October 2026 | Volume 24 ■ Issue 10

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

Smart Pump Challenges Persist — Avoid Common Programming Pitfalls

Problem: In our October 20, 2022 article, Safety Considerations for Challenges When Using Smart Infusion Pumps, we discussed safety risks and limitations that healthcare practitioners face when trying to optimize drug libraries and implement important safeguards to prevent catastrophic programming errors. Unfortunately, practitioners continue to report a variety of smart pump-related errors to ISMP, highlighting that this safety concern is real and continues to exist. It is particularly risky when end users need to manually select between pump screen options due to medications with different indications, variable dosing units, dose limits, or administration rates. As with most preventable adverse events, many latent system issues need to align perfectly with active failures of individuals to reach the patient. It is also important to note that even before the pump programming step, there were several contributing factors at play in the error reports described below (e.g., verbal communication misinterpreted, pump programmed without an order on the medication administration record [MAR]). However, as you review these events, think about human and system factors and how user interaction with the smart pump screen options influenced the outcomes.

Recent Errors Reported to ISMP

Case 1: *An ICU prescriber consulted a neurologist for a patient who was seizing. The neurologist recommended a midazolam infusion "at status epilepticus dosing." The ICU prescriber verbally told the nurse that they wanted midazolam to "start at 2 mg," intending to order 2 mg/hour. The organization had configured the critical care drug library for midazolam infusions with two options based on indication; each had different dosing units. The "Sedation" option was set up as mg/hour, and the "Status Epilepticus" option was set up as mg/kg/hour. The nurse selected the "Status Epilepticus" option and entered "2," which had mg/kg/hour dosing units. After 30 minutes, the pump alarmed that there was air in the line, and the nurse saw that the midazolam bag was empty. It was then that the nurse realized the midazolam had infused at 2* ***mg/kg/hour*** *instead of* ***2 mg/hour*** *as intended. The dose error-reduction system (DERS) did not generate an alert for the 2 mg/kg/hour rate because this was within the dose range built for status epilepticus. The nurse notified the ICU prescriber and the pharmacist. The patient was intubated, and their blood pressure dropped slightly, but then returned to baseline.*

Case 2: *A hospital reported multiple errors after nurses accidentally programmed patients' titratable infusion doses into the rate field rather than the dose field, resulting in wrong infusion rates. The pump screen displays the rate (e.g.,* ***mL****/hour) first, followed by the dose (e.g.,* ***mg****/hour,* ***mcg****/min). In one case, a prescriber ordered a* ***HYDRO****morphone infusion (0.2 mg/mL) with instructions to start at 0.5 mg/hour and titrate up by 0.5 mg/hour. The nurse intended to program the infusion to begin at 0.5 mg/hour but entered 0.5 into the rate field instead of the dose field. The patient was administered 0.5 mL/hour (0.1 mg/hour), a 5-fold underdose. Nurses titrated the rate up several times, each time in the rate field rather than the dose field. The patient's dose was only increased each time by 0.1 mg/hour instead of 0.5 mg/hour. In another case, a prescriber ordered a norepinephrine infusion at 16 mcg/mL with instructions to titrate to a maximum dose of 30 mcg/min. The nurse thought they had titrated to the maximum dose, and vasopressin was prescribed and administered for additional pressor support. The nurse later identified that they had programmed the pump to run at 30 mL/hour (8 mcg/min) instead of 30 mcg/min (112.5 mL/hour).*

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SAFETY wires

Beware of TikTok Trend—Live Goldfish Found in IV Bag. Both adults and children use social media platforms like Facebook, Instagram, TikTok, and X (formerly Twitter) to share videos about new trends or to "challenge" others to participate in a specific act. Sometimes, these trends or challenges support a charitable cause (e.g., Ice Bucket Challenge for amyotrophic lateral sclerosis [ALS]) or are shared just for fun. But sometimes these trends can be dangerous as they can lead to serious injuries or health concerns. In fact, the US Food and Drug Administration (FDA) has warned about the dangers of challenges involving medications–one involving an over-the-counter cold medicine, and one known as the "Benadryl Challenge" which resulted in several teens needing emergency care, and in some cases was fatal.

Just recently, a trend involving patients in the hospital setting was reported to us. A nurse entered a patient's room to find a live goldfish swimming in a 0.9% sodium chloride intravenous (IV) infusion bag! The nurse quickly confirmed that the bag's tubing was not attached to the patient. Upon interviewing the patient and family, it was discovered that a family member had brought the fish into the room, opened the IV fluid bag, placed the fish in it, and sealed the bag with tape. This trend appears to be circulating on social media (TikTok). This incident caused a lot of concern regarding the serious infection risk had the IV tubing been connected to and infused into a patient.

Everyone needs to recognize that participating in social media trends of this nature can lead to harm, especially in hospitals or healthcare settings where patients' health can be impacted. Healthcare practitioners are essential in educating patients and their families about the dangers associated with these trends. Patients must recognize that engaging in viral challenges with medications,

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Case 3: *Another hospital reported an event that occurred during a code in the ED. A prescriber gave a verbal order to a nurse to administer a 1 mg/kg lidocaine intravenous (IV) bolus to the patient due to repeated episodes of ventricular tachycardia. The nurse searched for a lidocaine order in the electronic health record (EHR) and selected an order for lidocaine 2 g in 250 mL of 5% dextrose in water infusion at 1 mg/min. The nurse added a free-text comment "verbal order for weight-based bolus 1 mg/kg, patient weight 60 kg, 60 mg bolus over 75 seconds followed by drip." The nurse removed a bag of lidocaine from the code tray. When the nurse attempted to program the lidocaine bolus dose in the smart infusion pump drug library, they received an unknown error message and administered the lidocaine without using a smart pump. The entire lidocaine 2 g bag was infused. The patient became bradycardic and arrested. A pharmacist who was responding to the code questioned why the bag was empty and identified the error. The prescriber ordered a lipid rescue infusion, which the nurse administered. The patient experienced a return of spontaneous circulation with improvement in hemodynamics and was transferred to an outside hospital for further care.*

During event investigation, the organization found that lidocaine was available in the code cart in both an infusion bag (for continuous infusion) and a syringe (for bolus administration). The drug library did not have an option to administer a bolus dose from the lidocaine infusion or to administer a separate bolus dose. The organizational protocol was for the nurse to administer the bolus dose from a syringe without using the pump, but the nurse did not have experience with this process.

Safe Practice Recommendations: Consider the following recommendations to address these commonly reported challenges when programming smart infusion pumps.

Plan for interoperability. Implement bidirectional smart infusion pump interoperability with the EHR to reduce the risk of infusion pump programming errors. To learn more about infusion pump and EHR interoperability, see the ISMP Guidelines for Optimizing Safe Implementation and Use of Smart Infusion Pumps.

Establish and approve dose limits. Establish and/or evaluate minimum and maximum dose limits for each medication infusion and bolus dose that requires administration via a smart infusion pump. Determine if the dose limits should be weight-based or non-weight based, aligning the dose limits with organizational protocols, dosing references, literature, and clinical practice. Be aware that continuous infusion units are generally dosed per hour, while boluses may be dosed per minute. Also consider the full range of titration when setting dose limits for titratable infusions. Smart infusion pump dosing limits should not cause nuisance alerts or prevent the programming of incremental doses. Once the drug library parameters have been determined, require approval by an interdisciplinary committee before updating or creating the drug library. Also, determine and communicate a process for practitioners to request changes to the set limits.

Create drug libraries. Set soft dosing limits in the drug library that reflect the minimum and maximum expected dose and rate prescribed, as well as a buffer for patients who may require more or less than the typical default doses and rates. Set hard dosing limits as a forcing function to prevent catastrophic errors, while considering patients who may clinically require atypical doses, to prevent end users from needing to program the infusion without engaging the DERS. Incorporate a quality control process into the drug library build prior to releasing it onto the pumps. Communicate changes to end users.

Use the EHR to drive safe practice. Establish dose range checking in the EHR to notify prescribers and pharmacists with an alert if it is likely that a medication dose has been prescribed outside of a safe dose range. Require all titratable medication orders to include the medication name, diluent, route, initial or starting rate, incremental units in which the rate can be increased or decreased, frequency of dose titrations, maximum rate of infusion, and an objective clinical measure(s) to guide changes. Ideally, medication names and corresponding dosing units listed in the smart pump should match exactly with those listed on drug labels, the MAR, and the automated dispensing cabinet (ADC) screen.

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fluids, or medical equipment in any setting is unsafe and inappropriate. Healthcare organizations should monitor for these emerging social media trends and take steps to protect patients, including disconnecting and removing medications and IV bags when they are no longer needed. Counsel patients and families about the dangers of replicating behaviors seen on social media.

Alpha-Gal Syndrome—Evaluate Active and Inactive Ingredients. Alpha-gal syndrome is a potentially life-threatening allergic condition that can occur after a patient has been bitten by a tick. It is named for a molecule, galactose-alpha-1,3-galactose, which is found in most mammals, but not humans. Symptoms may then occur after the patient eats red meat or is exposed to other products made from mammals (e.g., gelatin, dairy products). A hospital reported that a patient with alpha-gal syndrome received beef broth with their food tray despite a special diet order in the electronic health record (EHR) stating the patient cannot have beef or pork products. During an event investigation, the hospital identified deficiencies in the EHR that included how drug-food allergies do not cross over into the diet restrictions and not having a mechanism to screen for inactive ingredients in medications and vaccines (e.g., gelatin, glycerin, magnesium stearate, bovine extract) or animal-derived products (e.g., monoclonal antibodies, heparin, certain antivenoms) which may be contraindicated for patients with alpha-gal syndrome (see Products That May Contain Alpha-gal).

We discussed a similar concern with inactive ingredients in our July 2022, newsletter article, Hidden Pork Content in Colace Capsules. Some medications, including the **COLACE** brand of docusate sodium, have gelatin capsules sourced from pigs, but product labeling does not include that information. People with food allergies or those who want to avoid animal products need to know the origin of the ingredients contained in their medications. We contacted Avrio Health, the manufacturer of the brand product Colace, and confirmed that the gelatin used is sourced from pigs, which is not specified in the labeling. It appears that, under current regulations, the product label is not required to detail the animal source of the gelatin.

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Limit multiple indication-based options. If different indication-based library entries are needed for certain medications, determine if the infusion is only used for a single indication in a specific location, and limit the drug library for that location to only one option, when possible. Otherwise, let end users know about the infusions that have multiple indication-based options and communicate if these options have different dosing units. If possible, clearly include the indication in the drug name selection on the pump and make it obvious to the end users which option to select.

Communicate how end users should administer bolus doses. Ensure order sentences and order sets for medication infusions that may include a bolus have been built and tested by end users. On the EHR/MAR, clearly show the route and rate of administration of the bolus, and whether the pharmacy will dispense a separate bolus (or verify a bolus dose from an ADC), or if the practitioner should administer the bolus from the continuous infusion via a bolus infusion feature.

Safeguard bolus doses. Ensure bolus doses can be safely administered using the pump. Only allow practitioners to administer a bolus dose from a continuous infusion if your infusion pump has a bolus feature that automatically resumes the continuous infusion rate once that bolus dose has been administered, and if your drug library includes bolus dose range limits.

Test the drug library. Evaluate the drug library to ensure that soft and hard stops will capture a variety of prescribing and programming errors. For medication infusions with two options in the drug library based on the indication, test to see if this could lead to unintended programming errors. Gather feedback from end users to ensure it is intuitive to select between the two options. Consider conducting a usability study to observe end users as they program the pump under simulated conditions.

Communicate doses safely. Limit verbal orders to true emergencies. However, if a medication is urgently needed, practice closed-loop communication where the receiver repeats back a verbal order, stating the exact dose of medication including the units of measure and dosing units. Ensure the prescribed medication and dose make sense in the context of the patient's condition. Encourage practitioners to clarify any medication-related concerns prior to order execution.

Educate practitioners. Provide initial and annual competency assessments for practitioners who use smart infusion pumps. Provide practitioners with simulation-based education using scenarios (such as reported events published in ISMP newsletter articles) to achieve specific learning objectives, focusing on safe pump option selection and programming practices. Include education about internally and externally reported errors and safety concerns.

Review pump data. Have the smart infusion pump team regularly monitor drug library usage and alerts, including overridden soft alerts, and adjust the dose limits as needed based on current practice and the literature. Also review interoperability data to determine how often it is used for starting a new medication and for dose change adjustments.

Report errors. Emphasize that the organization values a culture of safety and encourages medication error reporting and sharing lessons learned. If there are any safety reports related to the use of the smart pump, notify the smart pump team for follow-up. Continuously monitor and reevaluate the data to determine warranted adjustments to the drug library and possible hospital dosing protocols.

Work with pump vendors. Collaborate with your smart pump vendor and provide them with feedback for consideration for future upgrades. Smart pump vendors must consider human factors to enhance the physical design of the pump and drug library, and to improve the programming experience for end users.

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There is a good chance that healthcare professionals may be unaware of alpha-gal syndrome and how patients with this condition may react to certain medications and inactive ingredients. Refer them to resources such as the Centers for Disease Control and Prevention (CDC) website. Consider building an alert to notify practitioners when you become aware of a patient with food allergies, or someone known to have alpha-gal syndrome.

Evaluate your EHR and/or pharmacy dispensing systems' functionality to determine if an alert would fire if a patient with alpha-gal syndrome had a documented allergy to an animal-derived product or an inactive ingredient known to trigger this allergy. During transitions of care, specifically ask patients about any reactions they have had from foods, medications, or inactive ingredients, and document the details of the reaction in the EHR and/or pharmacy dispensing system. If patients have concerns about the inactive ingredients contained in a medication, the pharmacy should review the package/label and prescribing information or contact the manufacturer for more information. Additional resources include the following: What medications are contraindicated with an alpha-gal allergy? *What mammal by-products could be listed as inactive ingredients on the package insert (i.e., magnesium stearate, gelatin)?* (InpharmD.com) and Alpha-gal Syndrome (VEGANMED.org).

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Editors: Shannon Bertagnoli, PharmD; Jana O'Hara, MSN, RN, CPHQ, CPPS. ISMP, 500 Virginia Drive, Suite 501, Fort Washington, PA 19034. Email: ismpinfo@ismp.org; Tel: 215-947-7797.