Passion for Safety Underpins Healthcare System's Infusion Pump Upgrade

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About the Author

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Seven years ago, Western Maryland Health System merged its two hospitals into a 275-bed community hospital and trauma center that also included a heart institute and cancer center. This new, state-of-the-art facility—the Western Maryland Regional Medical Center in Cumberland, MD—also presented a patient safety opportunity. Although the healthcare system prides itself on its culture of safety, its infusion pumps at the time of the hospital construction had limited safeguards for prevention of errors as compared with current technology.

As part of the construction of the new medical center, the healthcare system embarked on a journey of discovery that led to a new fleet of smart infusion pumps. Clinicians and pharmacists now have developed an effective practice around infusion pumps, such as using data to support education. Infusion safety continues to be a key component of improving practice.

Challenge

Even before its hospital construction project, Western Maryland Health System had a number of challenges with its existing infusion pumps: outdated technology, lack of standardization in equipment and infusion practices, and inadequate understanding of infusion-related patient safety issues.

Outdated Technology

Staff knew first-hand that their infusion pumps were becoming obsolete. "Our IV pumps were really old technology—old and breaking," said Chrissy Ruhl, BSN, MBA, CCRN, director of Critical Care Services at the healthcare system. "They required frequent service."

The old infusion pumps were traditional, manually programmed pumps, not "smart" pumps with automated programming functions, dose error reduction systems (DERS), or other built-in safeguards against programming and medication errors.

Lack of Standardization

The healthcare system also had a wide variety of infusion pump models, with no standard pump, standard tubing or supplies, or standard drug concentrations—a particular concern of pharmacists. Variability in medication orders (in terms of dose, rate, and mixtures) meant that clinicians had to reconfigure pumps every time an infusion order changed. Manual programming introduces the potential for errors, including dose, rate, and mixture errors.

The variation in infusion pump models could make the jobs of clinicians more complex as well, particularly for those who "floated" from one unit to another or whose patients were admitted to different patient care units.

"We wanted to get rid of all that really old technology and purchase a standard smart pump with DERS for patient safety," Ruhl said. "Our organization is very safety-driven. When we knew we needed new equipment, we went down the road of what's the safest for our patients."

Inadequate Understanding of Issues

Another challenge hampered that commitment to patient safety. Although it is common knowledge that medication errors occur in healthcare delivery organizations, Western Maryland Health System had limited data to quantify pump programming errors, drug delivery errors, or near misses associated with infusions.

Investigating and Implementing Smart Pumps

Western Maryland Health System's initiative proceeded through these five stages: 1) setting goals and developing criteria, 2) conducting research and site visits, 3) developing drug libraries and training, 4) testing, and 5) implementation.

Setting Goals and Developing Criteria

Western Maryland Health System brought together a robust, multidisciplinary team to ascertain which infusion pump would be appropriate for its new medical center. The CEO and chief nursing officer were the primary drivers of the initiative, which also included senior executives, nursing and physician leaders, nurses and physicians, pharmacists, biomedical engineering professionals, information technology (IT) specialists, materials management staff, and clinical educators.

This team first developed goals and criteria for selecting a smart pump. "The overwhelming goal was to continue our culture of safety with standardization and evidence-based medicine," Ruhl said. The team also wanted to standardize medications, drug concentrations and mixtures, pump tubing and supplies, and infusion protocols.

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Specific criteria addressed the following pain points and opportunities for harnessing smart pump innovation:

- Safeguards against programming and medication errors, including DERS
- Features for monitoring pump performance and infusions in progress
- Integration with the electronic medical record (EMR) and computerized physician order entry (CPOE) systems
- Wireless connectivity, which enables remote monitoring of infusions in process from nurses' stations and from the pharmacy department, and the ability to update drug libraries and software remotely
- The ability to collect and analyze data, track trends over time, and use data to improve clinical practice

The team benefited from both a refined procurement process and trust built over time during construction planning and acquisition of major capital equipment for the new medical center, as well as other collaborative initiatives.

"We're a community hospital, with lots of longevity in positions and staff," Ruhl said. "The leadership team and this team's members had worked on many projects prior. There was a level of trust, a level of comfort in the ability to speak openly and share ideas and thoughts. That's always really important in selecting technology and implementing it."

Conducting Research and Site Visits

With a shared vision of what they wanted to achieve, team members researched smart pump technology that would meet their criteria. They drew on guidance and information from the Food and Drug Administration (FDA). They also consulted evidence-based research on smart pumps from MD Buyline, a membership organization that evaluates medical technologies, including features, price, durability, user satisfaction, and reported issues, for hospitals and vendors.

From this research, the team narrowed its options to three infusion pumps from three

Features

During the hands-on training, nurses and other users had to demonstrate that they could go through the whole process of using the pump: scanning patients' identification bracelets, entering a drug into the pump, titrating the medication, backing out of the pump, starting another infusion, and running a secondary medication.

primary vendors. Then, a representative handful of team members conducted full-day site visits to three hospitals on the East Coast that already were using these three infusion pumps. The vendors arranged the site visits and vendor representatives accompanied the team members on the visits.

During the site visits, team members fanned out across the host hospitals to see the infusion pumps in use in clinical care areas. They also discussed the technology with their counterparts: nurse to nurse, biomed to biomed, and IT specialist to IT specialist. Then, the vendors did a presentation or demonstration of the technology at these sites.

"You learn all kinds of things when you go on a site visit," Ruhl said. "Biomed would talk to biomed, and they would learn about the pumps and their durability. IT would talk to the IT department and find out about connection issues, wireless issues, what the pump can really do as far as being integrated with your medical record. Obviously, we had nurses talking to actual nurses. We took our clinicians directly to the bedside with other nurses to see and talk about the infusion pumps. That's really how we ended up choosing what we did. It worked best for us." Nurses were most interested in ease of use, functionality, and a reliable uptime.

The team and a broader group of stakeholders also put the pumps through their paces with hands-on trials when vendors brought their pumps to Western Maryland Health System before the team made its decision. Clinicians used the pumps on one patient care unit for 2 weeks before giving the model a thumbs-up.

The pump selected met the team's criteria, which included a robust drug library, wireless connectivity, multichannel capacity, remote upgrades of drug libraries and software,

retrospective data, CPOE and EMR integration capacity, and a good track record on service and maintenance.

Developing Drug Libraries and Training
After the selection was made, Western Maryland Health System purchased 400 smart pumps for the new medical center. Then, it turned to one of the most challenging aspects of the project: developing a drug library or, actually, drug libraries.

The infusion pump vendor shared its basic drug library, which the team and key clinicians adapted into different drug libraries for critical care, step-down, surgical, pediatrics, obstetrics/gynecology, and other patient care units and patient populations. With standardization the goal, team members met with physicians to decide on standard drugs, doses, rates, concentrations, mixtures, and infusion protocols, such as titrations, for different patient care units and patient populations.

"You would think that would be an easy thing to do, but changing longstanding practices can be challenging," Ruhl said. "It has to be very collaborative. We came down to certain drugs where eventually somebody had to make an executive decision as to how we were going to do it." Usually, that would be the health system's critical care committee.

The drug libraries also needed to be built to integrate with the healthcare system's CPOE system. This took a lot of work, because it had to be done manually, which was a limitation of the CPOE system.

Simultaneous to the drug library development, Western Maryland Health System's clinical education coordinators worked with the vendor to develop a customized training program. Again, the vendor provided its standard training, which the clinical education coordinators adapted to better serve staff needs.

The training consisted of mandatory online training (about 1 hour in duration), followed by 2 hours of hands-on classroom training. During the hands-on training, nurses and other users had to demonstrate that they could go through the whole process of using the pump: scanning patients' identification bracelets, entering a drug into the pump, titrating the medication, backing out of the pump, starting another infusion, and running a secondary medication.

Superusers (lead, experienced nurses selected to serve as resources to colleagues on their units during implementation) were trained first and also received more training.

Testing, Testing

The IT and biomed staff at Western Maryland Health System were confident that the IT and wireless infrastructure at their medical center would be robust enough to handle the new smart pumps. After all, the medical center was brand new and had been outfitted with the capacity to add and upgrade technology for years into the future.

Even so, the technical staff did not take that capacity for granted. They put the new pumps to the test by rolling them around the building to ensure that the wireless connectivity worked and that the pumps could receive software updates without any hitches.

Implementation

For the first 2 weeks of go-live with the new pumps, the vendor staffed the hospital with its own clinicians on-site 24/7 to support the implementation. Superusers supported the rollout as well, with all patient units and all shifts, including weekends, covered by a bedside leader from each unit or department.

The timeline for the year-long project is shown in Table 1. Table 2 shows compliance rates for key infusion safety factors before and after the smart pumps were implemented.

Lessons Learned

Western Maryland Health System has realized patient safety gains from its infusion safety initiative—and gotten smarter about its smart pumps over time—by empowering improved practice with data, managing alarm systems, and continually reinforcing and improving practice.

Empowering Improved Practice with Data

Beginning with the implementation of the smart pumps, charge nurses conducted real-time, bedside audits of the actual use of the pumps in patient care. These audits, which entailed shadowing nurses as they set up and managed infusions, were conducted weekly for a time, with nurses' awareness. Today, now that the pumps are firmly embedded in practice, nurses continue to

Phase of Project	Length of Time
Setting goals and criteria	1–2 months
Research, site visits, and pump selection	3–4 months
Drug library and training development; staff training	3–4 months
Implementation	6–8 weeks

Table 1. Smart pump project timeline: 2011–12

Safety Factor	Goal	December 2011 (6 weeks after implementation)	July 2012 (6 months after implementation)
Dose delivered	95%	93%	100%
Rate delivered	95%	49%	98%
Correct patient care area programmed into pump	95%	92%	97%
Correct drug library selected for patient	95%	62%	92%

Table 2. Systemwide compliance rates for key infusion safety factors, 6 weeks and 6 months following implementation of smart pumps

Safety Factor	Goal	2015	2016*
Dose safeguards used	95%	92%	100%
Rate safeguards used	95%	92%	98%
Correct patient care area programmed into pump	95%	94%	97%
Correct drug library selected for patient	95%	86%	92%

Table 3. Systemwide pump audit results, 2015–16. *Data through mid-2016.

perform random audits every month.

The audits focus on making sure the pumps are working and used as intended. Charge nurses also check that the pumps support the "five rights" of medication safety (right medication, right dose, right time, right route, and right patient). If deviations are found, immediate feedback is provided to nurses at the bedside. Audit results are compiled by unit and hospitalwide. Recent hospital pump audit results are shown in Table 3.

In addition, nursing and pharmacy leaders review weekly reports of data from all smart pumps, and the data are used to educate clinicians and improve practice. These weekly reports began with the implementation and are currently ongoing. The reports enable the reviewers to drill down to the pump level to see exactly how clinicians had programmed it, as well as any attempts to override hard or soft maximum limits on drugs.

"By looking at the weekly reports we get from the pumps and evaluating the alerts from the pumps, we're able to share with staff averted errors and good catches," Ruhl said. "We can say, 'Look, you started to program this pump incorrectly and the pump stopped you from doing this.' If you take that to a staff meeting and show them those real-time examples that really hit their actual practice, it is very eye opening to them.

"If I take a potential insulin drip issue and averted error to an ICU staff meeting," Ruhl added, "and say, 'This was, potentially, what almost happened here by one of your peers,' they can all relate to that. They say, 'Wow, that's scary.' It just makes it all the more real to them."

Guided conversations like these have built trust in the smart pump technology, even among those who might have been skeptical or resistant initially. Clinicians today rely on the drug libraries and other safeguards that prevent inadvertent misprogramming and incorrect medical doses and rates, for example.

Alarm Management
When Western Maryland Health System first launched its smart pumps, it did what many hospitals do with new technology—it went overboard in enabling available features. Among other capabilities, the smart infusion pumps could be integrated with a nurse call system, which in turn is integrated with nurses' portable phones.

"We thought it would be a really great idea that if a pump was alarming, then we should have that go through our nurse call system and pushed out to the phones our clinicians carry," Ruhl said. "Actually, it was a lot of alarm fatigue."

The phoned-in alarm signals lacked relevance to clinicians. Staff didn't find benefit in "equipment alarms" that did not provide information about what was wrong with the pump.

In addition, integrating the infusion pumps with the nurse call system raised a connectivity issue. While the pumps operate wirelessly, the call system does not. If a patient gets up to move around, clinicians have to plug the phone cable back into a cable outlet once the patient is back in bed. "We had issues with getting those cables consistently plugged in all the time," Ruhl said. "Then you didn't have consistency with the alarms."

After about 1 year, Western Maryland Health System pulled the plug on the integration of the pumps with the nurse call system. "We pushed it for a while," Ruhl said. "Then, ultimately, you have to listen to your staff. That was something we learned." The medical center's safety initiative around alarm fatigue, including prioritizing alarm signals, informed that decision as well.

Nurses now receive audible alarm signals from the pumps, which works well. In addition, some tight alarm parameters have been eased over time, which also has reduced the alarm burden.

Continuous Reinforcement and Improvement
Western Maryland Health System has learned another important lesson from its infusion safety initiative: "You can never lose focus on this process," Ruhl said. "You can never take your eyes off of it."

That's because, as smart as the pumps are, people are smarter. Although pump functions are now automated, clinicians can still perform manual interventions on them. Clinicians are continually educated about the most potent and potentially dangerous drugs, such as heparin, insulin, propofol, and oncology drugs, and new drugs are always coming online. Plus, as in any hospital, staff turnover results in new staff needing to be trained.

Nursing leaders and pharmacists still use the weekly reports to spot problems and trends. For example, an uptick in manual interventions to set up infusions that exceed hard maximum limits could indicate the need to update drug libraries and adjust protocols. Standards of practice for oncology drugs, in particular, change frequently, Ruhl pointed out. The healthcare system updates its drug libraries at least annually, and more often if current situations warrant it.

Nursing leaders also share their findings from the data monitoring with clinicians in visual, viscerally comprehensible reports. The reports are used as an education and training tool to help clinicians understand how they programmed the pump, what they need to learn or do differently, and why and how to use the pump correctly.

Conclusion
Constant vigilance during Western Maryland Health System's 5-year infusion safety initiative was instrumental in achieving the overarching goal of enhanced patient safety. Ruhl summed up the results succinctly: "Our infusion safety project has been instrumental in the development of a solid practice with smart infusion."

Western Maryland Regional Medical Center's story shows that patient safety initiatives can be successful anywhere, in any size or type of facility. A passion for safety unites this community hospital with large, multihospital healthcare systems and elite academic and teaching hospitals alike. ∎