

WellSpan Cerner

Closing the Loop in IV Medication Administration



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This Clinical Perspective is underwritten by Hospira and reflects the institution's personal experience and opinions. All the information has been verified to be accurate. The information contained in this article may not be typical of all hospitals experiences.

The challenge: 400,000 injuries, \$3.5 billion in added costs¹

For nurses, expectations are high. Responses must be quick, but accurate. Attention must be paid to numerous, intricate details in an environment filled with urgency. No decision is unimportant. This is especially true in the administration of IV medication.

For more than a decade, healthcare professionals have been aware of the problems presented by medication errors. According to the 1999 Institute of Medicine (IOM) report *To Err is Human*, medication errors account for 7,000 deaths annually.² Analysis of data collected by the FDA over six years (1993-98) showed that the most common medication administration errors in cases that were fatal were related to administering the wrong dose, which made up 41% of errors.³ The wrong drug accounted for 16% of the errors, and the wrong route accounted for 9.5%.³ The IOM (as reported in the National Academies Quality Chasm Series) has found that errors in prescribing ranged from 12.3 to an astounding 1,400 per 1,000 patient admissions, depending on an individual study's methodology.⁴

The FDA further estimates that in the U.S. at least one death per day occurs due to medication errors, and 1.3 million people are injured annually.⁵ Another statistic, from observations in 36 healthcare facilities, shows that medication errors occur in about one-fifth of all doses given to hospitalized patients.⁶

The costs are significant. Each preventable ADE adds \$8750 to the hospital stay.¹ In 2006, the IOM reported that 400,000 preventable drug-related injuries occur in hospitals each year, with added medical costs of \$3.5 billion.¹

These data are overwhelming, but opportunities to change this landscape are available.

Integrating expertise

A hospital is a busy place, with demands on a nurse's attention at every turn. But accurate and safe administration of infusion therapies depends on concentration at every point—a missed decimal point or mistaken spelling can have terrible consequences. A double-tapping of a key that results in administration of 100 mg of a drug instead of the 10 mg prescribed—can happen in an instant. Selecting dopamine instead of dobutamine, or vice versa, compromises care. It is not impossible to imagine a nurse, who is responsible for the care of several patients, entering the wrong room and inadvertently administering the wrong medication to a patient.

Since the 1999 IOM report, numerous efforts have been successful in making medication administration safer and more efficient; the work continues as institutions tap a range of resources to help create an optimal medication administration environment in the clinical setting. WellSpan Health, a multi-site healthcare institution in south-central Pennsylvania and northern Maryland, has worked with Hospira Inc., a global specialty pharmaceutical and medication delivery company, and the Cerner Corporation, a global leader in healthcare information technology, to increase accuracy and improve clinical workflow in medication administration at the point of care. This involved integration of Cerner's CareAware® Infusion Management and Smart Pump Auto-Programming with Hospira's Symbiq™ Infusion System with Hospira MedNet™ safety software and WellSpan's electronic health record (EHR) and pharmacy ordering systems. The new process, designed to reduce the potential for manual errors while improving nursing efficiency, is among the latest advances in the industry. This paper describes the implementation of the new technology and the results achieved in York Hospital, part of WellSpan Health.

The collaborators

The WellSpan Health system, with 63 primary care and specialty physician practices, 10 outpatient health centers, and two hospitals (York and Gettysburg), is a community-based, not-for-profit health delivery system that serves over 450,000 people. The two hospitals have a total of 654 beds with an average daily inpatient census of 475. At WellSpan, more than 2,100 nurses and 450 physicians are part of the 8,300 personnel. The system has been recognized as "Health Care Provider of the Year" by GHX, a company that helps organizations gain efficiencies and realize cost savings. WellSpan, along with Hospira and Cerner, were the recipients of the unSUMMIT's (Bedside Barcoding Conference) Way Paver Award for its work on IV clinical integration of medication administration technology.

The launch of the Symbiq™ Infusion System and the CareAware® Infusion Management and Smart Pump Auto-Programming was initiated at York Hospital's 10-bed medical-surgical ICU. York is a 558-bed community teaching hospital with seven residency programs, five allied health schools, and other training programs. It received Magnet designation in January 2009.

Reducing Potential Errors and Streamlining Clinical Workflow Smart Pump Auto-Programming (New Infusion Order)



Figure 1: Links in the infusion administration process with the new technology.

Cerner: The CareAware Infusion Management and Smart Pump

Auto-programming solutions create links in the infusion administration process. An overview is shown in Figure 1. Using a barcode system, information is electronically captured and transmitted between the patient, the infused medication, and the Symbiq™ infusion pumps.

The information exchange is accomplished through a common platform called CareAware iBus, which makes two-way communication possible between devices and the EHR. The EHR is able to display infusion information (medication, dose, and rate), as well as hourly volume infused and a continuous volume countdown based on information received from the infusion system. The communication path goes from Millennium (a Cerner data-driven process management system) to CareAware iBus to the Hospira MedNet™ safety software to the Symbiq pump, and vice-versa.

Figure 2: Infusion Management



With the CareAware Infusion Management System, nurses no longer have to manually program the orders into the pump, which takes valuable time and can potentially lead to dosing or medication errors. With the new system, electronically entered orders are associated with the correct patient and the infusion pump is programmed automatically via barcode scanning. The system offers important advantages that reduce documentation time and potential for errors, and improves monitoring and surveillance:

- **Real-time infusion updates.** Clinicians can refer to real-time updates from the infusion pumps, which are displayed on the iAware infusion management dashboard
- **Real-time information from monitoring devices.** Clinicians can correlate the infusion information in real time with information collected from ventilators and other monitoring devices
- **Wide range of clinical information.** Information may include (over time) vital signs, hemodynamics, status of infusions, and other parameters
- **Multiple display formats.** Information is displayed as graphic, text, and relational (tabular) formats for easy interpretation
- **Hospital-wide access to information.** Monitoring information can be dispensed to all team members in real time at locations across the hospital (pharmacy, nursing, etc.) via iAware dashboard views
- **Choice of data sets.** A multi-patient perspective allows clinicians to view the infusion status in a particular unit, as well as by individual patient
- **Access to alerts.** Clinicians can have access to alerts that provide updates on infusion status, which allows proactive planning of patient care

Hospira

Designed with human-factors engineering (application of knowledge regarding human behavior), Hospira's Symbiq Infusion System with Hospira MedNet Software is an award-winning, general-purpose infuser. It features an integrated drug library that reflects and reinforces a hospital's best practices. Hospitals can define soft and hard limits for up to 400 drugs in 40 separate clinical care areas, which helps prevent administration of the wrong medication or wrong dose. Event logs allow hospitals to track medication administration events and develop quality assurance reports. The Symbiq infusion pump plays an important role in enhancing patient safety as acknowledged by the 2006 Human Factors and Ergonomics Award and the 2007 Medical Device Excellence Award (MDEA).

The Evaluation: Comparison of effects on nursing before and after implementation

To evaluate the effects of Cerner's CareAware® Infusion Management System integrated with the Symbiq™ pumps on nursing, it was decided to focus on the 10-bed MSICU (medical-surgical ICU) at York Hospital. The results from this single unit would demonstrate potential advantages for rolling out the technology throughout the WellSpan System, and would identify any missteps in putting the new system in place.

Evaluation objectives

Evaluation goals were to measure nursing time required for infusion documentation and medication administration prior to launch and after launch. Findings would also take into account nursing's opinions of the system, and its effects on nursing workflow.

Beginning in December 2009, components of the CareAware Infusion Management System were implemented at WellSpan, and in January 2010, the Symbiq Infusion Pumps with Hospira MedNet Software were launched. In July of 2010, WellSpan went live with the infusion clinical integrator with auto-documentation and Smart Pump auto-programming.

Results

Time study findings—CareAware Infusion Management System

Statistic	Titration (sec)	New infusion (sec)
Pre-go-live	Conventional procedure	
Average	26	60
Median	25	54
Post-go-live	Infusion Management System	Smart Pump Auto-programming
Average	13	44
Median	13	44
Time savings per event		
Average	13	16
Median	12	10

On average, 13 seconds was saved by nursing with the new system for each titration of an existing infusion, and 16 seconds was saved for each new infusion.

Case Study 1: Case experience with CareAware Infusion Management System

One area that resulted in a tremendous time-savings, as shown in one instance, was the follow-up documentation required following a code blue (high acuity/cardiac arrest situation). Retroactive charting can be very time-consuming, taking up to 120 minutes. Because the CareAware System pulled information directly from the infusion pumps during the code and automatically correlated it with physiologic and hemodynamic parameters from cardiac monitors, the data were recorded automatically in CareAware Infusion Management. Post-code documentation took the clinician 5 minutes instead of 120 minutes, without the need to gather information from memory or random scraps of paper.

Data capture—Symbiq™ Infusion System with Hospira MedNet™ Software

Hospira MedNet software captured infusion-related data for October and November 2010. The data reports can be configured in a variety of ways and are based on infusion parameters established by WellSpan. However, because some medication packaging is not bar-code ready for scanning, the data reported here also show statistics for manual programming of some infusions. Select infusions, such as sodium chloride and blood products, are adjusted for in the auto-programming compliance data. Blood products do not have a barcode; hence they cannot be auto-programmed. Sodium chloride flush bags are administered with antibiotic therapy and therefore are not reflected in the medication administration record (MAR/EHR) as separate orders, so they are not auto-programmed.

"Alerts" reflect attempts to administer an infusion outside of the library limits. Soft limit alerts can be overridden by the clinician to allow the infusion to be administered as entered to meet individual patient needs. Hard limit alerts must be edited before they can go forward. These instances are reflected as "overrides" and "edits," respectively.

- **Overrides**—Nurse continues infusion as entered, if clinically appropriate, even if it is outside of the library's soft limits for that medication
- **Edits**—Nurse changes the dose or rate in response to an upper or lower hard limit alert to remain within the library's predefined dosing limits

Analysis of the Hospira MedNet™ reports provide insight into the need for changes to drug library limits, adoption of the new technology in the clinical setting, and an understanding of practice trends that can help continue to enhance infusion administration at WellSpan.

Hospira MedNet Reports		Edit Variance Detail		York Hospital		Active Drug Libraries: 09/30/10 5:50 11812			
Advancing Wellness		York Hospital							
Infuser: Symbio™ Infusion System									
CCA: MSICU									
Medication/Concentration	Alert Date/Time	Rule Set	Limit	Limit Violated	Initial Value	Final Value	Variance		
DOBUTamine 500 mg/250 mL	10/01/2010 10:05:31	Dose Rate	1 mcg/kg/min	↓ lower soft	0.211	2	-76.96%		
DOBUTamine 500 mg/250 mL	10/08/2010 08:51:59	Dose Rate	40 mcg/kg/min	↑ UPPER HARD	500	0.5	1,150.00%		
DOBUTamine 500 mg/250 mL	10/08/2010 23:45:00	Dose Rate	40 mcg/kg/min	↑ UPPER HARD	62.5	3	56.25%		
DOBUTamine 500 mg/250 mL	10/13/2010 19:12:41	VTBI	250 mL	↑ UPPER HARD	400	200	60.00%		
fentaNYL 2500 mcg/100 mL	10/03/2010 12:09:00	Dose Rate	50 mcg/hr	↓ LOWER SOFT	3	75	-94.00%		
fentaNYL 2500 mcg/100 mL	10/13/2010 03:55:40	Dose Rate	300 mcg/hr	↑ UPPER SOFT	1250	25	316.67%		
fentaNYL 2500 mcg/100 mL	10/13/2010 03:55:48	Dose Rate	300 mcg/hr	↑ UPPER SOFT	625	25	108.33%		
NOREPINEPHrine 4 mg/250 mL	10/28/2010 21:52:03	Dose Rate	0.2 mcg/kg/min	↑ UPPER SOFT	0.8	0.08	300.00%		
phenylephrine 40 mg/250 mL	10/15/2010 23:21:06	Dose Rate	9 mcg/kg/min	↑ UPPER HARD	92	2	922.22%		
phenylephrine 40 mg/250 mL	10/16/2010 20:31:25	Dose Rate	9 mcg/kg/min	↑ UPPER HARD	77	1	755.56%		
propofol 1000 mg/100 mL	10/25/2010 07:35:20	Dose Rate	75 mcg/kg/min	↑ UPPER HARD	125	75	66.67%		
vasopressin 40 units/100 mL	10/20/2010 09:01:45	VTBI	102 mL	↑ UPPER HARD	200	90	96.08%		
amiodarone 450 mg/250 mL	11/23/2010 01:53:09	Dose Rate	33.3 mL/hr	↑ UPPER HARD	999	16.7	2,900.00%		
DOPamine 400 mg/250 mL	11/25/2010 05:50:24	VTBI	250 mL	↑ UPPER HARD	980	30	292.00%		
fentaNYL 2500 mcg/100 mL	11/19/2010 03:47:42	Dose Rate	300 mcg/hr	↑ UPPER SOFT	375	25	25.00%		
niCARdipine 25 mg/250 mL	11/25/2010 10:06:15	Dose Rate	15 mg/hr	↑ UPPER HARD	60	6	300.00%		
propofol 1000 mg/100 mL	11/25/2010 21:59:13	Dose Rate	75 mcg/kg/min	↑ UPPER HARD	152	10	102.67%		

Auto-programming and clinical overview. For October, the total number of infusion programs using auto-programming (65%/1,078) or manual programming (35%/577) was 1,655. In November, infusion programs using auto-programming (67%/1,349) and manual programming (33%/669) totaled 2,018. Compliance with the auto-programming technology, after adjusting for select medications (sodium chloride, blood, plasma, and platelets) was 78% in October and 79% in November. This shows that the new system has been adopted by the clinicians in the pilot unit at WellSpan.

Executive summary. Executive summary reports provide an overview of infusion practice at WellSpan for two months after implementation of CareAware Infusion Management with Smart Pump Programming. They show that the total number of Hospira MedNet programs, auto-programmed plus manual programming (one program could consist of multiple infusions, i.e., titrations) in October were 4,543 and were 5,112 in November, resulting in an overall average compliance of 94% with the use of the pump safety software. There were 240 alerts (infusion attempts outside of library limits) in October with 158 edits (changes in the dose/rate) and 82 overrides (infusion continued as entered, as clinically appropriate). In November, there were 213 alerts, with 149 edits and 64 overrides.

Alerts by drug, overrides. Most alerts in October, by drug, were for norepinephrine, resulting in 17 overrides. In November, phenylephrine accounted for most of the alerts (29), with 21 overrides. The override report data can assist in identifying entries in the drug library where the limits should possibly be reviewed so the alarms do not become a nuisance to the clinician.

Override summary. In October, 57% of overrides (47 of 82) were accounted for by five drugs: norepinephrine, propofol, phenylephrine, albumin and heparin. In November, 75% of overrides (48 of 64) were accounted for by the following five drugs: phenylephrine, norepinephrine, albumin 25% 12.5 grams/50 mL, albumin 25% 25 grams/100 mL, and nicardipine. Norepinephrine accounted for the greatest number of overrides (17) in October, and phenylephrine, the majority (21) for November.

Override Variance Detail

- An attempt was made to administer 51 mL/hr of potassium phosphate (19 mmol/250 mL); upper soft limit is 43 mL/hr. The limit was overridden to deliver the requested dose.

Edit summary—soft/hard edit variance. Fentanyl administration resulted in 20 edits in October; most (12) were for USLS. Interestingly, most of the edits in the other top drugs edited for the month were for UHLs: phenytoin sodium (19), drotrecogin alfa (11), and propofol (7). These data give the institution an insight

into clinical practice with a goal of preventing medication errors from reaching the patient and ultimately improving patient care.

Edit Variance Detail

- Administration of fentanyl was initially entered as 375 mcg/hr. The dose rate upper hard limit for this drug is 300 mcg/hr. The alert resulted in a change to 25 mcg/hr.
- Administration of nicardipine 25 mg/250 mL was initially entered as 60 mg/hr. The dose rate upper hard limit for this drug is 15 mg/hr. As a result of the alert, the dose was changed to 6 mg/hr.

See Table 1 (Override and Edit alert data) on the next page.

Discussion

"...it took [the nurse] from 20 clicks down to 2 clicks."

A time savings was realized for each new infusion with the new technology, though nurses considered that the impact on patient safety was the most important finding. As for titrations, time was cut by 50% for the actual titration and the time necessary to document it. The automated device data retrieval and documentation virtually eliminates the potential for manual data entry errors, further improving patient safety and nursing workflow. With the CareAware Infusion Management solution, frequency of documentation increased from every 8 hours to hourly, but did not increase the time the nurse spent documenting infusions. Documenting hourly intake has provided greater clinical insight into a patient's status across the care team without additional nursing time expenditure.

Nurses were pleased with the more complete infusion documentation and believed it would help reduce medication administration errors. It was thought that time was saved in entering new medication orders compared with manually inputting the order. Titrating multiple infusions showed a more dramatic impact because there was no need to go back and forth between the computer and pump for each titration, or write the rate changes down on paper prior to entering them electronically into the EHR.

The Symbiq™ Hospira MedNet™ Event Reports provided important information for managing infusions and helped determine areas that needed attention, from library dosing parameters to the need for staff education. The technology and the data achieved WellSpan's goal of preventing medication errors and improving patient care.

Table 1: Override and Edit Alert data

Wellspan York Hospital MSICU Auto-Programming Compliance								
Date	Total Count	Auto-Program Count	Total Manual Program Count	Auto-Program %	Manual Count Adjusted	Adjusted Total Manual Program Count	Adjusted % Compliance	Target Compliance
October	1655	1,078	577	65%	215	362	78%	80%
November	2018	1,349	669	67%	251	418	79%	80%
Wellspan York Hospital MSICU Hospira MedNet Data								
Hospira MedNet Drug Library Compliance	# of Total Programs	Total Alerts	Overrides	Edits	Upper Soft Limit Alerts	Lower Soft Limit Alerts	Upper Hard Limit Alerts	Lower Hard Limit Alerts
96.9% October	4,543	240	82	158	58	71	111	0
91.5% November	5,112	213	64	149	40	54	119	0
TOP HIGHLIGHTS								
Total Alerts by Drug								
Date	Drug/Concentration		Total Programs	Alerts	% Alerts to Programs	# Overrides	# Edits	
October	NOREPINEPHrine 4 mg/250 mL		320	26	8.0%	17 6 USL;11 LSL	9	
November	phenylephrine 40 mg/250 mL		106	29	27.0%	2 12 USL;19 LSL	8	
Top 5 Drugs Override Summary								
Drug Concentration			# Overrides	% Overrides to Programs	# USL Overrides	# LSL Overrides	# UHL Overrides (Symbiq only)	# LHL Overrides (Symbiq only)
OCTOBER								
NOREPINEPHrine 4 mg/250 mL			17	5.0%	6	11	0	0
propofol 1000 mg/100 mL			8	4.0%	0	8	0	0
phenylephrine 40 mg/250 mL			8	7.0%	2	6	0	0
albumin 25% 12.5 grams/50 mL			8	30.0%	8	0	0	0
hePARin 25000 units/500 mL			6	7.0%	6	0	0	0
NOVEMBER								
phenylephrine 40 mg/250 mL			21	20.0%	2	19	0	0
NOREPINEPHrine 4 mg/250 mL			11	6.0%	1	10	0	0
albumin 25% 12.5 grams/50 mL			6	16.0%	6	0	0	0
albumin 25% 25 grams/100 mL			5	3.0%	5	0	0	0
niCARDipine 25 mg/250 mL			5	21.0%	0	5	0	0
Top 5 Drugs Edit Summary								
Drug Concentration			# Edits	% Edits to Programs	# USL Edits	# LSL Edits	# UHL Edits	# LHL Edits
OCTOBER								
fentaNYL 2500 mcg/100 mL			20	13.0%	12	8	0	0
phenytoin sodium 300 mg/100 mL			19	136.0%	0	0	19	0
drotrecogin alfa 20 mg/200 mL			11	55.0%	0	0	11	0
propofol 1000 mg/100 mL			10	5.0%	0	3	7	0
NaCl 0.9% 250 mL			10	11.0%	0	0	10	0
NOVEMBER								
fluconazole 400 mg/200 mL			26	124.0%	0	0	26	0
NaCl 0.9% 250 mL			16	10.0%	0	0	16	0
phenytoin sodium 200 mg/100 mL			14	1.0%	0	0	14	0
vancomycin 1250 mg/ 250 mL			10	19.0%	0	0	10	0
phenylephrine 40 mg/250 mL			8	8.0%	4	4	0	0

Evaluation results summary

CareAware Smart Pump programming

- Helps reduce possibility of double-tapping errors at initiation of new infusions
- Eliminated multiple areas of risk for medication documentation errors related to manual entry
- Reduced number of mouse clicks per new infusion from 20 to fewer than 5
- 27% reduction in time to start and document a new infusion

CareAware Infusion Management

- 50% reduction in time to titrate and document action
- 87% reduction in time for a single document intake session
- Increased frequency of intake documentation from every 8 hours to hourly, with no increase in nursing time
- Reduction of retroactive chart time following a code blue from 2 hours to 5 minutes

Symbiq™ Infusion System with Hospira MedNet™ Software

- Overall average compliance with the pump safety software was 94%
- Alerts prevented infusions that exceeded library limits; these were edited or overridden (if clinically appropriate), which enhanced patient safety
- Alerts brought to the clinician's attention to edit critical catches associated with high-risk medications that could have caused patient harm

- Override reports identified medications with the highest level of alerts, which provided a basis for review of the drug library so not to nuisance alarm the nurses
- Administration event reports provide continuing access to medication administration practice

Conclusion

CareAware Infusion Management and Smart Pump Programming combined with Symbiq Infusion System with Hospira MedNet Software have provided WellSpan with enhanced infusion administration. The new technology provides near-real-time streaming data that enhances clinical decision-making, reduces infusion administration time for nurses, which improves workflow; and helps prevent manual programming errors, which improves patient safety. The safety software integrates the technology capabilities so that nurses do not have to select a drug from the library; rather it is automatically programmed for a given patient. The software safety limits, which are defined by the institution, prevent over- and under-dosing of drugs, especially important for high-risk drugs. Reports provide an opportunity to review infusion practices. Data can be collected over specific time periods and locations, which can help identify areas that need education. The reports also support proactive planning to enhance IV medication administration in a specific unit or throughout an institution.

The technology does not replace the important work that nurses do; rather, it allows them to use their skills directly on patient care. As one nurse put it, "We have been waiting for something like this."

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