changes. These results probably underestimate the potential for medication error “saves” — as compliance with the safety software was only 46% at the time.⁹ At a community hospital in California, the incidence of IV pump-related wrong dose errors fell from 24 events in 2002 to 10 events in 2003 (intelligent pump technology was introduced in January 2003).⁵ In a tertiary care hospital in Massachusetts, intelligent infusion pumps generated 863 alerts in 355 patients receiving parenteral anticoagulants over a 16-month period. The most common alerts involved underdosing (60%), overdosing (31%), and duplication of therapy (9%). In response to these alerts, users most frequently either cancelled (47%) or reprogrammed (43%) the infusions. During the 16-month study, four infusion rate errors occurred compared with 15 in the 16 months immediately preceding the study period.¹⁰ At a tertiary care pediatric hospital in Utah, the combination of standardized drug concentrations plus intelligent pump technology reduced the IV infusion medication error rate by 73%

(absolute risk reduction from 3.1 to 0.8 per 1,000 doses, $P < 0.001$). The frequency of at least 10-fold dosing errors fell from 0.41 to 0.08 per 1,000 doses.¹¹ Lastly, in a prospective, randomized, controlled trial conducted in two cardiac surgical intensive care units (ICU) and two step-down units during 2002, intelligent pump technology produced no measurable impact on serious medication error rates. This was likely due, in part, to bypassing the safety software (occurred during 25% of infusions) and overriding alerts, including the use of inappropriate boluses.¹

A major benefit of the combination of wireless technology with intelligent IV devices is the ability to manage devices from remote locations. With wired infusion devices, data retrieval from the pump is retrospective and device upgrades and downloads are performed manually, one pump at a time. Wireless infusion systems connected to a server provide the flexibility to download information to the pumps as well as collect up to 1 year’s worth of data, such as infuser status information and event data in near real-time on up to 2,000 devices simultaneously. An additional benefit of the near real-time transfer of infuser event and alarm data to a central server is that this information, when received, is stored in a SQL Server database and is immediately available to users for online viewing or reporting. The amount of data that can be stored in any SQL Server database is limited only by the actual disk space available to the system.

Wireless systems can provide bi-directional communication from server to pump and pump to server. Server-to-pump communication allows the facility to trans-

Table 1. Timeline for Implementation of “Intelligent” Pump Technology at Erlanger Health System

January to March 2004:	· Evaluation of existing marketed products
April 2004:	· Product selection
May 2004:	· Preliminary drug library(ies) prepared (<i>Excel Hospira MedNet</i>) · Delayed implementation due to lack of wireless capability
June 2005:	· Contractual arrangements finalized · Preparations started for “going live”
July 8, 2005:	· Safety software policies + procedures completed · Nursing inservices completed (goal: 85% to 90% of staff)
July 11, 2005	· Final version of drug library(ies) “ready to go”
July 20, 2005	· Erlanger East went “live”
August 5, 2005	· Erlanger Bledsoe went “live”
September 23, 2005	· Erlanger North went “live”
October 3, 2005	· Erlanger Baroness went “live”

fer hospital-specific drug libraries and configure wireless/network operating parameters to pumps from a remote location. Pump-to-server communication allows the pump to upload and report all events (eg, program start/stop, drug limit alerts, power state changes) and alarms to the server as they occur. Current technology has addressed issues regarding the protection of wireless transmission of data and patient information with the development of enhanced security features for 802.11g and 802.11a wireless networks.

Intelligent pumps also log data continuously, providing valuable continuous quality improvement (CQI) information.¹² These data may be retrieved for retrospective data analysis to help identify quality improvement (QI) issues that need to be addressed collectively or to prospectively analyze individual devices for specific clinical events. This technology also allows the facility to track idle and infusing pumps throughout the system; until recently, all such data review has been retrospective in nature. Additionally, wireless technology is available which allows “real-time”

review and intervention. Challenges associated with wireless technology include building a wireless infrastructure within the facility to support all of the wireless devices being used, as well as ensuring that the security of the existing network is adequate.

The purpose of this paper is to present the experience of a not-for-profit academic hospital during implementation of wireless intelligent pump technology across the entire multicampus facility.

BACKGROUND

Erlanger Health System (EHS) is a tertiary care, not-for-profit, academic facility affiliated with the University of Tennessee College of Medicine. The main hospital campus (The Baroness) and three outlying campuses (Erlanger East, Erlanger Bledsoe, and Erlanger North) are licensed for 818 acute-care beds and 50 long-term-care beds. One 24-hour central pharmacy and three satellite pharmacies (open 8 to 9 hours per day) service the four campuses. This facility is a Level I trauma center for adults and children and is the only provider of tertiary care ser-

vices for those living within a 150 mile radius of Chattanooga, Tennessee, as well as northern Georgia and northern Alabama. The main campus also houses the T.C. Thompson Children’s Hospital, which provides Level III neonatal ICU services. ICUs at EHS deliver trauma, medical, cardiac, surgical, burn, neurological, pediatric, and neonatal services with a total of 126 ICU beds. The EHS staff includes 999 registered nurses (RNs) and 124 licensed practical nurses (LPNs).

IMPLEMENTATION

A timeline for implementation of wireless intelligent pump technology at EHS is provided in Table 1. While evaluating the need to replace older infusion devices, EHS chose also to go wireless in order to streamline pharmacy’s workflow with the ability to upgrade drug libraries on multiple devices remotely. Wireless capability would also provide nursing the ability to manage and analyze data pulled from the pumps related to medication administration.

In early 2004, with the end of the device purchase contract peri-

Table 2. Location of Clinical Care Areas Within the Four Campuses of Erlanger Health System (EHS)

<i>EHS Clinical Care Areas (CCA)</i>	<i>Erlanger (The Baroness)</i>	<i>Erlanger East</i>	<i>Erlanger Bledsoe</i>	<i>Erlanger North</i>
Emergency Department	X			
Medical/Surgical	X		X	X
Labor and Delivery	X			
Obstetrics/Gynecology	X	X		
Pediatrics	X			
Pediatric ICU	X			
Neonatal ICU	X			
ICU	X			X
Renal Services/Dialysis	X			
Pediatric Emergency Department	X			
Cardiac Catheterization	X			
Operating Room	X			
Oncology	X			
Cardiac Step-Down Unit	X			

Note: The intensive care unit (ICU) CCA is used for all of the specialty ICUs housed in the main campus including: Medical, Cardiac, Surgical, Trauma, Burn, and Critical Care.

od nearing, a committee composed of 34 employees from various nursing units, nursing management, pharmacy, anesthesia, purchasing, biomedical engineering, and technology management evaluated four marketed IV infusion pumps. A weighted evaluation tool was created by representatives from pharmacy, nursing, and biomedical engineering departments to rate each infusion pump. Criteria evaluated included the physical dimensions, technical specifications, and equipment disposal requirements (IV solutions and administration sets). Ease of programming primary and secondary infusions, changing programming parameters, display of alarm messages and ease of resolving alarm conditions were also evaluated. The four different infusion systems were evaluated over a period of several months. The committee chose the *Plum A+* infusion system with *Hospira MedNet* software

and wireless capabilities (*Hospira Inc.*, Lake Forest, IL) for its safety features and flexibility. This infusion system allowed the administration of concurrent, delayed-start, and multistep infusions, for example, to deliver total parenteral nutrition and/or chemotherapeutic agents.

Within the multicampus hospital complex, eight CCAs were initially identified and selected for implementation of the new pump/software technology, which included: Emergency Department, Medicine/ Surgery, Oncology, Obstetrics/ Gynecology (OB/GYN), OB/GYN Erlanger East, Pediatrics, Surgery, and ICU. The safety software can store a total of 18 CCAs. The committee thought that tailoring the drug libraries to specific patient care areas would result in improved compliance due to the appropriateness of the drug-dosing parameters. Additional CCAs were created and designated across the

multiple campuses, again tailored to specific patient populations: Cardiac, Renal Services/Dialysis, Neonatal ICU, Medicine/Surgery Erlanger North, Medicine/Surgery Bledsoe, and Erlanger North ICU. Three CCAs were added in March 2006 (Pediatric Emergency Department, Cardiac Catheterization Lab, and ICU [antimicrobials]). An example of how this technology is responsive to the health system's needs is in the flexibility of designing the drug library and designating CCAs. After a period of time, end-user feedback prompted a review and change in CCAs to better meet the needs of specific patient care areas (see Table 2).

Proposed drug libraries were developed by a clinical pharmacist in May 2004 to help streamline implementation once contractual arrangements had been finalized. Initially, 13 drug libraries were developed; additional CCAs were

developed that were specific to patient population and/or location in the complex (see Table 2). While some CCAs contained as few as 10 medications in their drug libraries, all ICU CCAs used the software maximum of 150 medications per CCA. The programming parameters for any specific drug could vary between CCAs. When an infusion pump was initially assigned to a patient, the CCA had to be designated at that time. If the patient was transferred to another unit, the CCA would be changed by the receiving nurse to reflect the different unit or level of care the patient required.

Preparation of the drug libraries involved searching and collating the institution's existing resources. These included IV preparation guidelines, policies and procedures (P&P) governing medication administration (nursing and unit/patient population-specific P&P), and standing order/electrolyte replacement protocols. Drafts of the libraries were developed on an *Excel* (Microsoft, Redmond, WA) spreadsheet for subsequent import to the safety software. In retrospect, building the drug library utilizing the safety software from the beginning would have been more efficient due to the help features available in the software to assist the pharmacist with development. Additionally, using more nurses as resources in the development of the initial drug libraries may have alleviated some of the subsequent drug library revisions.

These drafts were first organized by generic drug names. Upon review, nurse managers requested a change to listing by brand names, with the exception of generic drugs dopamine, dobutamine, lidocaine, nitroglycerin, procainamide, van-

comycin, gentamicin, and tobramycin. The committee agreed that nursing staff would be more comfortable with brand names as opposed to generic names. Each library was organized in the following order: maintenance IV fluids, electrolyte replacement, individual nonantimicrobial drugs, and individual antimicrobial drugs. Brand and generic drugs were listed separately in alphabetical order. Hard and soft dosing limits were established primarily using data provided by the drug manufacturers as well as input from clinical specialists based on their area of clinical expertise and their experience delivering these medications to patients. It was challenging to set limits for each drug since dosing variations are common in clinical practice.

Following the review process, each CCA nurse manager signed off on her/his CCA drug library. A drug library request form was created to allow staff to suggest additional medications. If a prescribed medication was not listed in the drug library or if hard and/or soft limits in the rule sets of the drug libraries required adjusting, a drug library request form that was cosigned by the CCA nurse manager was to be submitted to the Pharmacy Department. The Software Program Administrator's responsibilities included managing drug library updates, device uploads, and data downloads. This position was shared by Biomedical Engineering, a clinical pharmacist, and an RN — all with upper-management positions and vested interests in the functionality of the device and patient safety initiatives while performing their other job responsibilities. A clinical pharmacist was responsible for ongoing library editing every 6 months or more,

often, based on analysis of data retrieved from the pump, such as identification of an ADE. Biomedical Engineering would be responsible for data uploads and library transfers after any library revisions were completed. The nurse's responsibilities included generating reports and analyzing the data retrieved to evaluate compliance with the safety software, medication administration practice, and to provide this information to the nursing staff.

EHS adopted a policy of virtually 100% compliance with the use of the Hospira *MedNet* software. Exceptions were only made in the case of an emergency or if a medication was not populated in the existing drug library.

Pump implementation was delayed until the facility's wireless network was functioning, which occurred in June 2005. Implementation was scheduled first in the smaller satellite facilities. Thus, Erlanger East campus, specializing in women's health services, was the first to implement the new pump/software technology (July 2005). Following this, implementation occurred at Erlanger Bledsoe (August 2005), Erlanger North (September 2005), and finally at Erlanger Baroness (October 2005).

Training a staff of over 1,000 clinicians campus-wide to correctly operate the pumps and safety software was a daunting task. "Super users", or clinicians that received additional device training and are used as educational resources for staff, were identified at the East campus and trained clinicians at the other campuses. During the first 10 days of use, compliance rate with the safety software at Erlanger East was at 72%. After implementation, dosing errors for the medications vasopressin and

Table 3. Safety-Software Use Report for November and December 2005

<i>Clinical Care Areas (CCA)</i>	<i># Unique Medications Infused* November/December</i>	<i># Infusions* November/December</i>	<i>% Infusions via MedNet Software* November/December</i>	<i>% Infusions with Soft-Limit Alerts* November/December</i>
All	212/202	89,003/91,334	43/38	4/3
Cardio/NW7	57/60	9,834/10,007	38/34	6/4
ED46/46	1,719/2,028	51/51	9/5	
ICU	108/111	26,968/29,769	57/51	5/3
ICU North	28/25	862/555	51/56	5/9
MedSurg	65/64	16,325/15,897	42/34	5/4
MedSurg Bled	14/14	798/839	49/45	7/4
MedSurg North	32/31	2,121/2,105	52/50	4/6
NICU	4/4	6,788/6,150	35/26	0/0.03
OB/GYN	30/31	3,787/4,348	61/56	5/4
OB/GYN East	24/19	1,565/1,443	70/79	5/5
Oncol	38/41	2,313/1,915	33/38	6/7

*Data are presented as November/December; however, the units went "online" between July 20 and October 3, 2005.

Bled = Bledsoe; Cardio = cardiology; ED = emergency department; ICU = intensive care unit (trauma, neuro, surgical, cardiac surgical, cardiac, and medical); MedSurg = medical/surgical ward; NICU = neonatal ICU; NW7 = north wing seven medicine; OB/GYN = obstetrics/gynecology; Oncol = oncology.

Unless otherwise indicated, CCAs were located in the main campus (The Baroness).

lidocaine were discovered in the ICU CCA drug library. Staff was notified not to use the existing libraries for those drugs pending library editing

All library revisions were finalized upon implementation of the *Plum A+3* triple-channel infusion devices in March 2006 at which time the placement of the wireless infrastructure throughout the multiple campuses was completed and functional. At this time, the devices were loaded with updated safety software and modified drug libraries. To analyze staff compliance with the safety software, a utilization report, generated in December 2005 with data pulled from the server for the months of November and December, was forwarded to nursing leadership (see Table 3 and Figure 1). The overall compliance rate with the safety

software at 1 month post implementation was an average of 48% with the highest being 70% at Erlanger East OB/GYN and the lowest being 8% in pediatrics.

Evaluating the root causes for low-compliance rates among some of the patient care areas led to the creation of corrective measures that would improve compliance rates with using the safety software. They included re-education of the staff, emphasizing the value of safely using the safety software in administering medications as well as reinforcing adherence to the policy surrounding safety software use. Re-education of the Pediatric Unit staff included discussion of strategies to increase safety software compliance rates. Currently, data are being pulled on a near daily basis with reports sent to nursing managers at least monthly

or more often when assessing if educational programs provided to staff regarding the safety software have impacted and improved compliance with its use.

In early to mid 2006, the overall compliance rate reached a steady state level of approximately 46%. Ongoing analysis of the data reports pulled from the server yielded some interesting details that addressed the need to revise the library as well as evaluate current practice. For instance, a high frequency of lower soft-limit overrides was noted for vancomycin infusions (94%) during November and December 2005. This was found to result from conflicting pharmacy instructions on the medication label regarding the duration of the infusion. The lower soft-limit was subsequently changed so that the library and

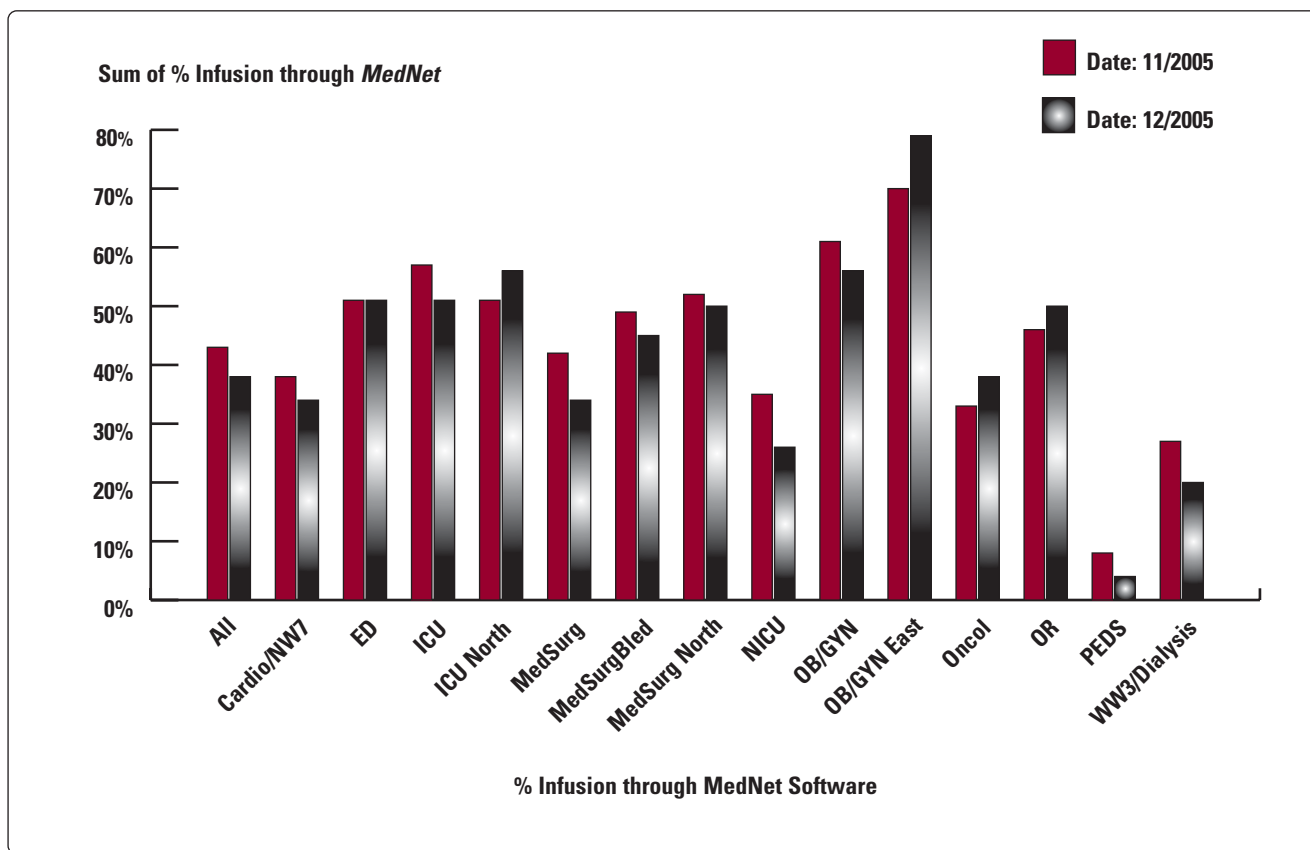


Figure 1. Percentage utilization of MedNet software (overall and by clinical care area) for November and December 2005.

Bled = Bledsoe; Cardio = cardiology; ED = emergency department; ICU = intensive care unit (trauma, neuro, surgical, cardiac surgical, cardiac, and medical); MedSurg = medical/surgical ward; NICU = neonatal ICU; NW7 = north wing seven medicine; OB/GYN = obstetrics/gynecology; Oncol = oncology; OR = operating room; PEDS = pediatrics; WW3/Dialysis = west wing three renal.

medication label instructions were congruent. This occurrence illustrates the necessity of reviewing pharmacy-generated label instructions during the drug-library development process.

Additionally, clinicians were re-educated as to the rationale for setting the lower soft-limit parameters in the drug libraries with respect to vancomycin. These were assigned to help prevent "red man syndrome" or chemical phlebitis that may occur when choosing to override the drug library settings when the alert message is displayed. Two adverse drug reactions related to IV vancomycin adminis-

tration may have been prevented had the safety software been used.

DISCUSSION

At EHS, advantages of using intelligent pump technology included an ability to limit the number of different drug concentrations utilized in the ICUs, thereby standardizing drug concentrations and clinical practice. Implementation of wireless technology occurred transparently and without compromise of patient care. One major advantage of wireless technology is the ability to access data in real time, so monitoring can be prospective in nature and

safety initiatives and interventions can take place before the medication errors progress causing potential patient harm. In addition, the nurse can be educated regarding the potential medication error while it is still fresh in her/his mind.

Wireless technology is a tremendous time saver, allowing immediate access to current data, as well as ready access to data from different geographical locations (ie, separate campuses of one facility). In the traditional system, monitoring is done retrospectively so medication errors are not prevented and nurse education is

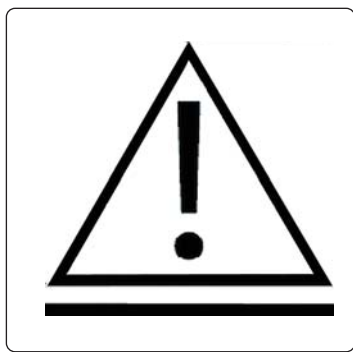


Figure 2. Example of the alert icon.

delayed. With wireless technology, nursing administration can access data to evaluate the effectiveness of educational programs provided to staff regarding safety software use for specific nursing units.

The ability of the Software Program Administrator to view the live library transfer status classification (ie, requested, pending, and completed) for each of the pumps provides an efficient way to track the progress of the drug-library update process. The safety software indicates changes in status for the library transfer from requested to pending as the wireless transfer progresses. Pending status indicates that the pump has successfully received the new library, and has placed it in a short-term storage location. Thus, the pump is now ready for the user to accept the library at a time when it will not interrupt patient care. Lastly, wireless technology allows software upgrades and library transfers to be done remotely, without the need to service each pump individually. Without wireless connectivity, library transfers would need to occur by connecting a laptop computer to each individual pump to transfer the library. Though this process might be manageable across a small pump population, it would be more difficult and time-consuming for large numbers of

pumps located across multiple facilities. For example, the Bledsoe campus is considered a critical access facility and is located 58 miles away from the main Baroness campus. Prior to wireless implementation, data downloads were performed manually, with anywhere from one to 15 pumps connected together to accept downloads at a time. Now, with a wireless network, Bledsoe data can be accessed remotely and expeditiously from the main campus location.

Erlanger's wireless network uses industry standard 802.11a/b/g WLAN equipment. This system is deployed in all nursing areas and most common areas throughout the hospital, which allows users (wireless phones, laptops, IV pumps, etc) to be mobile through the institution.

Despite user-friendly modifications to the drug libraries, initial safety software compliance rates were low. The potential reasons included inadequate knowledge/understanding of the device itself, time delays caused by searching the library, and differences in container volumes prepared by the Pharmacy compared with volumes in the library. Inadequate knowledge/understanding of the device was an unlikely contributor to the low-compliance rates since 353, or 33% of nursing staff were trained in the first week. This group included 127 super users and 22 certified nurse anesthetists. During the second week, 35 additional training sessions were offered.

In retrospect, many lessons were learned during the implementation process that may improve prospects for high- and sustained-compliance rates in use of the safety software. Ongoing staff education and reinforcement of that education is key and includes involv-

ing more end-users (ie, staff nurses) in the drug-library development process to improve buy-in from those end-users. Stressing the importance and the value of the safety software and the drug library during the training phase of implementation is also key. While the end-user can bypass the drug library to program the device, the committee agreed early on that it was appropriate for nurses to make this selection only in an emergency. Despite this education, several recent heparin medication delivery errors could have been avoided if the end-users had not bypassed the safety software when programming the pump.

Nursing management, when analyzing the data reports generated from the infusers, discovered an example of the value of the safety software in deterring potential medication errors. While the specific data were changed to protect the privacy of the patient and the nurse, this case study was shared among the staff as an example of a preventable medication error had the safety software been utilized. For example, a physician ordered a heparin drip using EHS's heparin protocol of 25,000 units heparin in 500 mL/0.45 normal saline to be administered at 20 mL/h. The clinician bypassed the drug library and unintentionally programmed the infusion for a rate of 200 mL/h. When the programming discrepancy was discovered and resolved, the patient was assessed and fortunately did not experience an adverse event. The report generated by the safety software confirmed the clinician's programming error and the infusion history of that event.

Another strategy to improve compliance with software use involved making routine unit spot-checks of pumps delivering IV

infusions to patients, looking for the alert icon (see Figure 2) on the screen, which indicates that the safety software was not in use. Reporting the results of these spot-checks, in addition to sharing pump data with the staff, resulted in a healthy competition between nursing units and raised compliance rates as well. Nursing staff are now requesting to see these data gathered from their pumps and thus are taking ownership for routine use of the drug libraries. Staff can witness firsthand the true value of the software when reports indicate medication errors that have been avoided as a result of its use.

Another case study involving a drotrecogin alfa infusion was shared with the staff. The physician ordered a drotrecogin alfa 24 mcg/kg/h infusion. The nurse received the medication from the Pharmacy labeled "Drotrecogin Alfa 24 mcg/kg/h to infuse at 20.34 mL/h." During the infusion programming, the safety software alerted the clinician that the rate should be 9.6 mL/h for a patient weighing 80 kg.

The pharmacist had inadvertently calculated and labeled an infusion rate for a patient weighing 177 kg instead of 177 lb. Using the safety software in this case clearly avoided a medication error at the point of care.

Recent reports (August through October 2006) indicate that the safety software-compliance rates have increased steadily to an average of 59% to 65% across the four campuses and continue to improve. As word of the value and the power of the safety software for improving medication administration safety spreads throughout the nursing units, staff members increasingly believe in its value, use it, and report that they are uncomfortable using infusion devices without it.

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