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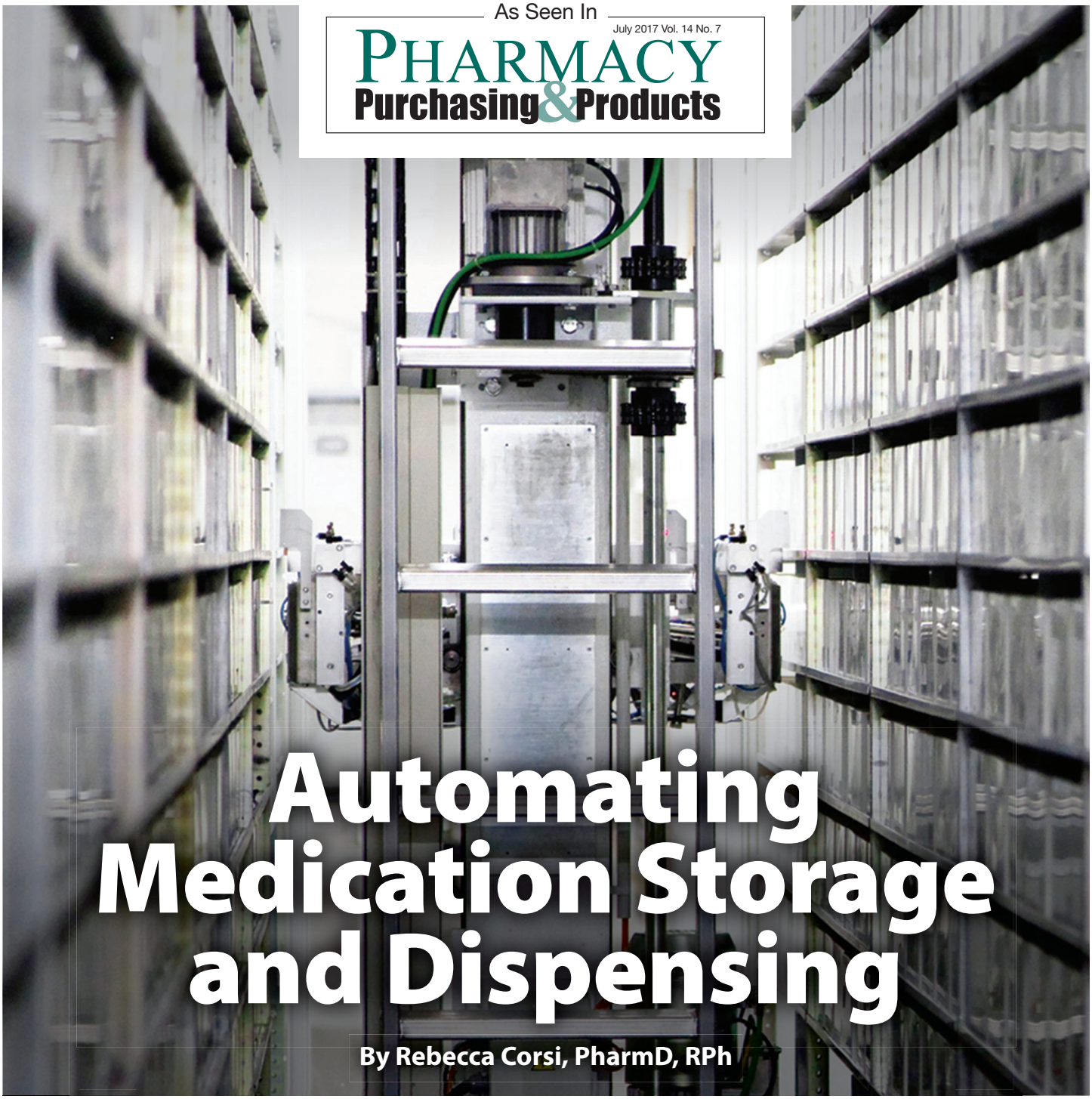

Automating Medication Storage and Dispensing

By Rebecca Corsi, PharmD, RPh

Automated medication storage and dispensing inside the pharmacy is becoming increasingly common. *Pharmacy Purchasing & Products*' 2016 State of Pharmacy Automation Survey highlights that more than one-third of organizations have adopted a carousel or robot storage and retrieval system, and most users rate these systems highly.[1]

Founded in 1914 as Peoples Hospital, Cleveland Clinic Akron General (CCAG) is a not-for-profit health care organization that serves as the hub for Cleveland Clinic's southern region. In addition to a 532-bed teaching and research medical center in downtown Akron, the Cleveland Clinic Akron General system includes a critical access hospital, rehabilitation services, visiting nurse services, numerous outpatient health and wellness centers, and specialty care services. The pharmacy model includes a central pharmacy, two critical care-oriented pharmacy satellites, a cancer center pharmacy satellite, and an OR pharmacy satellite all located at the medical center in downtown Akron. Three infusion center pharmacies and an OR satellite pharmacy for the outpatient surgery center are located at the health and wellness centers.

CCAG utilizes a charge-on-dispense model and several types of technology for medication management, including dispensing robots that store, package, and dispense drugs, as well as ADCs throughout the units and off-site locations. In the main hospital,

SIDEBAR

Staffing Considerations

Staffing and determining responsibilities surrounding the new automation involved many early discussions to facilitate effective decision-making, which would become important later in the process. Three lead automation technician FTEs (one per shift) were approved prior to robot implementation; these positions were filled by pharmacy technicians with an interest in and an aptitude for technology. Along with the pharmacy informatics team, these technicians participated in every step of the implementation process. Their primary responsibilities were packing and restocking, inventory configuration preparation, and troubleshooting.

Early establishment of this team was key to a successful project. Working together, the pharmacy informatics team and the lead automation technicians were instrumental in a smooth implementation project from beginning to end. Their knowledge and experience were critical to configuring and optimizing the automation. In addition, the support of the director of pharmacy, the pharmacy management team, and pharmacy staff were key to soliciting workflow feedback and generating staff buy-in. This collaboration facilitated staff investment in the new automation and workflow.

ADCs are primarily used for medications designated for PRN use and for controlled substances. The off-site locations hold a wider variety of medications for immediate dispensing and administration. A highly automated organization, the health system utilizes an electronic medical record, CPOE, and BCMA. Automated medication storage in the pharmacy is a cornerstone of our centralized medication distribution model.

History of Robotic Medication Storage at CCAG

Recognizing the need for robust medication storage inside the pharmacy, CCAG first implemented a robotic medication storage system more than 20 years ago with the goals of improving medication safety and medication dispensing efficiency. At that time, oral solid medications were packaged on a separate packaging machine, then loaded into robot storage for dispensing at a later time. Upon receipt of an order, a label was printed and placed on a box, which was sent into the robot on a conveyor belt. Medications were dispensed by the robot into the box, then transferred into a bag by a technician and labeled.

New robotic technology was implemented 2 years ago, including an all-in-one packaging, storage, and dispensing robot for unit-dose solids and smaller items, as well as a storage and dispensing system for larger and multi-dose items. Primary considerations for selecting a system were medication safety and workflow efficiency. Among the benefits of the new system, the most significant include:

- **Increased Storage Capacity.** The new robotic dispensing technology has a large storage capacity that meets the needs of our growing organization
- **Improved Safety Features.** The robotic system features robust bar coding capacity, which increases safety in the dispensing process
- **Reduced Checks Required at Point-of-Dispense.** Inventory configuration and verification are concentrated on the front-end of the process, reducing the need for multiple checks at the point of dispense as required under the previous system
- **Increased Efficiency.** The new system integrates packaging, storage, and dispensing within the automation process, a more efficient way of preparing drugs for dispensing
- **System Integration.** The integration of operations between the two robotic dispensing solutions enables a high level of auditing capability. This proved important later when we sought approval for a medication percentage check from the Ohio Board of Pharmacy.

The Implementation Process

The robots were implemented in succession, one after another (see **TABLE**). The packaging, storage, and dispensing solution for unit-dose solids and smaller items was installed first and went live in mid-March 2015. The storage and dispensing system for larger and multi-dose items went live in late July that year. Once the packaging and storage solution for unit-dose items was in production, the original robot was decommissioned and removed from its existing space to make room for staging and build of the storage and dispensing solution for multi-dose items. This robot improved upon the previous process, wherein larger products and multi-dose items (eg, creams and inhalers) were stored in a manual pick room.

Although the implementation of this complex technology seemed overwhelming at first, we had significant vendor support, which was critical not only for the logistical and technical configuration, but also to educate staff on using the automation, which would become the foundation of our future dispensing workflow. To properly harness this additional functionality, we had to reevaluate staffing and work processes within the pharmacy as a whole.

For example, ADC restocking was significantly reconfigured using the storage and dispensing robot. Each day, the ADC software sends a list of medications to the automation software that need to be reloaded into each of the 59 cabinets. These batches are sent to the robot so that all items (with the exception of large-volume IV fluids) can be pulled for restock in an efficient, safe manner. To streamline this operation, controlled substances are included in the robot inventory, for ADC restocking only. This facilitates a more efficient pull by the narcotic technicians, but prevents those controlled substances (schedules III, IV, and V) from being part of first-dose pulls for the general technician staff. Each controlled substance has a specific naming convention for easy identification and auditing and is assigned its own separate box location within the robot.

Building the Automation

Prior to undertaking the robot build, our team visited another hospital utilizing the same automation to gain an understanding of the logistics and robot footprint, and to observe the staff's interaction with the technology. This opportunity was invaluable, as it provided an eyewitness account of the automated packaging and dispensing process, and helped us visualize how the technology would impact workflow. In addition, the visit clarified the importance of adjusting our logistics for drug and consumable storage space.

One of the first steps during the build was to determine which medications should be housed in each of the robots. Our vendor assisted in evaluating each medication currently dispensed to decide which oral solids and vials were appropriate for storing in

the packaging and dispensing robot. Multi-dose products, bulk items, and larger volume medications that could not be packaged in the robot were assigned to the storage and dispensing system inventory.

Knowing that we planned to utilize the multi-dose storage system to restock the ADCs, we evaluated which medications were best stored therein to ensure an efficient ADC restocking process. Duplicate medications that were already housed in the packaging and storage robot were included, but were purchased in unit-dose packages so that they could be used to fill the off-site locations. Because most medications stored in ADCs are PRN and controlled substances, we were able to outline an audit process that allowed us to keep control level III, IV, and V items in the storage and dispensing system to be pulled only for cabinet restocking batches.

Once the machine was in place, the pharmacy informatics team and the lead automation technicians worked with trainers from the vendor on several week-long training sessions. The trainer visited the hospital for a week to provide education on configuring the technology, and then left for a period to allow us time to master this task. The next education session included packaging and loading the machine; once again, a week-long education visit provided us with the necessary information, and then the trainer left for a period to allow us time to master the process. This approach provided time for the team to learn about the automation while there was on-hand support, and then continue to solidify that process once the trainer was gone.

Once the machine was fully operational and duplicating the medication orders dispensing in production, several training sessions occurred prior to go-live to test functionality and train users on basic operation, maintenance, and troubleshooting. Using this train-the-trainer method, the lead automation technicians were then responsible for training staff on their shifts to use the automation. They are also responsible for training new staff and reinforcing best practices with existing staff.

Alarm handling, maintenance, and troubleshooting were critical parts of the staff education process. At the start of the robot implementation, we were assigned a vendor technician who was dedicated to our site. This assistance was critical to help acclimate our informatics, automation, and general pharmacy staff to handle alarms. This technician continues to be an invaluable resource; he visits weekly to perform maintenance on the machines, and is available 24/7 to assist with troubleshooting and alarms.

Benefits of an Incremental Rollout

The incremental rollout of this technology proved important for our implementation testing process, particularly for the unit-dose packaging and dispensing robot. Having both our original robot performing dispensing while the new robot was being built and configured was a best-case scenario. Once the packaging and dispensing robot for unit-dose solids and smaller items was built and loaded with product, a parallel interface was created from the pharmacy system to the robot. This duplicate feed of order information facilitates troubleshooting ADT information and translation, medication order dispensing, machine configuration, label generation, and charge and crediting verification.

The incremental rollout allowed us to monitor usage of consumables and train staff to manage the replacement of those consumables. This time also was instrumental in addressing challenges utilizing the machines and gain an understanding of what would be required to switch exclusively to the new robots. Utilizing both the old and new robots concurrently, in a setting where we did not have to depend on that technology for product dispensing, was important to gaining a comprehensive understanding of the automation.

TABLE
Important Dates in Robot Implementation

March 3, 2015	Started processing live data feed through robot and running first doses and batches while troubleshooting issues
March 17, 2015	Go-live date for packaging, storage, and dispensing system for unit-dose solids and smaller items in production environment
May 13, 2015	High point seen for empty bag errors in house batch
May 22, 2015	Achieved zero errors in the early morning house batch for first time
June 3, 2015	Started percentage check on packaging, storage, and dispensing solution for unit-dose solids and smaller items
July 28, 2015	Storage and dispensing solution for larger and multi-dose items go-live. Started processing live data feed through robot and running first doses and batches while troubleshooting issues

Obtaining Board of Pharmacy Approval

The possibility of obtaining board of pharmacy approval for partial check of medications dispensed from the robot was a significant benefit of robot implementation. This process required a 90-day pharmacist check of every dose coming out of the packaging, storage, and dispensing robot for unit-dose solids and smaller items. At the time of go-live, we were processing approximately 4000 doses per day between first doses, STAT doses, and cart-fill doses dispensed from that machine. During the 90-day audit, staff was required to track all errors found and categorize each according to type of error and level of severity. We found that the primary cause of error was related to packaging and fell into three categories: a broken tablet in the bag, an empty bag (missing a tablet), and a bag with more than one tablet inside. Our auditing process and success in implementation enabled an Ohio Board of Pharmacy approval for a percentage check of first doses/STAT dispensing and a percentage check on cart-fill dispensing, including the ADC restock batches.

Once the new robot was dispensing medications and the old robot was removed, the build was undertaken for the storage and dispensing robot designed to accommodate larger and multi-dose items. This build, which was somewhat simpler to configure, also went through a 90-day audit period, during which a 100% pharmacist check was required before it was given an approval for a percentage check by the Ohio Board of Pharmacy.

Addressing Challenges

Several challenges had to be overcome during the implementation and development of workflow surrounding the new automation. Changes were required not only to our methods of packaging, storage, and dispensing in the pharmacy, but also to the workflow. Medication handling as a whole had to be reevaluated throughout

the health system, as we changed from bags of medications to unit-dose medications secured on a patient-specific sealed ring. Pharmacy worked closely with nursing administration to develop and communicate policies on medication ring handling and use during drug administration to nursing staff, with special considerations for infection control rooms, etc.

In addition, the internal workflow for processing returned medications required modification, as it became clear that an increasing number of errored unit-dose bags returned from the floor were being returned to the drug-nest inventory. We now require that unit-dose bags be screened for anomalies when they are cut apart in the pharmacy, and again before they are loaded onto the return belt.

Another significant challenge involved identifying the most efficient way to handle unit-dose bags that had been broken off of the ring and returned to the pharmacy unused. The unit-dose package was still intact, but because the ring was broken, the bag could not be returned to drug-nest stock and credited via the return belt on the packaging robot. A significant number of these began to accumulate, even after re-educating nurses on the floors to prevent the bag being pulled from the ring unnecessarily. We were able to work with a labeling company to develop a patch, much like a reinforcement sticker for a piece of notebook paper, specifically designed for use in the packaging robot. Now, unit-dose bags that are broken off the ring and returned can to be patched and loaded back into the robot for crediting and return to inventory.

Benefits of Robotic Pharmacy Automation

Implementing the new robots has facilitated pharmacists' checking at the most critical points in the process, whereby one check can have a far-reaching impact on downstream processes. The inventory processing procedure is an excellent example. When a new inventory item enters the facility, it must undergo a mapping process and verification through the various pharmacy systems until it arrives for consideration at the robot. The item is added to the robot's inventory database and any NDCs are bar code-mapped to the item. Because the entire system is based on bar code-scanning technology, the accuracy of that initial bar code-mapping of NDC to inventory item is critical, and requires a pharmacist to verify the NDC and bar code of the item against the database.

As an additional safety measure, we also cross-check the item to our pharmacy system database to ensure that the drug identifiers for the inventory item NDC-correlate. Once the drugs are mapped, the unit-dose bags are packed into boxes that are stored in the drug nest. After this packing process is complete, the pharmacist verifies the orders. Verification includes a bar code scan and a visual inspection of the drug and information, which is loaded into the data disk of the box against the pill bottle itself. This is another critical point, wherein the data on an entire box of product prepped for packaging is verified against the bulk manufacturer bottle before packing. The robot is then ready to package unit-dose items out of that box of product.

Another advantage of the robots is the increased auditing capability inherent in the automated system. Unit-dose bags can be tracked from packaging through each cycle of dispense and return, and user activity can be tracked at all points in the system. Actions taken, whether packaging or pulling a medication out of the robot, can be tracked on an individual user basis.

Inventory tracking and replenishment efficiency have dramatically increased; wherein a technician might have had several places to look for a certain product under the old system, they now have one location from which to pull a particular item. In addition, both machines are able to self-monitor their supply and provide a report of items that need to be restocked to reach par level. The packaging robot automatically adjusts its par levels to accommodate a 4-day supply (based on the last 10 days of usage) in the drug-nest. A report is generated that can be printed and used to package items that have inventory below the required levels. The storage and dispensing robot for larger and multi-dose items generates a similar report that the buyer uses on a daily basis to order items to restock the inventory.

Conclusion

Despite the challenges inherent in implementing new technology in the pharmacy, the robot implementation and continued optimization of this automation have significantly improved our medication storage and dispensing process. Because medication safety is our organization's top priority, it is at the forefront of every decision that we make, and the workflow surrounding automation in the pharmacy is no exception. Utilizing a bar code-driven system to package, store, and dispense medications, with its safeguards and audit controls, creates an environment that is undoubtedly safer for patients and more efficient for staff. ■

References

1. State of Pharmacy Automation Survey: Carousels and Robot Storage. *Pharm Purch Prod.* 2016;13(8):18-19.

Systems Scoop

Multi-Dose Dispensing Robot	**Swisslog's BoxPicker**
Automated Packaging and Dispensing System	**Swisslog's PillPick**
Automated Dispensing Cabinets	**Omnicell**
Electronic Medication Record	**McKesson**

Rebecca Corsi, PharmD, RPh, is the manager of pharmacy informatics at Cleveland Clinic Akron General Medical Center. She received her pharmacy degree from Northeast Ohio Medical University in 2011. Rebecca and her team are currently working on transitioning to a new EMR, which is scheduled to go live in September 2017.