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ISMP Institute for Safe Medication Practices
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Educating the Healthcare Community About Safe Medication Practices

Improve workflow interoperability and end user alerts for effective action

Interoperability between smart infusion pumps and the electronic health record (EHR) is a huge step forward for patient safety, which many hospitals have implemented. However, interoperability does not solve all problems and has the potential for unintended consequences if the workflow has not been carefully vetted. Throughout the implementation process, practitioners have identified challenges including vague alerts from the smart pump that appear on the medication administration record (MAR) and do not explain what the user is expected to do. Organizations must also have access to compliance metrics to make meaningful changes, along with a plan for initial and routine education/competency assessments to coach staff about optimal workflow and share lessons learned.

In the Safety Wire, Infusion Errors Are Still Possible with Interoperability, **included in this newsletter**, we share a tragic event in which a patient died after receiving a massive overdose of amiodarone even though interoperability was in place and barcode scanning was utilized. Additional interoperability-related medication errors have been reported to ISMP and are highlighted below.

Failure to Recognize Alerts in EHR When Pulling Data from Pump

Two nurses completed an independent double check for a patient's heparin infusion titration. They documented that the double check was completed in the MAR. For this organization for titratable infusions, nurses must manually program titrations of medications on the pump. When the nurse entered the dose/rate titration parameters on the pump, they transposed the numbers and the wrong dose/rate was programmed. The second nurse did not recognize the error. Later, when the primary nurse was pulling data from the pump back into the EHR, the nurse overrode a wrong dose alert, leading to a second missed opportunity for the error to be corrected.

Scanning the Incorrect Channel

A patient had multiple infusion bags hanging on their intravenous (IV) pole that were no longer infusing, but were still connected to the patient, including a norepinephrine infusion. When one nurse went to administer a prescribed bolus dose of dextrose 5% water (D5W), they scanned the patient's identification band (ID), D5W barcode, and mistakenly scanned the wrong pump channel, initiating the norepinephrine infusion. They did not trace the infusion lines from the pump to the patient and vice versa, resulting in the inadvertently administered bolus of norepinephrine. The patient's blood pressure became elevated, and the error was identified.

A prescriber ordered a continuous infusion of Lactated Ringer's for a patient who had previously been receiving an insulin infusion. The insulin infusion had been held for the past hour due to the patient's blood glucose being lower than the prescribed parameter. When attempting to initiate the Lactated Ringer's infusion, the nurse did not trace the IV lines and inadvertently scanned the insulin channel, resulting in insulin infusing at 75 mL/hr. The error was identified during a routine pump check thirty minutes later. A dextrose bolus was given proactively to prevent hypoglycemia; however, the patient still experienced mild hypoglycemia.

One academic health system, Nebraska Medicine, which went live with interoperability in fall 2020, shared how they addressed common pitfalls related to interoperability. The network is

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Infusion errors are still possible with interoperability. A hospital recently implemented interoperability between their electronic health record (EHR) and smart infusion pumps. For a patient with atrial fibrillation, a prescriber ordered dextrose 5% water (D5W) to infuse at 75 mL/hour as a maintenance intravenous (IV) fluid, and amiodarone (450 mg/250 mL in D5W) to infuse at 0.5 mg/min (16.7 mL/hour). To initiate the infusions and EHR documentation, the nurse scanned the patient's identification (ID) band, infusion pump, and barcode on the D5W bag. She then scanned the patient's ID band, a second infusion pump channel, and the pharmacy label barcode on the amiodarone bag to initiate that infusion and document administration. Later, the prescriber increased the D5W maintenance infusion rate to 100 mL/hour. Around the same time, the patient's amiodarone infusion was nearly completed, so the nurse obtained a replacement bag from the pharmacy.

During the EHR barcode scanning steps to associate the new amiodarone bag with the infusion pump, the nurse scanned the patient's ID band, the pump channel that was infusing amiodarone, and a barcode on the amiodarone infusion bag. The pump generated an alert, "Channel is currently infusing," with error details, "Stop the channel or use a different channel and resend the order details to the pump." To resolve this, the nurse stopped the current infusion of amiodarone and cleared the pump settings. She then restarted the process by scanning the patient's ID band, the pump, and a barcode on the amiodarone infusion bag, and did not receive any alerts on the pump. However, an EHR alert was generated stating "This pump is associated to a different order." Not understanding what the alert meant and/or due to alert fatigue, the nurse bypassed the warning and initiated the infusion.

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comprised of two hospitals that have more than 800 licensed beds that provide care across multiple specialties including trauma, transplant, oncology, and pediatric/neonatal populations. The system also has multiple infusion centers and ambulatory surgical sites.

Recommendations

We encourage organizations to learn from Nebraska Medicine's experiences when implementing or optimizing interoperability.

Gather a team. Successful execution and optimization of interoperability requires interdisciplinary input and expertise. To ensure a thorough and thoughtful structure, Nebraska Medicine established a dedicated smart pump committee that includes nurses, pharmacists, biomedical engineers, and information technology (IT) representatives to oversee interoperability implementation and quality improvements. The team meets every 2 months and reports to the medication management committee. Together, the team reviews compliance data, errors related to interoperability, and plans for drug library updates. For additional information about establishing a team, refer to the ISMP Guidelines for Optimizing Safe Implementation and Use of Smart Infusion Pumps.

Establish a dashboard and monitor data. The ISMP Targeted Medication Safety Best Practices for Hospitals, Best Practice 8, calls for maintaining a compliance rate of greater than 95% for the use of dose error-reduction systems (DERS). To make interoperability compliance visible, Nebraska Medicine created a dashboard by unit and user level. The dashboard is reviewed routinely by unit leaders, monthly by the medication safety team, and bi-monthly at the smart pump committee. Outliers and trends are investigated and shared with staff so corresponding actions can be taken. This monitoring has helped identify opportunities to better allocate resources, uncover workflow challenges, and has helped identify specific medications that may need to be updated in the drug library to promote compliance. Examples of changes made through this review include the following:

- Collaboration with the Acute Pain Service team to update **HYDRO**morphone settings (e.g., soft maximum dose) for continuous and bolus dosing
- Collaboration with the antimicrobial stewardship pharmacist to update multiple antibiotic DERS, including maximum dose, administration rate, and concentration
- Validation with various subject matter experts (e.g., anticoagulation stewardship pharmacist, diabetes stewardship pharmacist, transfusion safety coordinator) that the current DERS are appropriate

Respond to alerts safely. With the Nebraska Medicine's medication safety team, a nurse/pharmacist dyad is responsible for helping to investigate and troubleshoot error codes to understand if it was a user or system issue. For example, if there is a mismatch between the order in the EHR and what is infusing on the smart pump when the nurse pulls integrated data (e.g., titrations, intake volume) from the pump to the EHR, they may receive an alert/banner warning, which should be a red flag that something is wrong. The following are examples of alert types in the EHR:

- **Order not active:** This alert signifies that since the last data pull from the pump to the EHR, the order has been discontinued and should no longer be infusing.
- **Mismatch between order and pump:** This alert signifies there is an issue with the association between the EHR and the pump. The nurse should disassociate the pump (break the link between the EHR and pump) and reassociate the order (scan the patient ID band, appropriate infusion bag, and channel).

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It turned out that the nurse had scanned the manufacturer's barcode on the diluent bag (D5W) that the pharmacy used to compound the amiodarone rather than the pharmacy-generated barcode identifying the compounded amiodarone product. The EHR associated the "D5W" scan (actually the amiodarone bag) with the D5W maintenance infusion order and disassociated the prior D5W maintenance infusion. Since the disassociation was not a discontinuation of the infusion, the D5W maintenance infusion continued to infuse at 75 mL/hour instead of 100 mL/hour as ordered. However, the associated amiodarone in D5W was administered at 100 mL/hour instead of the ordered rate of 16.7 mL/hour.

Approximately 2.5 hours later, the pump alarmed that the infusion bag had reached the volume to be infused (250 mL), and the nurse identified the error. The patient became hypotensive, a rapid response team was activated, and the patient was treated with IV fluids. However, the patient died the following day. Although the error was determined to not be the immediate cause of the patient's deterioration, it may have potentially exacerbated their underlying illness.

The organization identified several contributing factors: medication labeling issues resulting in multiple scannable barcodes on the infusion bag as well as staff unfamiliarity with the new interoperability technology and how to respond to alerts.

We warned about a different type of error related to an infusion bag having more than one scannable barcode in our June 2024 article, Recent Look-Alike Errors with Myxredlin Put Patients at Risk. In one case, the pharmacy inadvertently added a patient-specific label with a barcode for **ZOSYN** (piperacillin-tazobactam) to a premixed infusion bag of **MYXREDLIN** (insulin human). The nurse scanned the barcode on the pharmacy label, which led to the administration of the incorrect medication (Myxredlin instead of Zosyn). Both products were commercially available. In situations where commercially available premixed infusions are used, practitioners should scan the manufacturer's barcode printed directly

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- **Dose/rate mismatch:** This alert signifies that the dose/rate currently running on the pump does not match the MAR order. The nurse should review the MAR, medication, and pump to identify the discrepancy.

Educate staff. 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, review the order populated in the EHR, validate pump settings, trace infusion lines before starting the infusion, respond to or investigate alerts) to use interoperability safely. For infusion types that are not compatible with pump interoperability (e.g., titrations), educate staff about the required steps (e.g., a double check of manual programming of high-alert drugs) and have a plan for monitoring this process. Whether interoperability has been implemented or not, medications no longer needed should be immediately removed from the IV pole and discarded.

Use simulation. Use simulation to evaluate the systems in a test environment that simulates an actual patient room. Work directly with software vendors to understand potential problems that users have 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 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. At Nebraska Medicine, nursing professional development specialists use an interactive wall, comparable to a large wall-mounted touch screen computer tablet, for learners. This dynamic experience educates new nurses on pump interoperability workflows.

Gather feedback. Routinely meet with end users to foster increased communication and feedback. Nebraska Medicine's medication safety team brings any workflow related concerns or questions to the medication management committee for discussion. If issues with pump interoperability occur, staff are encouraged to escalate them to nurse leaders on their unit and through the organizational error-reporting program so that the medication team and clinical informaticists/analysts can investigate.

Understand barriers. Nebraska Medicine investigates instances when there is an opportunity to understand barriers to successful interoperability, correct system issues, and/or coach staff as needed. One way to do this is to review data to compare the pump programming to what nurses documented in the EHR and assess discrepancies. Investigate cases and share lessons learned from instances when the system generated alerts, such as:

- **Failure of pump to start:** This is a workflow issue. The nurse likely sent the infusion details to the pump but did not press start on the pump before the session timed out. Also consider if the pump may be malfunctioning and should be sequestered and sent to biomedical engineering for investigation.

- **Missing rate:** Some PRN flush orders may be ordered as a range volume so the nurse can enter the rate needed for post-medication flushes. If the nurse forgets to enter a rate for the flush, the infusion cannot be initiated through interoperability. Entering an infusion rate in the administration window on the MAR should resolve this issue.

- **Offline pump:** This could be a systemic Wi-Fi issue, or it is possible the nurse did not turn on the pump and allow enough time to pass for the pump to connect to Wi-Fi before attempting to use pump interoperability.

- **Order not sent to pump:** The nurse likely did not initiate the pump interoperability workflow.

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on the product, not the barcode on the pharmacy-applied label. This ensures that the right (or wrong) container is in hand to prevent the risk of a false positive barcode scan from an incorrectly applied pharmacy label.

Errors like this call for an evaluation of your policies and procedures regarding how labels with barcodes are placed on infusion bags. Nursing leaders and safety committee members should request a failure modes and effects analysis (FMEA) to determine if it is possible to remove the pharmacy-generated barcode from pharmacy labels placed on commercially available premixed products, to force scanning of the manufacturer barcode. Just as important, evaluate your process when pharmacy compounds an infusion, and consider covering the manufacturer's barcode before dispensing, which the organization involved in the error described above has begun to do, so that the nurse scans the barcode on the patient-specific label and not the manufacturer barcode on the diluent bag.

Vendors should ensure alert messages are intuitive and should review alerts with practitioners during training so that practitioners can understand the warning and take appropriate action. Prior to implementing interoperability, a team should proactively identify and address potential issues and barriers. During initial and annual competency assessments, educate practitioners about the proper use of interoperability, including what alert messages mean and how to respond appropriately. Provide simulations of the required steps (e.g., after scanning make sure to review the pump settings and the order populated in the EHR, review and respond to any alerts). Regularly monitor interoperability compliance data, including alerts and actions taken in response to the alert and identify related medication errors. If there is uncertainty around what an alert means, encourage practitioners to escalate the concern and clarify prior to administering the medication. Provide feedback to vendors if an alert is not clear. Gather feedback from end users, and incorporate lessons learned from close calls and errors that reach patients, including this case, so you can address any issues/barriers.

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- **Secondary workflow issue:** The nurse attempted to run a secondary infusion before starting the primary infusion.

Create an escalation plan. Develop a policy and procedure outlining action to take if a step in the process or system fails. Consider whether it is due to a pump issue or an interoperability issue (e.g., Wi-Fi, system downtime) to engage the appropriate stakeholders (e.g., biomedical engineering, IT). Consider instances where the system should prompt the nurse to obtain a double check before bypassing an alert to ensure the action is appropriate, or whether a hard stop should be built.

Learn from errors. Review internally reported interoperability-related errors as well as published external events. Encourage staff to report both close calls and errors that have reached the patient. Share impactful stories and recognize staff for good catches. Watch for trends and highlight the opportunities identified with direct communication to units involved, or if more widespread, consider broad communication via a flyer or safety bulletin.

Next steps. Nebraska Medicine is planning to continue to refine compliance dashboards for procedural holding areas. The team is also working on more comprehensive education on recognizing and understanding alerts in the workflow, pulling data from the pump to EHR, recognizing physical set-up hazards (e.g., IV poles safety, line labeling), and implementing IV pump interoperability in their clinic-based infusion center.

We want to thank Stacie J. Ethington, MSN, RN, and Sloane Hoefer, PharmD, BCPS, from Nebraska Medicine, for sharing how their health-system optimized interoperability as well as helping to write this article.

Good catch with heparin and sodium chloride flush syringes

A neonatal intensive care (NICU) nurse reported that the 10 mL 0.9% sodium chloride Easy-Flush syringes (TerraFirm) that the hospital had recently purchased, look very similar to the 5 units/5 mL heparin lock flush syringes (Medefil) used in the NICU. Both products have green labels and are similar in size (**Figure 1**). The NICU team was unaware of the saline flush product change that was decided at the purchasing department level. In this organization, nurses scan heparin flushes but do not scan saline flushes. The hospital has removed the saline syringes and is purchasing them from a different manufacturer.

Figure 1. The 10 mL Easy-Flush 0.9% sodium chloride syringe (TerraFirm) (top) and the 5 units/5 mL heparin lock flush syringe (Medefil) (bottom) look similar.

Our October 2025 article, Saline Infusions and Flush Syringes May Not Be as "Harmless" as You Think – Scanning Will Help, discusses barriers and safe practice recommendations around scanning sodium chloride products. Organizations should use barcode scanning when receiving, dispensing, filling the automated dispensing cabinet (ADC), and prior to administering all products, including flush syringes. No drug-related item (e.g., prefilled flush syringes) should be purchased without pharmacy involvement/approval. When a new product is brought into the organization, conduct a proactive review of product characteristics (e.g., same label color) that might cause confusion and lead to medication errors. Be sure to include multidisciplinary team members who may be using this new product to see how it impacts their workflow. Consider purchasing a product from a different vendor when problems are recognized. Store look-alike products separately and in a way that keeps their labels visible. Communicate with staff when a new product is available, and review the packaging, storage location, and other pertinent information.

Welcome our new staff

Director of Med Safety Board

Gretchen Brummel, PharmD, BCPS, joined our team as Director of Med Safety Board, an ISMP Company. Gretchen is a pharmacist and healthcare leader with expertise in safety, pediatric pharmacotherapy, digital and rural health, and disaster preparedness. She most recently served as Director of the Professional Experience Program at a college of pharmacy, leading experiential learning. Her prior roles include executive and clinical leadership at a performance improvement organization, a global information services company, and a quaternary medical center.

Medication Safety Specialist, Education

Kimberly West, MSN-Ed, RN, CHSE, joined ISMP as the Medication Safety Specialist for Education. Kimberly has worked in various hospital settings including maternal/newborn, gastrointestinal/endocrine surgery, and nursing informatics, and is a Certified Healthcare Simulation Educator (CHSE). Most recently, she served as an Assistant Professor of Nursing and Simulation Champion for Rasmussen University School of Nursing. There, she served in the development of faculty onboarding; mentoring faculty and students; as the course lead; as the exam coordinator; and was involved in curriculum design. Recently, Kimberly was involved in the building of a new simulation lab at the university in Mokena, IL.

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Special Recognition...

Our 2025 Nurse AdviseERR Clinical Advisory Board

Production of this peer-reviewed newsletter would not be possible without the assistance of a reliable and talented clinical advisory board. As 2025 nears an end, we want to thank each of the following members of the advisory board for their dedication to making this newsletter a valuable medication safety resource for clinicians.

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Institute for Safe Medication Practices (ISMP).
We wish you joy, health, and happiness
this holiday season!**