60 mL of doxepin elixir. This allowed the nurse a method to bypass the check system and simply type in numbers and administer a drug, whether it was the right or wrong ordered medication.

Alerts that are generated by BCMA systems often may not be noticeable. For example, a system may generate a visual display of the alert but not provide a distinct auditory alert. If a nurse does not look at the screen for any alerts after scanning a patient's wristband and/or barcoded medications, errors will ensue. Additionally, the alerts are not hard-stops, meaning that the system does not physically stop a practitioner from proceeding with scanning or administering a medication (Pennsylvania Patient Safety Authority [PSA], 2008). Problems have also occurred when other processes surrounding medication administration have broken down. Although the steps directly involved with the scanning of the medication and patient may be completed, errors can be introduced if distractions occur or medications are laid down after the scanning process.

One major issue that initially hindered the widespread implementation of BCMA systems was with the pharmaceutical industry's unwillingness to adopt a universal barcode standard and apply a barcode consistently to the container of all medications, including unit-dose packages. But in February 2004, the FDA established a new rule that requires a barcode on most products in a linear format that meets the Uniform Code Council (UCC) or Health Industry Business Communications Council (HIBCC) standards. This barcode must contain the product's NDC number, but the expiration date and lot numbers are optional (ISMP, 2004).

Further complicating the issue is the unavailability of unit-dose packaging for some medications. At this point, if hospital pharmacies that employ barcode technology cannot purchase medications that are packaged in a unit-dose system, they must re-package these medications and re-label each with a barcode. This can only be done at considerable cost in manpower and/or automated repackaging equipment. In addition, the chance of a medication error occurring is increased because doses must be taken from their original container and then re-packaged or re-labeled, and there could be an error in the application of the correct barcode label or in choosing the right medication. One medication error reported to ISMP includes a scenario where a facility utilized a BCMA system for their inpatients where not all injectables had manufacturers' barcodes on the vials or ampules, and pharmacy technicians had to generate computer-printed barcodes for those products. Prior to the intubation of a patient, a vial of succinylcholine chloride with an incorrect dose label was discovered. The printed label read 20 mg/10 mL, whereas the manufacturer's label read 20 mg/mL. Had the patient received the incorrect dose, it would have been 10 times the dose needed.

The use of BCMA systems can possibly introduce new types of medication errors. Although few medication errors have been reported with these systems, it can be hypothesized that some of the following types of errors could occur, especially if the system includes only the most basic of functionality:

- **Wrong dosage form**: Certain drug shortages may force a pharmacy to dispense a different strength or concentration (mg/mL) other than what is entered in the BCMA software.
- **Omissions**: After the patient's barcode armband and medication have been scanned, the dose is inadvertently dropped onto the floor. This results in a time lapse between the documentation that the medication was supposedly administered and the actual administration after obtaining the new dose.
- **Extra dose**: An extra dose may be given when there are orders for the same drug to be administered by a different route. For example, if one nurse gives an oral dose and is called away and the covering nurse administers the dose intravenously (IV). The problem arises when there is no alert between profiled routes of administration indicating that the medication was previously administered by one route that is different than the second route.
- **Wrong drug**: In situations when the nurse receive an alert indicating that the wrong medication was selected, but the alert is overridden and the medication is administered.
- **Wrong dose**: These systems are limited in their capability to verify the correct volume (e.g., 1 mL of oral or parenteral solutions to administer. Mo systems prompt a nurse to manually enter the vo ume that was administered.
- **Unauthorized drug**: An order to hold a medica unless a lab value is at a certain level such as an noglycoside (i.e., elevated gentamicin drug level
- **Charting errors**: Distinguish the indication fo administration of the medication (Tylenol 650 every four hours as needed for pain or fever),

Automated Dispensing Cabinets (ADCs)

Traditionally, hospital pharmacies provided medi for patients by filling patient-specific bins of un medications, which were then delivered to th ing unit and stored in medication carts. The A

computerized point-of-use medication-management system that is designed to replace or support the traditional unit-dose drug delivery system. The devices require staff to enter a unique logon and password to access the system using a touch screen monitor or by using finger print identification. Various levels of system access can be assigned to staff members, depending on their role in the medication-use process. Once logged into the system, the nurse can obtain medications from drawers or bins that open after a drug is chosen from a pick list.

Many healthcare facilities have replaced medication carts or open unit-stock systems with ADCs. The results of an ISMP survey showed that 94% of hospital respondents were utilizing ADCs in their facilities; of those, more than half (56%) were using the technology as the primary means of drug distribution (ISMP, 2008a). The 2011 ASHP national survey of pharmacy practice provided further evidence of a trend toward decentralized automated systems using ADCs to distribute patient medications. While the ASHP survey results showed that only 22% of hospitals in 2002 employed ADCs as the primary method of drug distribution, by 2011 this figure had increased significantly to include 63% of hospital respondents (Pedersen et al., 2011).

The rationale behind the wide acceptance of this technology may include:

- **Improved pharmacy productivity**: The use of ADCs may promote streamlining of the pharmacy dispensing process due to the reduced number of steps from filling each patient's individual medication bin to filling a centralized station. It also has the potential to reduce time needed to obtain missing medications.
- **Potential to enhance nursing productivity**: In a study that was designed to assess how nurses spend their time, nurse location and movement, and nurse physiologic response, approximately two-thirds of all time spent on medication administration was related to drug delivery to the patient (46.7 minutes). The other third (24.9 minutes) was spent preparing drugs for administration. The authors concluded that process improvements could reduce the time required for this step (Hendrich, Chow, Skierczynski, & Zhenqiang, 2008). Therefore, the time spent gathering or obtaining missing medications could be reduced with an automated decentralized drug distribution model using ADCs. Also, the turnaround time in obtaining newly ordered medications may be decreased.
- **Improved charge capture**: ADCs that are interfaced with the accounting department allow for the capture of all patient charges associated with administered medications.
- **Automated inventory control**: ADCs that utilize barcode technology can interface with the wholesaler for improved inventory control. In addition, the use of barcode technology increases the accuracy and efficiency of the ADC stocking process.
- **Improved security of controlled substances**: ADCs can be used to comply with regulatory requirements by tracking the storage, dispensing, and use of controlled substances.
- **Timelier drug availability**: ADCs can speed up delivery time for first and stat doses. In fact, a study found that storing key antibiotics in the ED ADC can significantly reduce order-to-antibiotic time and increase the percentage of severely septic patients receiving antibiotics within the recommended three hours from arrival to the ED (Hitti et al., 2012).
- **Enhanced patient quality and safety**: ADC systems often allow for organization-specific, user-generated alerts to prevent medication errors such as warnings related to potential errors associated with high-alert medications and with look-alike/sound-alike medication names.

However, such systems cannot improve patient safety unless cabinet *design* and *use* are carefully planned and implemented to eliminate opportunities for wrong drug selection and dosing errors. According to the PSA, nearly 15% of all medication error reports cited ADCs as the source of the medication, and 23% of those reports involve high-alert medications. Many of the reports described cases in which the design and/or use of ADCs had contributed to the errors. The types of errors reported included wrong drug errors, stocking/storage errors, and medications being administered to patients with a documented allergy (PSA, 2005).

Some documented unsafe practices with the use of these devices include **the lack of pharmacy screening of medication orders prior to administration**, which negates an independent double-check of the original order. In the aforementioned ASHP survey conducted in 2011, 96.2% of hospitals had ADCs that used patient-specific medication profiles, which limits user access to those medications with active orders for the specified patient after the order has been reviewed by the pharmacist. However, of those hospitals that used patient-specific profiles with their ADCs, it is estimated that 12.2% of medications are dispensed as overrides (the manual action taken to counteract or bypass the normal operation) (Pedersen et al., 2011). Unless a situation is emergent