By Sara Bekri, PharmD, and
Patrice Dupart, PharmD, BCPS, MSHCM

Photo courtesy of Omnicell, Inc

Insourcing IV Compounding with Robotics

Typically, human touch is considered an asset in health care, allowing providers to form relationships with patients. Yet, the opposite is true when that care involves compounding and medication sterility. In the hospital pharmacy, touch contamination poses significant dangers to patient safety, with the potential to also impact patient satisfaction, extend lengths of stay, and ultimately affect hospital costs. The loss of entire batches of IV medications ruined by human contamination or a dosing miscalculation leads many hospitals to consider automating the compounding process.

Transitioning from Outsourced Compounding to Insourcing

Inova Fairfax Medical Center is a 998-bed, nationally recognized medical center serving the Northern Virginia and Washington DC metro area. The medical center comprises the Inova Women's and Children's Hospital, the Inova Heart and Vascular Institute, and Medical/Surgical/ Critical Care towers.

The hospital's inpatient pharmacy department services a complex and varied patient population. Historically, the sterile products program in the pharmacy included manual compounding, outsourcing, and the purchase of manufactured premixed IVs. The strategy of procuring products from multiple outsourcing facilities and various manufacturers was designed to avert risk and complications. The outsourcing facilities we used were companies we trusted to deliver high-quality products and those we felt had a lower risk of danger from human errors. Nevertheless, because these outsourcing facilities used some manual processes, many of the safety checks that are intrinsic to an automated workflow may not be in place. Despite having built deep trust in our outsourcing vendors, we remained vigilant regarding the safety and affordability of our IV compounding. It became clear that insourcing with IV robotics was the best approach for our hospital and patients.

Our pharmacy department initiated the search for IV automation with the goals of improving safety and efficiency, reducing the high variability innate to compounding, and decreasing infection risks. Our aim was to leverage bar code scanning while simultaneously reducing the risk of human error and touch contamination within the compounding processes.

Selecting a Vendor

Several factors went into our vendor selection process; however, the ability to integrate the robotics with our current sterile compounding program was key. Secondly, we looked for a single server platform that could encompass robotics, workflow solutions, and analytics. From a practical perspective, the robot's footprint and cost also impacted the purchasing decision. Additional factors that influenced our vendor selection and the decision to insource our compounding include:

- **Dosing Accuracy.** Dosage accuracy is vitally important for IV medications, as administering an incorrect dose can have serious consequences. We chose an automated robotics system that utilizes gravimetric verification of all components to ensure precise measurement of compounds. In addition, bar code scanning and cameras are an integral part of the workflow, delivering additional safety and audit trails.
- **Flexibility and Sterility.** Systems that can produce both syringes and IV bags in a variety of sizes deliver important flexibility. Additionally, our robot places tamper-evident caps on final syringe containers, which helps to ensure medication safety and sterility.
- **Data Availability.** Compiling data on the robot's performance is critical to gauging the accuracy of the automated system. The system allows us to set specific accuracy tolerances for each compounded drug. For example, we set our neostigmine syringes to be within +/- 5% of the fill volume of 5 mL. The system uses the chemical density of the drug to determine the weight of the desired dose volume and compares it with the actual dose and then calculates the variance. If the variance measurement is within +/- 5%, the dose is acceptable and will be labeled before it is unloaded from the device. If the variance measurement is outside the specified range, the device will label the preparation as failed.
- **Cost Savings.** In addition to increasing patient safety, we wanted to reduce the approximately one million dollars we were spending annually on outsourced IV preparation services.

Ensuring C-Suite Support

To gain support from administration, we researched the various

Cover photos courtesy of: (from top to bottom, left to right) BD; Omnicell, Inc; Medi-Dose, Inc / EPS, Inc; Codonics, Inc; Grifols; International Medical Industries, Inc (IMI); Equashield LLC

robot vendors and compiled an analysis of our findings for presentation to the administrators' council for budget approval. The return on investment (ROI) was developed in conjunction with the vendor. Our ROI demonstrated that the savings associated with two IV robots would pay for the initial investment within 3 years of implementation. Fortunately, most administration team members, including our CEO, were committed to ensuring safe and efficient IV sterile compounding. The talking points on increasing patient safety and delivering major cost savings were key to winning their support. The ability to produce many items that were currently outsourced was another plus, particularly as the new process would enhance inventory management, process control, and cost savings.

Implementation and Staff Support

The implementation proceeded smoothly, even though our staffing resources were limited at the time. Initially, we used the robots to compound only two or three medications. Once staff was confident with the workflow, we added additional preparations gradually, ensuring that sufficient time was allowed to establish proper staff training and effective workflows.

Our vendor assisted in outlining safe practices and ensuring appropriate use of the robots, helping the pharmacy department to define and meet operational goals. As part of the implementation process, the vendor provided a pharmacy technician who worked alongside our staff in the cleanroom during the implementation phase and was available thereafter for troubleshooting as needed. This technician helped the staff develop proficiency and provided guidance on standardizing processes. The vendor also provides training and onboarding support for new staff members when needed.

After reviewing the list of medications that historically had been outsourced, our team chose to utilize the IV compounding robots for batch compounding to achieve both workflow and cost efficiency. We currently compound about nine medications using the IV robots. Most drugs were selected due to a significant ROI, although insulin was added strictly for safety reasons as standardizing and automating this high-risk medication delivers strong value in terms of safety.

Five technicians rotate through the IV robot shifts. We operate the robots Monday through Friday, on a total of seven shifts per week. Typically, the technicians check par levels when they first come in, and adjust production thereafter. The technicians are responsible for gathering supplies and starting the daily batch production. All doses prepared by the robots undergo a pharmacist check, and the technicians then prepare batches for sterility testing as indicated. During the sterility-testing process, the batches are quarantined for 2 weeks; once results are available from the laboratory, the batches are released for patient use. A weekly quality audit is performed to verify compliance with the standard workflow.

Return on Investment

Although the processes and testing required for establishing extended beyond-use dating (BUD) are complex, we decided to create a robust sterility testing and BUD program based on USP Chapter <71>. The BUDs on CSPs produced in the robots are similar to the dating our outsourcing facility provided.

One year after implementation, we reduced our IV outsourcing expenditures by $661,000; our net savings amounted to $134,000. Currently, we prepare approximately 4500 IV doses per month. Our projected reduction in IV outsourcing for year 2 is 1.2 million dollars with net savings of $704,000. We expect to surpass our goal of breaking even at the 3-year mark, as established in the initial ROI calculations.

In addition to controlling what we compound, another significant benefit of the robots is the ability to control the processes surrounding that production. As such, inventory is now managed based on usage.

Just as there are many benefits that accompany the implementation of new technology, there are also some new issues that must be addressed. One of the challenges we find with insourcing products includes the intricacies of product stability. For example, we considered admixing nicardipine, but upon dilution, the pH changes and the product becomes unstable. Managing stability issues and BUD has become the new challenge for our compounding program.

Looking forward, we plan to add additional IV robots to our hospital portfolio to support the continual expansion of our insourced compounding program. We have experienced success through automating IV compounding thus far, and will continue to benefit from the sterility and dosing accuracy of the medications while also enjoying cost savings. Implementing IV robotics allows pharmacy to contribute to our organizational goal of providing high-quality, technologically advanced care for our patients. ■

Sara Bekri, PharmD, the pharmacy supervisor at Inova Fairfax Medical Campus, received her PharmD from Virginia Commonwealth University School of Pharmacy.

Patrice S. Dupart, PharmD, BCPS, MSHCM, is the senior director of pharmacy at Inova Fairfax Medical Campus. She received her doctor of pharmacy degree from Xavier University of Louisiana and her master's in health care management from the University of New Orleans.