# Evaluation of Medications Removed from Automated Dispensing Machines Using the Override Function Leading to Multiple System Changes

Karla Miller, PharmD; Manisha Shah, MBA, RT; Laura Hitchcock, BSN; Alicia Perry, PharmD; Jane Englebright, PhD, RN; Jonathan Perlin, MD, PhD, MSHA, FACP, FACMI; Hayley Burgess, PharmD

## Abstract

Automated dispensing machines (ADM) are a computerized companion technology that reduces labor and contributes to patient safety. When stocked, ADMs store medications and control electronic dispensing. In emergent situations, facilities can approve nursing retrieval of medications prior to pharmacy review via override from the ADM. However, retrieving medications by the override mechanism and administering prior to pharmacy review increases the risk for medication errors. The primary objective of this study was to evaluate the appropriateness of medications removed from the ADM using the override function at a facility owned by Hospital Corporation of America (HCA). The secondary objective was to determine the barcode scan rates of medications removed by the override function. Information was collected to determine which medications were removed from the ADM and the shift, indication, and medication barcode/patient armband scanning rates. Based on medication errors identified, significant changes have been made to the override process, including the number of medications available for override and the requirement of an indication prior to medication removal. Formulary changes were made and opportunities for education identified during the evaluation. This study highlighted an opportunity to embed the culture of patient safety to promote safe medication practices.

## Introduction

In February 2000, shortly after the Institute of Medicine's seminal publication of *To Err is Human*,[1] Hospital Corporation of America (HCA) began developing electronic medication administration recording (eMAR) and barcoding technology with the goal of improving medication administration safety and fostering a culture of patient safety. eMAR and barcoding represent the use of technology to prevent and detect errors by using data to identify and measure improvements. The implementation of an information technology solution (eMAR) paired with item-specific identification (barcoding) enables the user to administer medications with general confirmation of the Five Rights of Medication Administration: Right Patient, Right Medication, Right Dose, Right Route, Right Time. In addition to these "five patient rights," the system allows for review of lab values and for allergy/interaction verification. For the successful

implementation of the system, the pharmacy was required to barcode all medications at the unit of use or to provide a patient-specific prescription barcode, which is applied to piggybacks, intravenous solutions, and multidose medications. All patients admitted to the facility receive a barcoded armband that is unique to their identity and to that particular hospitalization.

The eMAR and barcoding system uses mobile carts with laptops, tethered barcode scanners, or desktop computers with wireless scanners to read barcode labels on medications and patient armbands. Pharmacy order entry creates the patient's medication profile, which provides a cross-reference when the medication is scanned. If a medication is required urgently, the system is integrated with the Automated Dispensing Machine (ADM) to display available "override" medications on the patient's profile. This enables a caregiver to scan the medication and verify the patient's armband before administering a stat medication that has not been reviewed by the pharmacists.

## Automated Dispensing Machines

ADMs, which interface with the pharmacy computer system, are employed in more than half of the hospitals in the United States.[2] Orders are entered into the pharmacy system and linked to the ADM, where a nurse can pull up a patient's profile and access the medication for orders that have been verified by the pharmacy. While this technology allows retrieval of scheduled medications, it also provides rapid accessibility for emergency medications via the override function. These automated medication storage and retrieval lockers help improve the accuracy and efficiency of medication dispensing, inventory maintenance, and charging functions. The dispensing machines allow for systematic monitoring of access to controlled substances, auditing capability in case of discrepancy, and medication storage per regulatory guidelines, while making medications accessible in a timely manner.[3] The impact of ADMs on medication error reduction has not been widely researched.[4]

ADMs may help with accuracy and efficiency, but they do not prevent medication errors. According to the U.S. MEDMARX data report, during 2003, 361 facilities submitted 8,862 records (4.1 percent) citing the dispensing device as the cause of error.[5] The highest percentage of errors was attributable to manual replenishment functions, returning drugs to the wrong location in the machines, human overrides, and circumvention of the machines' safety features.

## Override Function

The override function allows a nurse to remove a medication from the machine before a pharmacist reviews the order. The purpose of the override function is to allow access to medications in urgent/emergent situations. The override function is frequently utilized in clinical settings with non-24 hour pharmacies, emergency departments, and most procedural locations. Inappropriate uses of the override function are often based on practice patterns and perceptions that the pharmacy cannot process orders as quickly as needed. It might also occur if staff has a verbal order and acts upon it, or if a physician demands that a medication be given stat.

Administering medications prior to a pharmacist review increases the risk of medication errors.[3-5] The Joint Commission Standard Medication Management 4.10 (MM.4.10) states that a pharmacist must review all medication orders before dispensing a medication, removing it from floor stock, or removing it from an automated storage and distribution device.[6] Exceptions

include situations in which a licensed independent practitioner controls the ordering, preparation, and administration of the medication and urgent situations, when a delay would harm the patient. The challenge with ADMs is to prevent medication overrides in nonurgent settings and to avoid administering medications from orders that have not been reviewed by a pharmacist.

Numerous medication errors secondary to ADM override have been identified in the literature. During one study, researchers examining 470 overridden medications found that 55 of the medications removed from the ADMs (11.7 percent) had not been retrieved in support of a physician's order; 47 of the 55 overridden medications (10 percent of total overrides) resulted from improperly documented orders, such as medications being ordered verbally. The remaining eight overrides (1.7 percent of total overrides) were a result of medication errors or "close calls," described as medications removed incorrectly but never given to the patient. The authors explained that these problems occurred when the pharmacy was closed and when all medications were available only through the override function. They suggested that the override function only be used when the hospital's pharmacy was closed, in emergencies, and pre-procedure, and that intravenous pain medications should always be obtainable via override.[7]

Another study of ADM-related errors found errors in pharmacy, in nursing, and in the ADMs themselves. Ten ADMs, holding 2,858 drawers, were studied. The researchers found expired medications in 10 drawers (0.3 percent); incorrect bulk medications were found in another 10 (0.3 percent) drawers. Both of these errors were due to mistakes made by pharmacy, which loads the bulk medications into the ADM. The authors combined errors created by the ADM together with those by nursing, reasoning that, for example, medications correctly placed in the ADM by nursing could have fallen between the drawers. Sixty-seven drawers (2.3 percent) were found to hold incorrect single-dose medications; 31 intended medications were not even stored inside an ADM.[8]

## Objectives

This study was conducted at the Parthenon Pavilion, a psychiatric facility at HCA's Centennial Medical Center, which utilizes electronic medication barcoding technology. Hospital process calls for physician orders to be reviewed by pharmacy, and then for nursing to procure barcoded medications from the ADM once they are on a patient's profile. The barcodes from the medication and patient armband are scanned prior to administration of the medication. In urgent/emergent situations, medications can be retrieved prior to pharmacy review, using the override function. Historically, medications were added to the override list because of staff request only.

The Parthenon Pavilion has four automated dispensing machines; each floor has one machine that is used by two units. The medications available for override were not consistent throughout the building. This created a problem because staff frequently floated between the floors. A decision was made to reduce the override medication list to 23 medications and to standardize the override list among the four ADMs (Table 1).

The primary objective of this study was to evaluate the appropriateness of medications removed from the ADM using the override function. The secondary objective was to determine the

barcode scan rates of medications and patient verification when medications were removed using the override function.

**Table 1. Medications available for override at Parthenon Pavilion**

- Ammonia
- Aspirin
- Benztropine, PO/IM
- Chlorpromazine, IM
- Dextrose
- Diazepam
- Diphenhydramine, PO/IM
- Flumazenil
- Glucagon
- Glucose tablets
- Haloperidol, PO/IM
- Insulin (regular)
- Lidocaine
- Lorazepam, PO/IM
- Naloxone
- Nitroglycerin, PO/ointment
- Phenobarbital
- Ziprasidone, IM

## Methods

The study encompassed all medications removed from the Parthenon Pavilion's four ADMs using the override function during the period from May 2006 through July 2006. In total, 59 transactions were analyzed retrospectively. The following information was collected from patient medical records: patient sex, diagnosis, and age; medication route; time the medication was reviewed by pharmacy; whether there was a medication error or subsequent adverse drug reaction (ADR); indication for medication administered; and whether the nurse scanned the medication barcode and the patient armband prior to administration.

A medication error was defined using the National Coordinating Council for Medication Error Reporting and Prevention definition as any preventable event that could cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer.[9] ADRs were tracked using the hospital ADR reporting system. Appropriateness of the medication override function was determined by a match between indication and symptomatology and by whether the physician order corresponded to the medication administered. Barcode medication and patient armband scan rates were evaluated for compliance with patient safety technology.

## Results

Fifty-nine instances of medication removal via the override function were documented. The patients in this convenience sample had a mean age of 51.65 (±15.37) years. Fifty-nine percent of patients were female; the most common diagnoses were bipolar disorder (N = 17), major depressive disorder (N = 14), schizophrenia (N = 11), and schizoaffective disorder (N = 7).

The most frequently removed medication (N = 19) was lorazepam intramuscular (IM) formulation, followed by haloperidol intramuscular (N = 8), lorazepam oral tablet (N = 7), and nitroglycerin sublingual tablets (N = 6). Other medications removed via the override function included ziprasidone, benztropine, chlorpromazine, aspirin, diphenydramine, lidocaine viscous solution, glucagon, and phenobarbital.

Indications for the medications removed via the override function included: treatment of acute agitation (N = 28), chest pain (N = 8), unknown (N = 6), psychosis (N = 5), extrapyramidal side effects (N = 4), anxiety (N = 3), pruritis, alcohol or benzodiazepine withdrawal, hypoglycemia, seizure, and unscheduled procedure (N = 1 each). Of the 59 instances of override, 17 (28.8 percent) occurred during a first shift (7:00 am to 3:30 pm); 31 (52.5 percent) occurred during a second shift (3:00 pm to 11:30 pm); and 11 (18.6 percent) occurred during a third shift (11:00 pm to 7:00 am). Forty-five overrides (76.3 percent) occurred on weekdays. The hospital pharmacy was staffed 24 hours per day, 7 days per week.

Of the 59 override transactions, 50 were appropriate according to the match between symptoms and the medications' listed indications. Medication errors occurred with nine of the transactions: three administrations had no documented physician order; one involved the wrong route; in two instances, the wrong medication was given; and two patients received the wrong dose. In addition, one patient received lorazepam despite the generation of an allergy warning to this medication. Lorazepam and haloperidol were the most common psychiatric medications administered by override, most commonly in response to agitation or psychotic behavior. The barcoding scanning rates for the 59 transactions were 62.7 percent for the medications and 57.6 percent for the patient armbands.

The largest number of overrides occurred during the second shift, which was also when the majority of patients were admitted. Medications removed via override were used appropriately in 85 percent of instances. Nine override occurrences resulted in administering medications inappropriately. The lorazepam administration error did not result in an adverse event for the patient, since the allergy was disputed in the patient record. Based on the low scan rates identified in this study, the barcoding system was not used to its full patient safety potential during emergent situations. The average scan rate for both medications and patient armbands was 97.0 percent, compared to the 62.7 percent for medications and 57.6 percent for armbands during emergent overrides.

In six instances, the appropriateness of medication use could not be assessed because there was no documentation explaining why the medications were given. Antipsychotics were commonly removed via override and were also commonly associated with a wrong medication, wrong route, or wrong dose error. Agitation followed by chest pain were the most common symptoms associated with medications being removed via the override function. Scan rate compliance was lower for medications removed via override.

Based on medication errors identified, significant changes were made to the override process, including decreasing the number of medications available for override and adding the requirement of an indication prior to removal of medication (Table 2). Formulary changes were also made. Olanzapine IM was removed from the formulary to decrease the risk of the wrong medication being given for acute agitation.

Educational opportunities were identified during the evaluation, specifically the need for differentiation between chest pain and panic attacks. This study highlighted an opportunity to embed the culture of patient safety. By educating staff and helping them recognize the benefits of using scanning technology to prevent errors, we hope to decrease the number of system bypasses and increase the scan rates.

## Discussion

This study demonstrated a wide variety of reasons for using the override function for retrieving medications from ADM. The high rates of complications in this situation suggest a need for greater control of utilization, while preserving rapid access for genuine emergency situations.

This study confirmed that, even with barriers in place, there was still a potential for inappropriate use of medications removed via the override function. Limiting override access could decrease medication errors and improve patient safety throughout the hospital.

Centennial Medical Center initiated review of all medications that were removed via the override function to evaluate for appropriateness of use. HCA's medication safety team is now sharing this learning throughout its more than 300 facilities, providing guidance to reduce the number of medications available for override and education to the staff regarding the appropriate use of the override function. The medication safety team is also reinforcing the importance of utilizing the electronic medication barcoding technology, especially in the "override" situation.

**Table 2. Approved AcuDose-Rx® indications for override**

- Acidosis, metabolic
- Acute MI
- Acute RDS
- Agitation, severe
- Allergic reaction
- Anxiety, severe
- Arrhythmia
- Benzodiazepine withdrawal
- Bleeding
- Chest pain
- Electrolyte imbalance
- Extrapyramidal symptoms
- Heparin (central line)
- Hypertensive emergency
- Hypoglycemia
- Labor admission
- Local anesthesia
- Narcotic reversal
- Nausea (new onset)
- Procedure (MD present)
- Sedation (emergency)
- Volume expansion

Organizations using ADM should establish usage and access requirements and regularly reconcile medications that have been removed via the override function. Periodically, safety checks should be conducted to ensure that the devices are being used and maintained as intended. These would include periodic "checks" to validate medication placement accuracy—checking presence, absence, and appropriate dose—within the specified compartments of the device.

Pharmacy departments should work with nursing departments to develop effective policies and procedures that address potential sources of error in order to prevent ADM errors. Establishing a limited selection of medications that can be removed via the override function and diligently reviewing the medication being accessed via the override function could help reduce medication errors. Requiring that pharmacy review and verify the appropriateness of all orders for medications prior to their administration, except when such a review might cause a medically unacceptable delay, should help decrease the number of medications that are removed via the override function. For a successful implementation of eMAR and barcoding, it is imperative to understand and follow the built-in safety triggers.

## Author Affiliations

Hospital Corporation of America, Nashville, TN.

*Address correspondence to:* Karla Miller, PharmD, Director of Medication Usage and Safety, HCA Clinical Services Group, One Park Plaza, Nashville, TN 37203; telephone: 615-344-6518; e-mail: karla.miller@hcahealthcare.com.

# References

1. Kohn LT, Corrigan JM, Donaldson MS eds. To err is human. Building a safer health system. Washington, DC: National Academies Press; 2000.
2. Cohen M, ed. Medication errors, 2nd edition. Washington, DC: APhA Publications; 2007.
3. Paparella S. Automated medication dispensing systems: Not error free. J Emerg Nurs 2006; 32: 71-74.
4. Murray MD. Automated medication dispensing devices. In: Shojania KG, Duncan BW, McDonald KM, et al, eds. Making health care safer: A critical analysis of patient safety practices Evidence report/technology assessment No. 43 (AHRQ Pub. 01-E058). Rockville, MD: Agency for Healthcare Research and Quality; 2001. Available at: www.ahrq.gov/clinic/ptsafety/chap11.htm. Accessed March 12, 2008.
5. MEDMARX 5th anniversary data report: A chartbook of 2003 findings and trends 1999-2003. Rockville, MD: The United States Pharmacopeia; 2004.
6. Medication management standards. Oakbrook Terrace, IL: Joint Commission; 2005.
7. Kester K, Baxter J, Freudenthal K. Errors associated with medications removed from automated dispensing machines using override function. Hosp Pharm 2006; 41: 535-537.
8. Klibanov OM, Eckel SF. Effects of automated dispensing on inventory control, billing, workload, and potential for medication errors. Am J Health Syst Pharm 2003; 60: 569-572.
9. NCC MERP: The first ten years: Defining the problem and developing solutions. National Coordinating Council for Medication Error Reporting and Prevention; 2005 December. Available at: www.nccmerp.org/pdf/reportFinal2005-11-29.pdf. Accessed March 12, 2008.