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ISMP
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Implementation of smart infusion pump interoperability in the emergency department (ED)

Interoperability between smart infusion pumps and the electronic health record (EHR) allows information to be shared seamlessly between the two systems. With this level of bidirectional (e.g., auto-programming and auto-documentation) interoperability, infusion parameters are wirelessly transmitted from the EHR to prepopulate settings on the smart infusion pump, and infusion data are wirelessly sent back to the EHR, where it is documented. To start an infusion, the nurse first scans the barcode on a patient's identification (ID) band, the medication/infusion bag, and the pump or associated pump channel. Infusion parameters are transmitted from the EHR to the pump for the nurse to verify and accept, eliminating manual programming steps. Also, programming information is transmitted back to the EHR, validated by the nurse, and recorded electronically, creating a closed-loop system.

As described in the ISMP ***Guidelines for Optimizing Safe Implementation and Use of Smart Infusion Pumps***, successful implementation of interoperability can effectively reduce the potential for a variety of pump programming related errors such as wrong drug, wrong drug concentration, wrong rate, and wrong patient weight. For this reason, the ISMP ***Targeted Medication Safety Best Practices for Hospitals***, *Best Practice #8*, calls for the implementation of smart infusion pump interoperability with the EHR and organizational expectations (e.g., compliance goals) for the use of the bidirectional modality for all medication and hydration infusions.

Although interoperability is a huge step forward for patient safety and many hospitals have implemented it, challenges exist that have limited its use outside inpatient units, including in the emergency department (ED). Reported barriers include the practice of nurses infusing certain medications without an infusion pump (e.g., antibiotics) and the need for practitioners to administer bolus fluids at a rate that some pumps cannot accommodate.

Practitioners from the University of Virginia Health Medical Center (UVA Health) discussed their experience implementing interoperability in the ED during the May 2024 Medication Safety Officers Society (MSOS) member briefing. Although they implemented interoperability in 2017, they excluded the ED at the time due to barriers noted earlier. However, in 2022, a pump programming error occurred in their ED, highlighting the importance of expanding the use of interoperability there. The organization reevaluated the feasibility of implementing interoperability in the ED and moved forward with implementation. The highlights of their journey are as follows.

Project Oversight

Successful execution of interoperability requires interdisciplinary input and expertise. To ensure a thorough and thoughtful structure, UVA Health created two implementation teams: an executive steering committee and a working project team.

The steering committee met every other week and served as the decision-making body, provided strategic directions, and removed barriers to ensure the goals and timelines were met. The committee included a project manager, the chief of nursing, pharmacy, information and technology, quality, and operations, as well as ED nursing leadership, and the director of clinical engineering.

The project team met weekly for the duration of the project and was tasked with evaluating and designing workflows, identifying and overcoming barriers (with the support of the steering

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SAFETY wires

Fleet enemas, not as benign as they seem. A 22-month-old child visited the emergency department (ED) for constipation. A prescriber ordered a **FLEET ENEMA** 133 mL (monobasic sodium phosphate monohydrate/dibasic sodium phosphate heptahydrate solution) per rectum. The child received this Fleet Enema dose; however, this was the recommended dose for patients 12 years and older. The child developed hyperphosphatemia and hypocalcemia within a few hours of being admitted for observation and was transferred to the pediatric intensive care unit (PICU) for electrolyte management as a result of receiving the incorrect dose.

Prescribers may not realize that Fleet Enemas actually contain sodium phosphate. In the December 2019 issue of this newsletter, we published an article that discussed how the label of some Fleet Enema products refers to them as a "saline enema," which implies the products only contain normal saline or sodium chloride 0.9%, which it does not. Additionally, ISMP has previously published errors when prescribers ordered Fleet Enemas for patients with decreased renal function (ISMP. Worth repeating... Phosphate enemas may pose problems for renal patients. *ISMP Medication Safety Alert! Acute Care*. 2012;17[16]:3).

The US Food and Drug Administration (FDA) published a Drug Safety Communication in 2014 in which the agency warned that using more than one dose of any over-the-counter (OTC) sodium phosphate drug (including rectal enemas) in a 24-hour period can cause rare but serious harm to the kidneys and heart, and even death. In addition, practitioners should never recommend or administer the rectal form of these products to children younger than 2 years. Practitioners and patients should only administer Fleet Enemas to patients 2 years or older and with stable and normal renal function.

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committee), developing a training and education plan, and building go-live strategies. This team included the steering committee project manager, the lead ED clinical pharmacist, the nursing interoperability subject matter expert (SME), and representatives from ED nursing leadership, pharmacy leadership, clinical engineering, informaticists, medication-use strategy pharmacists, and ED physicians, along with an infusion pump vendor representative for support.

Workflow Design and Build

The project team began by reviewing data, lessons learned, and experiences that had been documented during the inpatient interoperability implementation. They revisited a previously completed failure mode and effects analysis (FMEA) and identified significant gaps in training during the inpatient rollout, resulting in poor compliance after the initial go-live date. As the team prepared for interoperability in the ED, the FMEA served as the blueprint for implementation. Also, the project team evaluated the ED nursing workflow to determine if the general interoperability principles used for inpatient units could apply to nurses in the ED. The team identified that the layout of the ED rooms mimicked inpatient rooms for interoperability purposes, as each room had an infusion pump and an adjacent computer.

One barrier that the team identified and acted upon was that the barcode scanners were stored away from the computers. Poor ergonomics led to difficulty for nurses accessing and redocking the scanner, resulting in the lack of use and loss of battery power for continued use. Barcode scanning is a crucial step in interoperability. To address this, the team identified optimal placement to support the best ergonomic position, and mounted scanners on the walls near computers. The team also invited ED nurses and leadership to inpatient intensive care units (ICUs) to allow the nurses to observe interoperability in practice and how it can be beneficial in timely situations for critically ill patients. This also provided the ED nurses with opportunities to identify differences in workflow, such as the EHR software modules that prescribers use to order medications in the ED.

The team then collaborated with ED clinical pharmacists and nursing staff to identify additional practices that may differ from inpatient units that could be incompatible with the interoperability process in the ED. Three primary concerns were raised. The first issue was the lack of the ability to order a rapid (e.g., faster than 999 mL/hour) intravenous (IV) fluid bolus infusion administered either via gravity or with a pressure bag without impacting interoperability compliance numbers, as that would exceed the smart infusion pump's maximum rate. The solution to this was to build a new ED-specific fluid bolus order for these clinical needs and have the orders be out of scope for interoperability. Prescribers, pharmacy, and nursing collaborated to build and test these orders in their respective workflows.

The second issue involved intermittent infusions. The general practice in the ED was to administer intermittent infusions, such as antibiotics, without using a pump or as a primary infusion. To facilitate ED nurses using the pump to administer intermittent infusions, the team developed and provided education and hands-on training on how to set up secondary infusions using the pump. In addition, they added an alert in the EHR when a prescriber ordered an intermittent infusion for an ED patient to prompt the order of a carrier fluid (e.g., a small bag of compatible fluid that is used as a primary infusion to allow administration of the intermittent infusion via a secondary administration set). The team worked with the hospital supply chain to ensure the ED maintained a sufficient inventory of appropriately sized carrier fluid bags to accommodate the increasing need for secondary infusions. They also evaluated supplies, such as tubing, to ensure they were available in all ED medication preparation locations.

Finally, considering the new practice of administering intermittent infusions via the pump, the ED nursing team was concerned about the limited number of infusion pump channels available. While UVA Health did purchase additional channels, one specific concern was the potential for a delay in antibiotic administration to septic patients if nurses had to search to locate another infusion pump channel. To alleviate this, the clinical team developed ED-specific orders for first-dose beta-lactam

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To prevent errors, consider building an order set to guide the treatment of constipation, outlining pharmacologic and non-pharmacologic treatment options, and monitoring parameters for bowel movements. Develop age-based and renal dosing guidelines for Fleet Enemas. Establish dose range checking alerts that will capture excessive doses of phosphates based on the patient's age and/or renal function. Ensure Fleet Enemas are listed throughout the electronic health record (EHR) as *sodium phosphate rectal enema (Pediatric)* or *(Adult)* and do not refer to them as saline enemas. When possible, standardize automated dispensing cabinet (ADC) stock to pediatric (66 mL) or adult (133 mL) sizes of Fleet Enemas based on patient population. The enemas should not be available via override. Ensure prescribers can find Fleet Enema dosing recommendations as this information is often mixed in with intravenous (IV) sodium phosphate dosing in tertiary drug references.

Insulin dosing error close call due to look-alike syringe packaging. Due to a back order of their usual brand of syringes, a hospital purchased Easy Touch U-100 insulin syringes and Easy Touch luer-lock syringes with a metric scale (**Figure 1**), distributed by MHC Medical Products. Both products

Figure 1. The packaging for the 1 mL Easy Touch U-100 insulin luer-lock syringe (top) and luer-lock syringe (bottom) look nearly identical.

come as 1 mL luer-lock needleless syringes with similar-looking packaging. A nurse prepared a patient's subcutaneous insulin dose using a 1 mL syringe with a metric scale rather than the U-100 insulin syringe (**Figure 2**, page 3). Fortunately, the nurse identified the error before it reached the patient. Luer-compatible needleless insulin syringes may be required for intravenous (IV) administration of insulin (e.g., treatment of hyperkalemia) on certain patient care units (e.g., critical care, emergency department).

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antibiotics that could be administered via IV push. These orders were restricted to the first dose of antibiotic administered in the ED.

Communication and Change Management

While the build was in progress, the project team routinely met with nurses, prescribers, and pharmacists in the ED to discuss the rollout. This helped the team maintain consistent messaging and avoid abrupt changes without significant communication and feedback from end users. The team also set up a simulation area in the ED to allow nurses to test interoperability. In addition to introducing the nurses to the new workflow, the simulations allowed the team to identify which steps were most troublesome or unclear to the end users. The consistent presence and visibility of key members of the team cultivated a positive relationship with the ED staff, which contributed to a successful go-live implementation.

The EHR changes the team built to accommodate interoperability in the ED were implemented incrementally using just-in-time teaching methods. This allowed team members to immediately apply the content learned. This was a strategic recommendation, as one of the major weaknesses the team identified from the inpatient implementation was that training was completed too far in advance of the initial go-live date. Incorporating incremental changes allowed the nursing staff to focus on each step of interoperability rather than multiple changes at once.

Education

The team collaborated with an ED clinical pharmacist and ED nursing educator to develop simulation scenarios. The simulations were intended to mimic the ways users could interact with the interoperability systems and incorporated commonly used medications prescribed for ED adult and pediatric patients. Simulations included common errors and barriers that nurses may encounter with corresponding recommendations to address them. Incorporating the scenarios into the interoperability test domain of the EHR and smart infusion pump for simulation was resource-intensive, requiring significant support and prioritization from the executive steering committee.

Once the team built scenarios, the nursing SME for interoperability educated one primary trainer, along with select ICU nurses with interoperability experience (e.g., train-the-trainer program) to ensure consistency in content and style of training. ED leadership ensured all users were allotted time to complete their training, and nursing leadership worked proactively to encourage training sign-up. The team was able to achieve a near 100% training rate in the 3 weeks immediately prior to the go-live date.

Prior to simulation training, all users completed a computer-based learning (CBL) activity to preview the process. After completing the CBL, users attended an assigned 2-hour training block. The team designed the training simulation to mirror true practice as closely as possible. The simulations included orders in the EHR environment used in the ED, along with fluids and tubing to administer to a simulated arm. This level of simulation allowed the trainees to encounter various error messages and problems to allow troubleshooting.

Go-Live Strategies

The project team proactively planned for support and monitoring for go-live. For the first week, the pump vendor and several key members of the project team were stationed in the ED for 24/7 support. Because of the relationships developed in the months leading up to interoperability, the ED nurses were comfortable coming to the team with questions and need for assistance. To identify potential problems in near-real time, the team designed a scorecard that showed scanning compliance percentage (e.g., patient ID band, medication, pump/channel), what types of errors were occurring, and which specific infusions were not administered with interoperability. For the first two weeks, ED leadership and the project team reviewed this scorecard and followed up on

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Over the years, similar errors have been reported to us involving measuring subcutaneous insulin doses inappropriately in mL syringes instead of insulin syringes that have unit markings because of a lack of understanding regarding the differences between insulin and other parenteral syringes.

Figure 2. Easy Touch U-100 insulin luer-lock syringe with unit markings (top) looks similar to the luer-lock syringe with mL markings (bottom).

We reached out to the manufacturer to report this concern and recommended differentiating the packaging. If your organization carries these Easy Touch syringes, consider purchasing one from an alternative manufacturer, as the reporting organization did. Limiting use of luer-compatible needleless insulin syringes for pharmacy-dispensed insulin doses or in hyperkalemia kits is preferred due to the risk of administering subcutaneous insulin doses via the IV route. If these syringes are available in certain units, separate their storage from other insulin and parenteral syringes (e.g., stock only in code carts, away from other syringes) with clear labeling on the storage bins so they are less likely to be inadvertently mixed up.

New medical device for hypertension calls for risk-prone 1 liter sterile water for injection bags. A pharmacist reported a concern with a newly approved device used in her hospital's radiology department to treat patients with resistant hypertension. The Paradise Ultrasound Renal Denervation (RDN) System by Recor Medical was approved in November 2023. The device involves a generator that uses ultrasound energy to disrupt nervous system signals to the kidneys, resulting in decreased blood pressure.

The device requires the use of sterile water for injection as a coolant in the device to protect the renal arteries during the procedure. According to the Operator's Manual (see page 14), acceptable coolants

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each infusion to understand the barriers to using interoperability. With time, the scorecard was reviewed weekly by ED leadership, and then monthly. Members of the team continue to evaluate compliance data and collaborate with ED leadership to identify any barriers.

Results

On the first day of using interoperability, the department achieved an 81% compliance rate (n=97/119). The vendor's goal for the go-live date was 80%, although the vendor did note that hospitals do not often achieve this on the first day. Not only was the ED team able to achieve this goal on day one, but they maintained and increased their compliance rates. Since the go-live date, compliance rates have consistently been similar to hospital-wide averages at nearly 90%.

Recommendations

ISMP encourages organizations to engage leadership in evaluating the feasibility of implementing interoperability in the ED. Consider the following recommendations:

Complete an FMEA. Prior to implementing interoperability in the ED, a team such as the medication safety committee should complete an FMEA to identify and address potential issues and barriers. If your organization has already implemented interoperability in other areas (e.g., inpatient units), gather feedback from end users, incorporate lessons learned from errors and close calls (i.e., good catches), and address any issues/barriers. Determine differences in ED workflow and environment (e.g., ED medication-specific nuances, location of equipment) that need to be addressed from the system standpoint.

Designate resources. Plan for and provide support for ED staff before, during, and after go-live. Routinely meet with nurses, prescribers, and pharmacists in the ED to discuss the rollout, enhance communication, and gather feedback.

Use simulation. Before implementing interoperability in the ED, use simulation to evaluate the systems in a test environment. Work directly with software vendors to understand potential problems that have been reported and recommendations to prevent them. Simulate the workflow to test what does and does not work, gain crucial feedback from end users, and identify any potential safety gaps. Consider holding "a day in the life" to run real-life simulations to see how interoperability works in your ED settings with a diverse group of end users and compare to vendors' testing environments. Ask end users to identify vulnerabilities and discuss concerns with the team so they can address any issues before implementation.

Educate practitioners. Prior to implementation and during new hire orientation and annual competency assessments, educate practitioners about the proper use of interoperability. Ensure end users understand the steps required (e.g., after scanning make sure to review the order populated in the EHR), and the risk of patient harm if they bypass interoperability.

Promote a culture of safety and learning. Routinely meet with end users in the ED to discuss the rollout and foster increased communication and feedback. Regularly ask staff about safety issues, and exhibit appreciative listening.

Analyze and respond to data. Nurse managers and pharmacy leaders must have a system to monitor compliance and gather feedback from end users to ensure the use of interoperability is maximized. Develop and share interoperability compliance goals, and regularly evaluate if system changes are needed. Investigate instances where interoperability was bypassed to understand barriers, correct system issues, and/or coach staff as needed.

Learn from errors. Review internally reported interoperability-related errors as well as published external events. Encourage staff to report close calls and errors that have reached the patient.

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to be used with the Paradise System are 250 mL, 500 mL, and 1 liter sterile water for injection bags. However, the use of 1 liter bags outside of the pharmacy conflicts with the ISMP ***Targeted Medication Safety Best Practices for Hospitals***, *Best Practice #10*. The goal of this *Best Practice* is to prevent accidental intravenous (IV) administration of sterile water to a patient. Administering large quantities of hypotonic sterile water IV has resulted in patient harm, including death, from hemolysis.

ISMP has received reports of mix-ups between 1 liter bags of sterile water for injection, irrigation, and inhalation with 1 liter bags of dextrose 5% (D5W) and 0.9% sodium chloride (normal saline [NS]). These products look very similar in size, shape, and type of flexible plastic bag used for distribution. The *Best Practice* recommends using an alternative to avoid the storage and use of 1 liter bags of sterile water for injection, irrigation, or inhalation in patient care areas. For example, replacing 1 liter bags of sterile water with 2 liter bags of sterile water, or using bottles of sterile water for irrigation or inhalation, or vials.

We reached out to the US Food and Drug Administration (FDA) and Recor Medical to notify them of this concern. Recor Medical has escalated this issue, and their engineering team is investigating the use of 2 liter bags and sterile water bottles as an alternative to 1 liter sterile water for injection bags.

Organizations must take precautions to avoid mix-ups between sterile water and IV fluids. A policy should be in place that ensures that pharmacy alone can only order sterile water bags. If your organization uses the Paradise System, establish an effective process for ensuring the chain of custody for sterile water for injection bags. Inform staff of the risks of infusing sterile water for injection bags and the importance of verification during medication preparation and administration. Consider the use of auxiliary labels on sterile water for injection bags (e.g., only for use with Paradise System). Ensure barcode scanning verification is completed for all infusion bags before administration.

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Share impactful stories and recognize staff for good catches, including those caught through the use of interoperability. Inform staff that the changes were a result of reporting to foster ongoing reporting.

Conclusion

UVA Health's interoperability experience was successful in part due to thoughtful planning with simulations and education to prepare staff. As with any system implementation, a proactive plan to demonstrate compliance and implement quality improvements is advised. At UVA Health, this is accomplished internally by monthly reviews of interoperability compliance. Data and errors are evaluated and shared with staff to gather feedback, facilitate learning, and enhance workflow and systems.

We thank Amy Johnston, MSN, RN, AGCNS-BC, CNRN, Principal Lead for Nursing Medication Safety Programs, and Kara Thornton, PharmD, MEd, CCRP, Medication Quality, Performance Improvement and Safety Pharmacist, at UVA Health for sharing a systematic review of their ED interoperability implementation, as well as helping to write this article. Email ISMP (ismpinfo@ismp.org) with questions.

Welcome our newest staff members

Director of Consulting and Education

We are pleased to announce that **Jana O'Hara**, MSN, RN, CPHQ, CPPS has joined ISMP as the Director of Consulting and Education. Jana has worked in a variety of clinical quality, safety, and leadership roles. Most recently, she served as the Director of Marketplace Operations for a healthcare staffing company, leading clinical and non-clinical teams that support clinical staff across the country. Prior to that she served as the Director of Patient Safety for University Health in San Antonio, TX, overseeing patient safety across the entire healthcare system including inpatient, ambulatory, ambulatory surgery centers, dialysis, and correctional facilities.

2024-2025 FDA/ISMP Safe Medication Management Fellow

Desire' Johnson, PharmD, is the ***2024-2025 FDA/ISMP Safe Medication Management Fellow***. She received her Doctor of Pharmacy degree at Mercer University College of Pharmacy in Atlanta, GA and completed a PGY-1 acute care residency at AdventHealth Altamonte Springs in Altamonte Springs, FL. She will spend the first 6 months of her Fellowship at ISMP and the second half of the year at the US Food and Drug Administration (FDA). Desire' aspires to become a servant leader in medication safety and aims to increase awareness of the importance of establishing safe medication-use processes.

Please join us in welcoming our new staff members!

Report medication and vaccine errors to ISMP: Please call 1-800-FAIL-SAF(E), or visit: www.ismp.org/report-medication-error. ISMP guarantees the confidentiality of information received and respects the reporters' wishes regarding the level of detail included in publications.

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Two phenazopyridine tablets packaged in a single unit dose blister. An organization reported that a patient received a double dose of phenazopyridine due to how the manufacturer packages the tablets in a blister. The manufacturer (Reese Pharmaceutical) packages two 95 mg tablets, the typical dose (190 mg), into a single blister (**Figure 1**), but each blister is labeled "95mg HCl Phenazopyridine" (**Figure 2**). Due to the potential for dosage confusion and the fact that the blister card

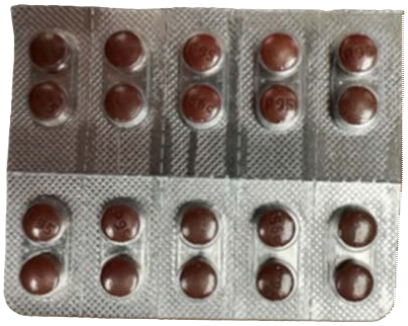

Figure 1. Reese Pharmaceutical packages two phenazopyridine 95 mg tablets into a single blister.

Figure 2. Each blister is labeled "95mg HCl Phenazopyridine" but contains two 95 mg tablets (190 mg) and does not have a barcode.

lacks a barcode, the organization typically opens each blister and repackages them as individual tablets. However, a newer staff member was unaware of this process and restocked the blister cards in an automated dispensing cabinet (ADC) on a patient care unit. A nurse thought that each blister contained 95 mg and administered the contents of two blisters equaling 380 mg (4 tablets) rather than the intended 190 mg (2 tablets) dose. There was no patient harm; however, the organization is concerned this event may occur again.

Any time more than one tablet or capsule is packaged together in one blister, always confirm the dose of each tablet before administration. If you are not sure, contact the pharmacy for clarification. Report any concerns internally and externally to ISMP.