Patient Safety Tip of the Week

January 1, 2019

More on Automated Dispensing Cabinet (ADC) Safety

In our December 11, 2018 Patient Safety Tip of the Week "Another NMBA Accident" several issues arose about the role of the ADC (Automated Dispensing Cabinet) in the unfortunate accident in which a patient was inadvertently administered a fatal dose of the NMBA (neuromuscular blocking agent), vecuronium.

In that December 11, 2018 Patient Safety Tip of the Week "Another NMBA Accident", the following ADC-related issues were discussed:

1. The vecuronium was dispensed from the ADC via an override.
2. The warning on the ADC about vecuronium was too vague. It said it should be for STAT orders. Instead, we feel the warning **should have requested confirmation that "the patient is intubated/ventilated or about to be intubated"**.
3. No independent double check was required for ADC overrides.
4. NMBA's (neuromuscular blocking agents) should not be available in floor stock or ADC's other than in the OR, ER, and ICU's. And in the latter areas there are probably better ways/places to store NMBA's (ISMP recommends they be stored in lidded boxes or in rapid sequence intubation kits).
5. The ADC search function defaulted to generic names, when the CPOE order used a brand name (so the nurse could not find the correct ordered medication when searching the patient's profile).

Since that column, another serious incident in which an ADC was a factor has been reported (CDPH 2018). A patient was given a fatal direct IV injection of concentrated Levophed (norepinephrine) rather than the diluted IV continuous drip infusion that had been ordered. The Levophed had been in a concentrated form in a vial in an ADC in the ICIU where the patient was hospitalized. It was removed from the ADC by a licensed nurse (LN1), even though a pharmacy premixed IV infusion of Levophed was stored in a refrigerator across from the ADC. It is not clear whether a formal double check was required for removal of this high alert medication from the ADC. The CDPH statement of deficiencies says that a second licensed nurse (LN2) was "cosigner" for LN1 but never looked at the medication and was unaware it was going to be given by IV push. LN1 noted she pushed the touch screen for each of the patient's meds and did not read the touch screen instructions written for Levophed to be diluted in 250 ml of D5 and given as a drip. LN1 stated she had never given Levophed and did not research it or double check with the co-signer about the medication administration,

In addition to training and education on a variety of issues related to this incident, the facility implemented several changes in processes and procedures related to the ADC and storage and dispensing of Levophed following the incident:

- Process changed for new, after-hour orders for levophed, 2 RN's are required to access and sign out Levophed from automated dispensing machine.
- Levophed purchased as a premixed bag from pharmaceutical company and placed in ICU automated dispense system and on all Code Carts In hospital.
- Added to automated dispensing system an alert for Levophed: MUST BE DILUTED IN D5 250ml. For IV infusion Only. Not for IV push.
- Levophed vial (concentrated) was removed from automatic dispensing system.
- Levophed vlal was made part of a kit which included the medication vial, a 250 ml bag of admixture solution, mixing instructions and a label. (Items included in the label are: Drug Name, Amount of Drug, Type and Amount of Diluent, Concentration, Added By Date, and Expiration Date). This kit is only used when pre-mixed bag would not be available.

So these 2 cases got us wondering about other vulnerabilities and safety issues related to ADC's. ADC's, of course, have many valuable benefits. They certainly help get medications to patients in a more timely fashion. They also improve inventory functions, allow tracking of medications, and improve charge capture. We're also glad to see they're being used to manage certain non-medication medical supplies (Bourcier 2016). We have advocated for that for over 10 years (see, for example our April 21, 2009 Patient Safety Tip of the Week "Still Futzing with Foleys?" where we suggested we treat Foley catheters like medications and use CPOE and barcoding to improve management).

A survey of nurses about their attitudes toward ADC's (Rochais 2014) found that nursing staff considered the introduction of ADC made their work easier (level of agreement of 90%), helped to safely provide patients with care (91%), and helped to reduce medication incidents/accidents (81%). Nursing staff was particularly satisfied by the narcotic drugs management with the ADCs. Nursing staff were not satisfied with the additional delays in the preparation and administration of a medication dose and the inability to prevent a medication from being administered when stopped on the medication administration record (48%).

But, regarding medication safety, other than rates of wrong-time medication errors, results have been mixed (Grissinger 2012). ISMP (ISMP 2008) notes "ADCs can also reduce the risk of medication errors, but only when specific safeguards are consistently available and used."

A significant problem with ADC's is the **override** process. Note that the override process bypasses several medication safeguards. It often is the result of a verbal order and bypasses verification by a pharmacist and the bedside medication verification (barcoding) system.

As early as 2005 the Pennsylvania Patient Safety Reporting System (PA-PSRS 2005) began noting a role of ADC's in medication errors. Nearly 15% of all medication error

reports cited ADCs as the source of the medication, and 23% of these reports involved high-alert medications. Many of these reports described cases in which the design and/or use of ADCs contributed to the errors. The types of errors include wrong drug errors, stocking/storage errors, and medications being administered to patients with a documented allergy. They noted factors contributing to these errors:

- Lack of pharmacy screening of medication orders prior to availability for administration.
- Excessive use of overrides in cabinets with patient profiling, placing the patient at risk of allergic reactions, drug interactions, and other hazards.
- Failure to recognize look-alike names in the design of an ADC's alphabetic pick list or storage compartments, which can lead to choosing the wrong medication

The PA-PSRS report noted, in addition to overrides, other types of workarounds:

- removal of medications using the "inventory" function to gain access to medications for patients without pharmacy screening
- removing a larger quantity of medications than ordered for one patient
- removing medications for multiple patients while the cabinet is open

The PA-PSRS report also mentions the types of LASA (look-alike, sound-alike) errors and "picklist" errors that we discussed in our December 11, 2018 Patient Safety Tip of the Week "Another NMBA Accident".

In 2008 ISMP (ISMP 2008) reported results of a survey on ADC's. They found gaps in using double checks when stocking ADC's or when withdrawing medications from ADC's. They noted a case where an automated dispensing cabinet on the neonatal unit had been inadvertently stocked with heparin vials containing 10,000 units/ml. Nurses were used to drawing heparin from 10 units/mL vials from that cabinet and did not notice the difference (see our December 2007 What's New in the Patient Safety World column "1000-fold Heparin Overdoses Back in the News Again"). ISMP notes the importance of the 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. The override capability in ADC's may short-circuit that safety feature. Stocking multiple concentrations of medications in the ADC's can also be problematic. They also noted problems with ADC design, ADC locations (some locations may be more vulnerable to distractions), workflow issues, practice habits, and workarounds.

ISMP offered the following "12 Core Processes Associated with Safe ADC Use":

1. Provide ideal environmental conditions for the use of ADCs
2. Ensure ADC system security
3. Use pharmacy-profiled ADCs
4. Identify and include information that should appear on the ADC screen
5. Select and maintain proper ADC inventory
6. Select appropriate ADC configuration (e.g., lidded compartments are preferred to matrix drawers)
7. Define and implement safe ADC restocking processes

8. Develop procedures to ensure the accurate withdrawal of medications from the ADC
9. Establish strict criteria for ADC system overrides
10. Standardize processes for transporting medications from the ADC to the patient's bedside
11. Eliminate the process for returning medications directly to their original ADC location
12. Provide staff education and competency validation

ISMP has also recently re-surveyed hospitals and is in the process of revising its Guidelines for Safe Use of Automated Dispensing Cabinets (ISMP 2018a). Though the latter is yet in draft format, we hope you'll read the guidelines that are far too numerous for today's column. But here are a few highlights:

They have good recommendations about using biometrics for access to ADC's, defining user privileges, strict management of usernames and passwords, timeframes for the ADC to time out, audits, procedures for addressing discrepancies, optimizing and maintaining ADC inventory, and many others.

They have excellent recommendations regarding **overrides**, including good planning for when overrides would be allowed and regular review of override reports by an interdisciplinary group. You should implement strategies that reduce the risk of error when an override is used:
a. Avoid the use of multi-dose containers.
b. Limit the quantity and number of drug concentrations available on override.
c. Use a process where the drug and dose are checked against the patient's allergies and weight, if applicable, to determine if the drug and dose are appropriate.
d. Require documentation of override rationale.
e. Consider an independent double-check with another licensed healthcare provider when removing organization-identified high-alert medications on override.

They recommend you should limit overrides to the following situations:
a. When a licensed independent practitioner controls ordering, preparation, and administration of the medication.
b. When medications are required in emergent circumstances and waiting for a pharmacist to review the order could adversely impact the patient's condition, such as the need for:

- Antidotes, rescue, and reversal agents
- Life-sustaining medications
- Urgent comfort measure medications (e.g., to manage acute pain or intractable nausea and vomiting)

In our December 11, 2018 Patient Safety Tip of the Week "Another NMBA Accident" we discussed 2015 the Pennsylvania Patient Safety Authority advisory about overrides of healthcare technologies (Grisinger 2015). **Over 75% of the overrides involved ADC's**. The most common type of event involving overrides of ADCs were unauthorized

medications (e.g., obtaining a medication for a patient with no prescribed order for the patient), followed by wrong-drug events and wrong dosage form events (e.g., selecting a sustained-release product instead of the immediate-release form, selecting an oral formulation instead of the injection). A majority of the unauthorized medication events specifically stated there were no orders for the medication, and over 30% of the unauthorized medication events involved a high-alert medication. Many of the cases involved withdrawal of a medication from the ADC before pharmacist verification or when the pharmacy was closed.

An analysis of safety of nebulized medications (ISMP 2018b) found that trying to obtain a nebulizer medication via override from an ADC was a factor linked to numerous wrong drug/strength/form errors and wrong patient errors.. Many of the errors involved mix-ups when selecting albuterol, and the combination product, ipratropium and albuterol. In most of the reported events, a respiratory therapist had removed the medication via override prior to administering the treatment. In a few instances, nurses had obtained the medication via override and either administered it or gave it to a respiratory therapist who was not allowed to access the ADC.

The ISMP revised guideline draft (ISMP 2018a) provides good lists of which medications should not be included in ADC's (examples: medications that require multiple dilutions or calculations, U-500 insulin vials and pens, vials/ampules of concentrated electrolytes, and medications that have been restricted from ADC storage based on organizational USP 800 Assessment of Risk).

They note that, if neuromuscular blocking agents are stocked in an ADC, ADC pockets or drawers containing neuromuscular blocking agents should include an auxiliary label to clearly communicate that respiratory paralysis will occur and ventilation is required (e.g., WARNING: CAUSES RESPIRATORY PARALYSIS—PATIENT MUST BE VENTILATED). Note that, while we endorse that label, it is not enough. The message that should appear on the ADC screen when an NMBA is selected should **require confirmation that "the patient is intubated/ventilated or about to be intubated"** before access is granted.

The ISMP revised guideline draft also discusses the need to define procedures for accurate ADC withdrawal and transfer to the bedside. Good practice would:

- Prohibit the removal of medications using an inventory function.
- Confirm accurate selection by comparing the product to the order or the MAR.
- Require that practitioners remove medications from the ADC one patient at a time.
- When medications are removed from a non-profiled ADC, and additional safety support such as bedside barcode medication administration is not available, configure the ADC to require users to barcode scan medications upon removal to ensure the correct drug has been selected.
- Label all clinician-prepared syringes of IV push medications or solutions, unless the medication or solution is prepared at the patient's bedside and is immediately administered to the patient without any break in the process.

- Transport medications, removed from the ADC, to the bedside in their original unit-dose or unit-of-use package. Open packages immediately prior to use at the patient's bedside. The only exception may be for medications that need to be crushed, measured, or wasted.
- Hand-carry a single patient's medications for one administration time directly to the patient's bedside. Alternatively, establish standard work to allow practitioners to sequentially remove two patient's medications while at the ADC provided that each patient's medications are bagged separately and appropriately labeled at the time of removal. (We don't like that "alternative". We think that carrying medications destined for two different patients always increases the risk of wrong patient errors).

Drake and colleagues (Drake 2016) described a successful quality-improvement project in which CPOE was utilized to limit overrides in the emergency department. Before November 2012, the ADCs in the emergency department (ED) at Indiana University Health Methodist Hospital were programmed for "total override," allowing nurses access to all medications in the machines independent of patient orders. At the time of CPOE implementation, ADC inventory for each area of the ED was evaluated in order to anticipate which medications should not be subject to override limitations. It was decided that these products should include life-saving, ED-specific medications (e.g., alteplase, activated charcoal), medications used for bedside procedures (e.g., bupivacaine injection, topical tetracaine), comfort care medications (e.g., acetaminophen tablets), and bulk items (e.g., magnesium citrate oral solution, oxymetazoline spray).

The nursing staff leadership were concerned over pharmacist turnaround time, ED nurses were accustomed to accessing medications from ADCs without delay. CPOE autoverification logic was implemented to allow for certain medications to be accessible from ADCs without pharmacist verification (i.e., immediately upon order placement by a provider, the status of certain orders was automatically changed to "verified" and the ordered medication could be removed from an ADC right away). It was decided that the autoverification list should include only medications considered to be emergently needed and those with a wide therapeutic index and minimal monitoring requirements and only if an ordered medication posed no threat of drug allergies or interactions.

After implementation of the limited override functionality, the proportion of ADC-stocked medications removed on override was reduced to 17.5%. Fifty-five percent of the orders entered in the ED qualified for autoverification. The mean total verification time, including autoverified orders, was 2.48 minutes. The mean pharmacist verification time, excluding autoverified orders, was 5.39 minutes. Two years after implementation of the new processes, all ADCs within the ED continued to operate on limited override. Subsequently, additional ADC's in postoperative, labor and delivery, and procedural areas were removed from total override.

ADC's are very valuable tools and are clearly here to stay. But careful attention is needed to ensure that they don't inadvertently contribute to serious medical errors. It's critical

that you don't just do perfunctory review of ADC overrides. You need to find out how often and why such overrides are used. We hope that the recommendations in today's column and our December 11, 2018 Patient Safety Tip of the Week "Another NMBA Accident" about not only overrides but also the stocking, storage and dispensing issues, and the critical messaging functions for drugs like NMBA's will help you identify vulnerabilities in your own organizations.

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