



Nurse Advise-ERR®

Educating the healthcare community about safe medication practices

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Follow ISMP guidelines to safeguard the design and use of automated dispensing cabinets (ADCs)

Automated dispensing cabinets (ADCs) are decentralized medication distribution systems that provide computer-controlled storage, dispensing, and tracking of medications at the point-of-care. This technology was introduced in hospitals in the late 1980s. Although adoption started slowly, as of 2007, more than 80% of hospitals use ADCs to replace manual floor stock systems and/or medication carts that previously held a 24-hour supply of patient-specific medications.¹

Benefits of ADCs

ADCs offer the following benefits:

- Provides nurses with increased access to medications in patient care areas to facilitate timely administration
- Ensures locked storage of medications on patient care units and electronically tracks use of controlled substances and other drugs
- Tracks medication stocking and distribution to improve inventory control
- Supports the clinical review of medication orders by a pharmacist prior to administration if the ADCs are interfaced with the pharmacy computer
- Can be interfaced with other databases such as the facility's admission/discharge/transfer system, and billing systems, thereby increasing the efficiency of drug dispensing and billing
- Can be interfaced with barcode technology to automate the restocking process, track dispensing, and if linked with point-of-care bar-coding systems, ensure an electronic match between prescribed and selected medications.

What the Research Shows

Based on the benefits described above, ADCs have been recommended as a

potential mechanism to increase efficiency as well as reduce medication errors. To date, a small body of evidence has been published regarding the impact of this technology on error rates. Several years ago, Oren et al. conducted a meta-analysis which identified just seven *controlled* studies linking ADCs with medication error rates or other secondary endpoints.²

In general, after ADC implementation, these studies identified:

- A reduction in dispensing error rates when filling ADCs compared to manual filling of traditional unit-dose cassettes^{3,4}
- A reduction in drug administration errors (mostly wrong time errors) and fewer missed doses^{5,6}
- A reduction in drug administration errors on a cardiovascular surgery unit, but an increase in errors on an intensive care unit⁷
- An increase in errors (by more than 30%) in six of seven nursing units evaluated.⁸

With the exception of wrong-time errors, these studies showed mixed results for reducing drug administration errors with ADCs. Similar results were found by a government-funded compilation of evidence related to ADCs.⁹ However, many of these studies were conducted before important software and hardware enhancements were available, such as interfaces between ADCs and pharmacy computers, and cabinets with individually lidded compartments. While few studies clearly link ADC design and use to the error rates, error-reporting programs have uncovered many factors that influence the ability of ADCs to reduce medication errors.

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⚡ "2day" gets "86'd." The order below is for **SLOW-MAG** (magnesium chloride), misspelled as "Somag," 64 mg TID "2Day." The pharmacist

questioned whether this meant to give the medication TID for 2 days (her initial thought) or give it just "today" (2Day). She called to clarify the order, and it turned out that "2Day" was "text messaging" shorthand for "today." The pharmacist asked the nurse to rewrite the verbal order and politely suggested that text messaging language was not appropriate for transcribing medical orders due to potential misinterpretation. Using text messaging abbreviations with medical orders is a new and evolving chapter in the dangerous abbreviations saga.

⚡ T1D or TID? T1D (letter T, number 1, letter D) is a potentially dangerous abbreviation for "type 1 diabetes" that appears occasionally in the literature. If it is used when writing orders for patients, we envision that the abbreviation will eventually be mistaken for "three times daily," so avoid its use.

⚡ Inside label too small. A hospital that wanted to boost local community pertussis immunity began to stock **ADACEL** (diphtheria and tetanus toxoids, acellular pertussis vaccine) in its emergency department, while maintaining supplies of **DECAVAC** (diphtheria and tetanus toxoids) for selected patients as needed. Both products are available in prefilled syringes from sanofi-pasteur. They are fairly easy to differentiate when in the outer carton. Once removed from the box, the syringe packages are only labeled with a set of peel-off stickers that look almost identical (Figure 1).

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Factors That Influence Safety

ADCs cannot improve safety unless cabinet design and use are planned and implemented with attention to the following factors.

Patient profiling. If the ADC is linked to the pharmacy computer, a pharmacist can review each new medication order and screen it for safety before the drug can be removed from the cabinet—such a feature facilitates adherence with The Joint Commission's (TJC) requirement for such reviews. Without this feature, nurses may not be alerted to unsafe doses, potential allergic reactions, duplicate therapy, contraindications, drug interactions, or other important information. An example from the ISMP Medication Errors Reporting Program (MERP) follows.

Before colchicine injection was removed from the market last year, a patient died after receiving 10 mg IV. The physician had prescribed "colchicine 1.0 mg IV now," but the decimal point was poorly visible. This, and the use of a trailing zero, led the nurse to believe the dose was 10 mg. If a pharmacist had prescreened the order, the nurse would have been instructed to remove one ampul of colchicine (1 mg) to administer the dose. However, the error reached the patient because the ADC was not profiled to the pharmacy computer, and there was an excessive quantity of colchicine in storage: ten 1 mg ampuls. Thus, the nurse was able to remove enough ampuls to administer the fatal dose.

Overrides. Even when ADCs employ patient profiling, this feature is sometimes overridden to allow removal of drugs in an emergency. However, misuse of overrides has resulted in errors, as in the following example from the Pennsylvania Patient Safety Reporting System (PA-PSRS).

A physician prescribed ZOSYN (piperacillin and tazobactam) for a patient. The first dose was given in the emergency department, and a second dose was given

on the medical unit. Both doses were retrieved from an ADC prior to review by the pharmacy. Later, when pharmacy reviewed the order, it was noted that the patient had a documented allergy to penicillin. Luckily, the patient did not experience a serious allergic reaction.

Overrides are not the only examples of workarounds used to access medications from ADCs. Other types of workarounds include use of the "inventory" function (designed to determine the current number of doses of a particular medication on hand) to gain access to medications for patients before pharmacy screening, removing a larger quantity of medications than ordered for one patient, and removing medications for multiple patients while the cabinet is open.

Number and placement of devices. If a sufficient number of ADCs are not available, nurses may remove doses ahead of time due to limited access during busy drug administration times. Placement of ADCs in areas with high traffic or low lighting can lead to distractions and misread screens or labels.

Screen set-up. Choosing the wrong medication from an alphabetical pick list is another contributing factor arising from look-alike drug names. An example from the MERP follows.

One hospital reported several mix-ups between injectable diazepam and diltiazem when removing the drugs from an ADC in the ICU. In each case, the nurse incorrectly chose diazepam on the screen, which was listed directly above the intended product, diltiazem. In one case, diazepam was given at the prescribed diltiazem dose. In another case, the error was discovered before it reached the patient when a physician noticed the amber colored vial and re-checked the product label. It's important to note the nurses in these cases thought they had removed the correct product from the ADC. Thus, they failed to inspect the product label carefully, missing opportunities to catch the original selection error.

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The font size on the white stickers is also very small. Then although the syringes have different color backgrounds, the black plunger makes it hard to read the syringe labels (Figure 2). We have contacted sanofi-pasteur about our concerns, and the company is considering a label change. Meanwhile, ask your pharmacy to affix an auxiliary label to the inner packages to help differentiate the two products once removed from their outer cartons.

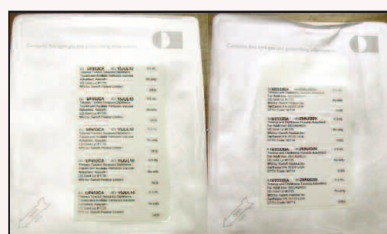


Figure 1



Figure 2

⚡ Don't use empty pre-labeled syringes/bowls. ISMP has long brought attention to the need to label syringes and bowls on the sterile field using sterile pens and markers, which is also one component of The Joint Commission's National Patient Safety Goal (NPSG) associated with labeling all medications. We have also been staunch proponents of using prefilled, pre-labeled syringes. On several occasions, we have been asked our opinion about using empty pre-labeled syringes and bowls that can be subsequently filled with the labeled medication. We are aware of at least one manufacturer that offers empty pre-labeled syringes for common products (e.g., contrast media, midazolam, phenylephrine, lidocaine, saline, heparin). However, the use of empty pre-labeled syringes is not

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A way to guard against this predictable failure is to ensure that ADC cabinets are interfaced with the pharmacy computer so they do not allow access to drugs that do not appear on a patient's profile.

Quantity of drugs. ADCs that contain a wide assortment or excessive quantities of medications can also increase the risk of errors, like the colchicine incident above, especially if the ADCs are not profiled to the pharmacy computer. The following example, from the MERP, shows the safety net that carefully limited ADC stock can offer.

After the pharmacy was closed, an order was written for "1 gram calcium gluconate IV." Each 10 mL vial contains 1 g of calcium gluconate, which is equivalent to 93 mg of elemental calcium. The nurse misunderstood this information on the label and thought she needed 10-11 vials to prepare the 1 g dose. The ADC contained only six vials. The ten-fold error was discovered and averted when the nurse contacted a pharmacist for additional vials.

Stocking processes. Stocking medications in ADCs is primarily a pharmacy function, although nurses may return unused doses—an error-prone practice we do not endorse. Cabinets that do not employ bar-coding technology are vulnerable to errors because there is rarely any system used to verify that the correct drug has been placed in the correct drawer. You might recall the well-publicized infant deaths when vials of heparin 10,000 units/mL were misplaced in a pocket meant for heparin 10 units/mL. Other examples submitted to PA-PSRS and MERP involved errors stocking the following drugs or strengths, many with look-alike names or packaging:

■ **NUBAIN** (*nalbuphine*) in an adjacent drawer intended for **BUPRENEX** (*buprenorphine*)

■ **FIORICET** (*acetaminophen, butalbital, caffeine*) in a drawer intended for **FIORINAL** (*aspirin, caffeine, butalbital*)

■ **HYDROMORPHONE** 4 mg syringes in a drawer intended for morphine 4 mg syringes

■ **tiZANidine** (**ZANAFLEX**) in the compartment intended for **tiaGABine** (**GABITRIL**)

■ **Abbott Carpuject** syringe of **digoxin** in the drawer intended for **ketorolac**.

Storing medications with look-alike names and/or packaging next to each other in the same drawer or bin has contributed to stocking and retrieval errors, particularly during emergencies when the patient profiling system is bypassed. An example of this type of error reported to PA-PSRS follows.

*During a cardiac catheterization, a nurse received a verbal order for IV **LOPRESSOR** (*metoprolol*). She accidentally removed **LEVOPHED** (*norepinephrine*) from the ADC, which was stored in a bin adjacent to Lopressor. The patient received the incorrect medication and required treatment and observation during and after the procedure.*

ADC Safety Recommendations

In 2007, ISMP held a forum to develop interdisciplinary guidelines for promoting safe practices with ADCs. The guidelines were posted in March (www.ismp.org/Tools/guidelines/ADC_Guidelines_Final.pdf). A few examples of recommendations in the guidelines appear in Table 1 (page 4).

In February 2009, Cardinal Health's Center for Safety and Clinical Excellence sponsored a webcast on *Best Practices for ADCs*, in which ISMP participated. You can listen to this free webcast at: www.cardinalhealth.com/clinicalcenter/materials/webcasts/index.asp. Also, we have nearly completed a self-assessment for ADC technology, which will be freely available on our website by the end of April. We encourage organizations that employ ADCs to review the guidelines, listen to the webcast, and complete the self-assessment to maximize safety.

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recommended. Labels should never be applied to syringes or basins in advance of medication/solution preparation, nor should they be pre-labeled before preparation. There is just too much chance of an error—accidentally picking up and filling the wrong syringe or pouring a solution into the wrong basin. Or in a pinch, a clinician may use one of the empty pre-labeled syringes or bowls to prepare a different product, believing the risk is minimal because he or she will be using/administering the product. As we know well from reports about product mix-ups with unlabeled syringes, these pre-labeled syringes may be put down before use and mistaken as the labeled product, and pre-labeled basins may not be under the direct control of the person who poured the medication/solution into it. Labeling must occur when preparing the medication or solution, not ahead of time. Incidentally, the use of empty, pre-labeled syringes and bowls is not a practice that meets the intent of The Joint Commission's NPSG regarding labeling of all products on the sterile field. (See the Frequently Asked Questions for NPSG 3D at: www.jointcommission.org/NR/rdonlyres/F2FD5301-FOA3-43CD-B16A-BD55EAE206A/0/2008_FAQs_NPSG_03.pdf.)



Company comments on insulin pen safety.

Based upon reports published by ISMP and FDA, sanofi-aventis has notified health professionals to exercise all necessary precautions to avoid the potential for risks to patients caused by using an insulin pen for multiple patients, even if needles are changed before each use. Recommendations include prohibiting use of insulin pens as floor stock, providing reminders to staff that insulin pens are for single patient use only, and avoiding placement of labels on removable caps. The letter can be viewed in full by visiting: www.ismp.org/newsletters/acutecare/articles/hcp-Letter.pdf. ISMP appreciates this action by the company.



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Table 1. Examples of ADC Recommendations

1. Provide ideal environmental conditions for the use of ADCs.	Locate ADCs in a secure, isolated environment, close to IV tubing and other supplies.
	Ensure that a phone is near the ADC for outgoing calls only.
2. Ensure ADC system security.	Prohibit the use of temporary, shared, or reused passwords.
	Update the system daily to remove inactive passwords and add new passwords.
3. Use pharmacy-profiled ADCs.	Ensure that all ADCs have pharmacy-profiling capabilities, including those in outpatient areas.
	Require a double-check when removing medications from an unprofiled cabinet.
4. Identify information that should appear on the ADC screen.	Ensure the drug name on the display screen matches the drug label and MAR.
	Use active alerts when possible (e.g., ADC alert appears when selecting a drug for which the patient is allergic versus relying on the nurse to read the allergy field).
5. Select and maintain proper ADC inventory.	Establish criteria for including or excluding medications in ADC inventory. Exclude hazardous drugs or medications that require extensive dilutions or calculations.
	Establish appropriate maximum par levels designed to prevent multifold overdosing.
6. Select appropriate ADC configuration.	Store each drug and strength in an individual lidded compartment.
	If matrix drawers must be used, limit them to non-prescription analgesics and antacids.
7. Define safe ADC restocking process.	Make sure unit-dose products most closely match the usual doses used by the associated patient care area (e.g., stock commonly used ½ tablets).
	Use barcode scanning to confirm product selection and placement in the ADC.
8. Develop procedures to ensure the accurate withdrawal of medications from the ADC.	Have ADC screens indicate the location of the medication to be removed.
	Display PRN medications separately in a different section of the ADC drug profile screen.
9. Establish criteria for ADC system overrides.	Ensure medications available for override are unit specific and removed only when there is emergent need.
	Implement strategies (e.g., an independent double-check) that reduce the risk of error when an override is used.
10. Standardize processes for transporting medications from the ADC to the patient's bedside.	Transport medications to the bedside in their original unit-dose package.
	Hand-carry a single patient's medications for one administration time directly to the patient's bedside.
11. Do not return unused medications to their original ADC location.	Return all medications to a common secure one-way return bin and not to an individual pocket or bin within the ADC.
12. Provide staff education and competency validation.	Inform the ADC user during orientation and ongoing competency validation of the risks associated with drug selection.

References: 1) American Society of Health-System Pharmacists. Survey of US Hospital and Health System Adoption and Implementation of Health Information Technology. Unpublished data presented at HIMSS 2008 Annual Conference. 2) Oren E, Shaffer ER, Guglielmo BJ. Impact of emerging technologies on medication errors and adverse drug events. *Am J Health-Syst Pharm* 2003; 60:1447-58. 3) Klein EG, Santora JA, Pascale PM, et al. Medication cart-filling time, accuracy, and cost with an automated dispensing system. *Am J Hosp Pharm* 1994; 51:1193-6. 4) Ray MD, Aldrich LT, Lew PJ. Experience with an automated point-of-use unit-dose drug distribution system. *Hosp Pharm* 1995; 30(1):18,20-3,27-30. 5) Borel J, Rascati K. Effect of an automated, nursing unit-based drug-dispensing device on medication errors. *Am J Health-Syst Pharm* 1995; 52:1875-9. 6) Shirley KL. Effect of an automated dispensing system on medication administration time. *Am J Health-Syst Pharm* 1999; 56:1542-5. 7) Schwarz H, Brodowy B. Implementation and evaluation of an automated dispensing system. *Am J Health-Syst Pharm* 1995; 52:823-8. 8) Barker K, Pearson RE, Hepler CD, et al. Effect of an automated bedside dispensing machine on medication errors. *Am J Hosp Pharm* 1984; 41:1352-8. 9) 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 (Prepared by the University of California at San Francisco-Stanford Evidence-based Practice Center under Contract No. 290-97-0013), AHRQ Publication No. 01-E058, Rockville, MD: Agency for Healthcare Research and Quality. July 2001.

► Teleconference Announcement

ISMP teleconference. On **May 18, 2009**, join us for **Pediatric Medication Safety: High-Leverage Strategies for a High-Risk Patient Population**. During this teleconference, you will learn why pediatric patients are at high risk for medication errors and strategies to decrease that risk. Topics that will be covered include pediatric adaptation of bar-coding technology, tips on compounding pediatric solutions, issues with standardized doses, and the use of resuscitation cards. Go to www.ismp.org/educational/teleconferences.asp to register.

Free webinar from Nursing Leadership Congress (NLC). Please join us **May 14, 2009**, for a webinar, **Information and Strategies for Present on Admission (POA)**, based on CMS rules and how nursing and other healthcare professionals can reduce the occurrence of patients developing a hospital-acquired condition. To register, go to: www.nursingleadershipcongress.com/Webinars.asp.

Newsletter clarification

In response to our March 2009 article on various release formulations of oral opioids, we were notified of a potential error in the table regarding commonly confused opioids. In the table, we listed **KADIAN** (morphine extended release) with directions for administration every 12 hours. Kadian actually has a 24-hour duration of action. However, the daily dose can be given in two divided doses every 12 hours. We apologize for any confusion regarding this drug.

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