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utomated dispensing cabinets (ADCs), first introduced in the 1980s to help with medication distribution, storage, security, and retrieval documentation, now have the highest adoption rate of any medication safety technology. In 2007 more than 94% of hospitals used this technology, with 56% of those using ADCs as the primary means of drug distribution (Halvorsen, 2011; Institute for Safe Medication Practices [ISMP], 2008a). Drug distribution has become more decentralized with the use of ADCs (Pedersen, Schneider, & Scheckelhoff, 2009).

Nurses perform the majority of transactions related to ADCs and thus play a key role in ensuring their safe use. While pharmacists focus mainly on dispensing and distribution, nurses are responsible for medication administration, a much different task that requires different skills, understanding, and professional expertise. Strong nursing-pharmacy collaboration is essential to improving ADC safety and productivity (ISMP, 2008c).

ADC safety features have improved steadily over the years, yet concerns about ADC use remain. Such concerns include bypassing safety features, managing overrides, queuing, making selection errors, storing high-alert medications, and using risky practices for medication removal and transportation to the bedside (ISMP, 2008c). In California, the Department of Health has increased its focus on ADC use, especially on adherence to individual hospital policies and procedures (ISMP, 2008b).

To help hospitals and clinicians address these concerns, the Institute for Safe Medication Practices issued its Guidance on the Interdisciplinary Safe Use of ADCs (ISMP, 2008c). Nationwide webcasts sponsored by CareFusion (formerly Cardinal Health) Center for Safety and Clinical Excellence in January and May 2009 brought together medication safety experts to focus on pharmacy and nursing considerations in safe automated cabinet use (CareFusion, 2009).

Following is a summary of information presented by the authors during the nursing webcast, as they shared their expert knowledge and experience with ADC use. Discussion points include the benefits and challenges of ADC use, the importance of interdisciplinary collaboration, the ISMP’s guidance and self-assessment tool on safe use of ADCs, regulatory issues, and specific nursing best practices to optimize the safety and productivity of ADC use.

Benefits of ADC Use

Automated dispensing cabinets can reduce the risk of medication errors, but only when cabinet use is carefully planned and specific safeguards consistently are available and used. Profiled ADC systems are one of the most important safety enhancements that have evolved in

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ADCs during the last decade. This safety feature provides a direct interface between the pharmacy information system and ADCs so pharmacists can profile, screen, and approve medications before they are removed from the cabinet for administration (ISMP, 2008a).

For nurses, ADC use can help improve medication safety, ensure pharmacist review of orders prior to administration, and reduce or eliminate delays due to medication availability, missing doses, and time-consuming controlled substance counts. Pharmacists who are less tied to the dispensing function may have more time to collaborate with their nursing colleagues, check physicians' orders against patients' drug profiles, and participate in patient-care rounds. At hospitals without 24-hour pharmacy service, remote order entry applications may allow pharmacists at an outside location to receive and review scanned orders, access patients' drug profiles, and approve drugs to be released at a profiled ADC on a patient care unit for nurses to select and administer (ISMP, 2008a).

The many benefits of ADC use include improved drug security, charge capture, inventory control, computerized alerts, and the potential to limit practitioner access to particular high-alert drug products. Bar coding is being used to improve the accuracy of drug restocking and removal from the ADC (Cina et al., 2006; Maddox, 2005). Controlled substances, look-alike/sound-alike medications, and high-risk medications can be segregated. High-risk medications can be associated with clinical warnings, and safety updates can be implemented easily house-wide through the ADC system. With the use of profiled ADCs, nurses only can administer medications that have been reviewed by a pharmacist. An authorized list of emergency medications can be defined for which this check can be overridden in an emergency.

Guidelines for Safe Use

Until recently, few resources have been available to guide health care organizations toward best practices and safer use of this technology. In March 2007, ISMP convened an interdisciplinary ADC National Forum on Safer Use, sponsored by Cardinal Health (now CareFusion), McKesson, and Omnicell. Forum attendees included medication use experts from small hospitals, specialty hospitals, health systems, academic teaching centers, industry, and ISMP. High-level collaboration among nursing leaders, frontline nurses, pharmacists, technology experts, and ISMP staff identified safe practice strategies for each of the ISMP 12 core processes (see Table 1) that are detailed in the ISMP Guidance on the Interdisciplinary Safe Use of ADCs (2008c). In June 2009, ISMP released the Medication Safety Self Assessment® for Automated Dispensing Cabinets (ISMP, 2009). Both documents can be downloaded at no charge from the ISMP web site.

Another resource is a report by Pedersen and colleagues (2009) of a national survey about issues across the country with regard to medication dispensing and administration. It addresses both nursing and pharmacy issues, and provides hospital benchmarks for comparison to other institutions. In November 2007, ISMP also conducted a survey on ADC use in acute care organizations (ISMP, 2008a). When compared to data from ISMP's 1999 survey on ADCs (ISMP, 1999), the 2007 survey found more organizations were employing important safeguards; however, the improvements appeared incremental and not as widespread as needed to maximize the safety benefits that ADC technology offers (ISMP, 2008a).

### Multidisciplinary Collaboration

Multidisciplinary planning and collaboration among nurses, pharmacists, and hospital leaders is of utmost importance in working to improve the safety of ADC use. At University Medical Center in Lubbock, TX, a chief nursing officer can serve as a liaison to help ensure pharmacists and nurses understand each others’ patient care processes and collaborate on policy development to provide the best care. In another approach, a nurse is in charge of pharmacy-nurse relations at a 550-bed, tertiary-care, community teaching hospital in southeastern Michigan.

Before and after implementation of ADCs, it is important to assess and optimize current processes related to delivering and managing medications on the nursing units. In particular, members of an interdisciplinary team need to (ISMP, 2008c):

- Identify opportunities to improve the safety and efficiency
of the medication use process to meet current and anticipated clinical needs.

- Identify appropriate workflow solutions and equipment requirements, considering the nursing unit environment, census, and number of clinicians who will be accessing the ADC.
- Redefine the clinical workflow, and develop policies and procedures for removal of drugs from the ADCs and transport to the patient bedside.
- Define delivery times and refill procedures in coordination with nursing workflow.
- Configure equipment with regard to drawer type and the location for various medications.
- Identify clinical best practices and regulatory requirements to help achieve the highest level of patient and caregiver safety with regard to ADC use.
- Conduct follow-up assessments to ensure staff members are maximizing the benefits of the technology by using the features, streamlining processes, and meeting ADC best practices (ISMP, 2008c).

**Location and Ideal Environment**

Creating ideal environment conditions for ADC use requires many decisions about the number and locations of ADCs and their proximity to other supplies. Ideally, ADCs should be located in secure medication rooms, as opposed to busy nurses’ stations or unit hallways with frequent interruptions and distractions. For efficient medication administration, ADCs should be located within 100 feet of the patient room and as close as possible to patient beds. The number of cabinets should be based on the patient population, unit bed capacity, and drug distribution model. Organizations with more highly decentralized drug distribution models in which as-needed, first dose, and scheduled doses are accessed primarily from unit ADCs may require more cabinets to accommodate storage needs and the increased number of user transactions.

Nurses’ input is essential to identify concerns that pharmacists might not consider. For example, ADCs should be situated to allow for simultaneous opening of the door into the medication area and the medication drawers in the cabinet. Staff should have access to electronic medication administration records (eMARs) via a designated computer monitor screen that is readable from each ADC. If manual/paper MARs are used, sufficient counter space should be provided to place the MAR at the ADC in a location where it can be read during the ADC transaction.

**ADC Configuration**

Nurses’ input on ADC configuration can help to avoid unsafe practices such as storing certain medications close to each other, particularly look-alike/sound-alike drugs. Practical matters also should be considered. For example, nurses may wish to have frequently accessed medications placed higher in the cabinet to avoid having to bend repeatedly.

**Drawers**

Locked-lidded drawers can provide a high level of security by allowing access to only one pre-selected medication at a time. In contrast, high-capacity, low-security, matrix drawers, which hold large quantities and allow open access to all medications in the drawer, should be used only for the lowest-risk medications that otherwise cannot be stored adequately (ISMP, 2008c). In the 2007 ISMP survey, just 50% of respondents noted ADCs were configured with individual compartments for each drug versus matrix drawer configurations in which users have access to multiple drugs contained within the drawer (ISMP, 2008a). This demonstrated additional controls and process improvements are needed to reduce risk.

**Screens**

A nurse may need to have more information on the ADC screen than a pharmacist realizes in order to administer a medication safely and correctly. For instance, most pharmacists know which medications are considered hazardous and how they should be handled. One hospital's pharmacy-nursing liaison nurse created an ADC clinical category to caution the nurse that a drug is hazardous, if personal protective equipment is required, if tablets can be crushed or split, and how to dispose of packaging and medication.

**Withdrawal of Medications**

**Pharmacy-Profiled ADCs**

Joint Commission Standard MM. 05.01.01 (2011a) requires a pharmacist review of new medication orders before administration. This requirement has led to the development of pharmacy profiling systems, whereby nurses cannot remove a medication from an ADC unless a pharmacist has reviewed and released it. In 2007, 64% of ISMP respondents reported their facilities had adopted pharmacy profiling, but only 59% reported that all ADCs were capable of profiling. Interestingly, only 56% of frontline nurses reported pharmacy verification always or frequently occurs before medications are removed from ADCs, compared to 72% of pharmacists (ISMP, 2008a). Hospitals without a 24-hour pharmacy increasingly are using remote order entry so pharmacists at another location can review orders and release medications throughout the week, any time of day (Siegel & McCarrell, 2006; Wakefield, Ward, Loes, O’Brien, & Sperry, 2010).

The Joint Commission allows two exceptions to the requirement for pharmacist review: urgency and physician control of the medication (Joint Commission, 2011b). Importantly, these should be considered exceptions only when necessary, not all the time. The Centers for Medicare and Medicaid Services (CMS) Hospital Conditions of Participation allows only urgency (CMS, 2011). At least one state, California, strictly follows the CMS standards and also allows only urgency (California Board of Pharmacy, 2012). Other accrediting and state
regulations also may change to match the CMS.

In addition to the Joint Commission, other organizations that accredit hospitals in the United States are DNV Healthcare’s National Integrated Accreditation for Healthcare Organizations (DNV, 2009) and the American Osteopathic Association’s (AOA) Healthcare Facilities Accreditation Program (AOA, 2009). All three accrediting organizations base their requirements on the CMS Hospital Conditions of Participation.

Alerts

An incident at a 415-bed academic medical center in which a patient received double dosing of a medication illustrates the need for nurses’ input regarding alerts. The policy on a nursing unit was to have two nurses care for a group of patients so patient care would not be delayed if one nurse was unavailable. In this incident, one nurse administered a medication to a patient but failed to document the medication before taking a break. The second nurse reviewed the MAR, thought the medication had not been administered, and gave a second dose. Investigation revealed an alert could have been activated on the ADC to notify the second nurse the medication had been given within a defined period of time. That functionality was activated and has been used successfully since that occurrence. ADCs also can be configured to display selective warnings for medications that require a double-check or a witness for withdrawal, or other key safety information.

Overrides

An override occurs when a nurse withdraws a medication that has not been reviewed and released by a pharmacist. When an override is required, double-checking of targeted high-alert medications by another practitioner is critical to prevent a potentially fatal error. Yet only 29% of survey respondents reported that such double-checking was required before a drug was removed from an ADC via override (ISMP, 2008a). ISMP emphasized overrides should be used only in circumstances in which the patient’s condition might be affected adversely and should not be used routinely for particular drugs or particular ADCs (ISMP, 2008a).

Standardized Transport

Probably the most difficult problem identified at the ISMP ADC Forum was variability in transporting medications. Transport practices continue to evolve, and nursing workflow has not been aligned yet with some of the more highly decentralized models. Even a hospital that has used barcode systems for years may report large numbers of good catches (near misses) in which bar coding prevented a medication from being administered to the wrong patient.

For transporting medications to the bedside, the ISMP Guidance suggests nurses hand-carry a single patient’s medications for one administration time directly to the bedside or use computers-on-wheels (COWs) that have locked and labeled patient drawers (ISMP, 2008c). However, one hospital evaluated the use of COWs and elected not to use carts with drawers because nurses indicated they would use them to store medications. If this occurred, pharmacy would no longer be able to monitor expired or recalled medications. Another drawback of carts at this hospital is that they are used not only by nurses but also by physicians, pharmacists, and respiratory therapists during rounds, thus potentially compromising control of the medications by the nurse.

Safety and Workflow Challenges

Distractions and Interruptions

MedMarx data from 2003 to 2006 showed almost 50% of medication errors involved distractions (Hicks, Becker, & Cousins, 2008). In addition, almost 50% of respondents to the ISMP 2007 survey reported ADCs were not located in areas free from distraction (ISMP, 2008a). To reduce distraction and interruptions at or around ADCs, the ISMP Guidance recommends creating a so-called sterile cockpit environment (ISMP, 2008c). The term is taken from the airline industry’s efforts to ensure crew members would not be distracted and unable to respond appropriately during crucial times, such as taxiing, take-off, landing, and flying below 10,000 feet. A similar approach could help to reduce or eliminate distractions that could lead to medication errors.

The best way to create a sterile cockpit environment for ADCs is to place the cabinets in dedicated medication rooms. However, that is not always possible. ADCs should not be placed in hallways where nurses can be interrupted by fellow staff members, families, alarms, and telephone calls. The ADC should be in an area that is not highly visible but where contact can still be maintained with the patient care environment, as in dedicated rooms or in recessed halls.

Some organizations have put tape on the floor to create a Do Not Disturb or Quiet zone around the ADC (see Figure 1). Other hospitals have attempted to reduce distractions and interruptions by having nurses wear a Do Not Disturb sash or vest when they are administering medications and should not be interrupted. A pilot program at Kaiser Permanente, in which nurses used both Do Not Disturb zones and vests, resulted in a significant reduction in the number of staff interruptions (Kaiser Permanente Innovation Consultancy, 2009).

A major drawback to these proposed solutions is that patients and visitors may not notice the zone or vest, know what it means, or even be aware they are interrupting the nurse. A nurse frequently may have to explain the purpose of the zone or vest. Plus, given the frequency with which a nurse is passing medications, putting a vest off and on repeatedly could be burdensome.

Whatever safety features are used to reduce distractions and interruptions, nurse leaders must promote a culture that recognizes medication administration as a cognitive task that should be respected. The process of retrieving and administering medications is complex and requires concentration to perform accurately.
During medication administration, discussion should be kept to a minimum or avoided completely so the nurse is not interrupted. Allowing the nurse to maintain focus until administration is completed can help prevent medication errors and preventable adverse events (Agency for Healthcare Research and Quality, 2011).

Queuing

Queuing, or having to wait in line, is a major difficulty frequently associated with ADC use. Queuing can lead to rushed medication selection, errors in medication removal, and unsafe workarounds such as removing more than one patient’s medications at a time. In the ISMP ADC survey (2008a), almost a third of frontline nurses reported always or frequently waiting in line to access the ADC. Queuing often is a symptom of larger issues that lead to workflow barriers. For example, the unit may not have enough cabinets, too many clinicians may be removing medications from one access point, or nurses or respiratory therapists may be removing medications for multiple patients or for multiple medication times. This may be associated with recent trends to utilize a more decentralized drug distribution model and maximize medication storage in cabinets. As a result, however, the size and number of cabinets may be insufficient as drug storage in ADCs becomes denser and the number of transactions per user increases.

Hospital and nurse leaders must solicit feedback from nurses about queuing issues and possible solutions. Bigger issues, such as needing to provide additional access points or move equipment to a more convenient location, may be involved. ADC-generated reports can be used to determine if certain access points are being over-utilized. Data showing much more activity on one device than another can help support the need to provide additional access points.

Withdrawing Medications for More Than One Patient at a Time

A common ADC workaround is removing medications for more than one patient at a time. About 30% of frontline nurses reported always or frequently removing several patients’ medications at a time—a practice known to lead to drug administration errors. This workaround also complicates charting accuracy because the time of medication removal is not the same as the administration time. Educating nurses during orientation and annual competency testing on the importance of removing only one patient’s medications at a time is an important component in the safe use of ADCs (ISMP, 2008c).

Switching from Paper to Electronic MAR (eMAR)

Nurses have long used the MAR as a legal record to guide the medication process, from withdrawing the medication at the ADC to administering it to the patient. The same principle applies when ADCs are used as the primary means of medication distribution. However, switching from using a 24-hour paper MAR to a real-time eMAR raises many questions in relation to access, availability, and convenience. With the implementation of the eMAR, expectations for using the MAR did not change. However, nursing practice did change. This has led to workarounds, such as creating work sheets, printing the eMAR in the morning and using that to guide medication removal at the ADC, or simply removing medications based on memory.

Nurses may argue they still log onto the eMAR after they remove the medication and check it again prior to administration, in some cases scanning the patient’s wristband. While this practice might catch an error, it also could lead to discovering the error in front of the patient. Withdrawing the wrong medications would create additional workflow steps for the nurse, often after he or she already had attempted administration. Carefully educating nurses and rehearsing what is involved in changing from a paper MAR to an eMAR is essential to standardize medication administration practices and maximize safety.

Medication Diversion

Medication diversion is not uncommon and detection is difficult. Nursing staff and pharmacy personnel share responsibility for detecting diversion. ADC-generated reports can help identify discrepancies in controlled substance use. If a discrepancy is not resolved, another ADC report can be run to identify who removed the medication in question. ADC

FIGURE 1. Quiet Zone

Advanced Practice
reports may validate nursing behaviors that otherwise might prompt suspicion. For example, a nurse identified as having above-average use of controlled substances could be working in an area such as outpatient surgery where high utilization is appropriate. If a pattern of unresolved discrepancies emerges, however, appropriate action can be taken.

**Continuing Improvement**

**Education**

The chief nursing officer and other safety leaders need to ensure nurses have the necessary education to use all functions of the ADC competently to improve safety and increase efficiency. Confirming that nurses utilize the available orientation programs and tutorials, and receive annual competency tests, is another leadership responsibility.

Continuing follow-up assessments also can ensure staff members are using the available features, streamlining processes, and complying with best practices identified for the technology. The ISMP Medication Safety Self Assessment for Automated Dispensing Cabinets can be used to help evaluate ADC safety practices, identify opportunities for improvement, compare a hospital’s experience with hospitals of similar size and demographics, and track and document progress (ISMP, 2009).

**Conclusion**

Automated Dispensing Cabinets are now the most widely used medication safety technology (Pedersen et al., 2009). Safety features and best practices for ADC use continue to evolve; however, challenges remain. To meet these challenges and optimize the safety and productivity of ADC use, nurses, pharmacists, and hospital leaders must collaborate. A multidisciplinary ADC safety team can use the ISMP Guidance on the Interdisciplinary Safe Use of ADCs (ISMP, 2008c) and the ISMP Medication Safety Self Assessment for ADCs (ISMP, 2009) to help plan ADC implementation and identify opportunities for safety improvements, track progress, and benchmark performance. Education and follow-up assessments can help ensure staff members are maximizing the benefits of an ADC system by using the available features, streamlining processes, and complying with ADC regulations and best practices.

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**ADDITIONAL READINGS**


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