

Do Automated Dispensing Machines Improve Patient Safety?

THE “PRO” SIDE

Improving patient safety is always a key focus in the hospital setting, and pharmacists have been exploring a variety of strategies and technologies to achieve this goal. Automated dispensing machines—decentralized medication distribution systems that provide computer-controlled storage, dispensing, and tracking of medications—have been recommended as one potential mechanism to improve efficiency and patient safety, and they are now widely used in many hospitals.¹ There is no doubt that these machines can enhance the efficiency of medication distribution, but their capacity to reduce medication errors is controversial and depends on many factors, including how users design and implement the systems.² Still, we are confident in providing the following reasons and experiences to support our position that automated dispensing machines improve patient safety.

Before the implementation of unit-based automated dispensing machines in 1995, the hospitals within the University Health Network in Toronto, Ontario, relied heavily on manual distribution systems, including traditional floor stock and medication carts, which held a 24-h supply (or, at Princess Margaret Hospital, a 10-day supply) of patient-specific medications in individual patient cassettes. A floor stock system is flexible, but the pharmacy has little control over inventory. Although the 24-h unit-dose cart exchange offers tighter inventory control, it is often regarded as an inefficient drug distribution system.³ In addition to being labour-intensive, other major concerns with these carts include delays in delivery of the first dose, loss of doses, and “borrowing” of patients’ medications.⁴ In contrast, automated dispensing machines provide a good balance among security, accessibility, and inventory control of medications, which are all recognized as important characteristics of a safe medication distribution system.

Automated dispensing machines provide secure medication storage on patient care units, along with electronic tracking of the use of narcotics and other controlled drugs.² Reports can be generated to help identify and prevent potential diversion. Automated dispensing machines save nursing time by eliminating the need for manual end-of-shift narcotic counts in patient care units. Before 2004, large quantities of floor stock were available in the operating rooms at Toronto General Hospital, with narcotics and other controlled drugs being stocked manually in a double-locked cabinet. This system was prone to many problems, including under- or over-stocking of inventory,

missing or inaccurate drug charges, no tracking of drugs and drug waste, and complicated manual documentation procedures for narcotics and other controlled drugs. To improve efficiency and control of narcotics and other medications in the operating suite, a system of automated dispensing machines was implemented, in conjunction with a 24-h exchange program for anesthesia trays.⁵ This project began in early 2003 and was completed in May 2004. Every anesthetist has now completed the required training and is accountable for using this cabinet for the removal and return of narcotics and controlled drugs to be administered during surgery. The goal of maximizing patient safety has been achieved through the choice of automated dispensing machines with mini-drawers, which open only when a specific medication is selected and which limit access to the selected quantities.

Another clinical feature of automated dispensing machines is the capability to track and proactively monitor drug usage patterns. This is accomplished by setting up clinical indicators during removal of specified drugs. One example of this approach involved aprotinin, a medication that is administered by injection to reduce bleeding and to decrease the need for blood transfusions during complex surgery. This drug is expensive, and there are restrictions on its use; it was therefore deemed suitable for testing the use of clinical indicators. During the test period, physicians were asked to select the specific indication for use, by on-screen prompting, whenever they removed aprotinin from the automated dispensing machines. The reporting capabilities of the machines allowed pharmacy staff to regularly track and monitor the appropriateness of aprotinin use, and the results of tracking were reported back to the physicians. This process reduced inappropriate use by more than 50%. Similar processes for enhancing patient safety by enforcing appropriate utilization can be set up for any high-risk drug.

Automated dispensing machines enhance first-dose availability and facilitate the timely administration of medications by increasing their accessibility on patient care units. This benefit is particularly important in emergency departments and intensive care units, where most hospitals still use a floor stock system because of frequent dose changes and need for immediate access. There is increasing recognition of the complexity of medication use in both of these areas and the high potential for serious medication errors.⁶ Automated dispensing machines allow physicians to treat critically ill patients efficiently by providing convenient access to medications for emergency situations during and after pharmacy hours. In addition, the single-access drawer feature of automated dispensing machines offers tighter control by allowing access to just one medication at a time for medications with high potential for mix-up (e.g.,



those with look-alike or sound-alike names), as identified by the Institute for Safe Medication Practices (ISMP).⁷

Automated dispensing machines eliminate the dispensing of unused “as-needed” (prn) doses, thereby decreasing the potential for administration errors that can arise if more doses than needed are dispensed and available for administration. Because Princess Margaret Hospital is a specialized oncology hospital, antiemetics and analgesics are often prescribed on an as-needed basis, in multiple dosage forms for various routes of administration. These drugs represent a high percentage (more than 40%) of orders for as-needed medications for oncology patients. Such therapies are changed frequently to achieve optimal symptom control. Doses that have been administered are tracked within the patient’s profile in the automated dispensing machines, allowing pharmacists access to real-time, up-to-date data about administered medications. This information is crucial in modifying therapy and enhancing patient safety. The automated dispensing machines in inpatient units, including ICUs, are interfaced with the pharmacy computer and hence support clinical review of medication orders by a pharmacist before administration, without impeding the timeliness of dosing. The combination of timely and accurate dosing with review by a pharmacist is another aspect of patient safety.^{2,8}

Finally, from a workload perspective, automated dispensing machines reduce pharmacists’ dispensing time, as inventory management is driven by the pre-established minimum and maximum levels and is handled exclusively by pharmacy technicians.^{6,9} Hence, pharmacists have more time to dedicate to direct patient care activities and patient safety initiatives.

In this age of technological advances, automated dispensing machines have certainly met our requirements for an efficient medication distribution system. When cabinet design and use are carefully planned and the cabinets are utilized to their full potential, the implementation of automated dispensing machines is a step toward greater patient safety.

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THE “CON” SIDE

The answer to the question of whether medication safety can be enhanced through the acquisition and implementation of pharmacy automation is a resounding “maybe”. For this discussion, we will focus on the most widely implemented (and planned for) form of automation: the automated dispensing machine.

Automated dispensing machines were pioneered in US hospital systems, and a recent review indicated that about 72% of US hospitals have adopted some form of this technology.¹ The primary reason cited for this widespread implementation is the ease and accuracy of capturing medication use by an individual patient for billing purposes.² Several attempts have been made to review the impact of automated dispensing machines on medication safety,^{3,4} but, as we shall see, almost all of these have had serious methodologic flaws. Virtually all studies of these dispensing systems, as well as reviews of those studies, have commented on the lack of evidence of an increase in medication safety attributable to the automated dispensing machine alone.^{4,6} Many authors have suggested that automated dispensing machines may promote a safer medication system if they are part of an overall strategy that includes computerized physician order entry (CPOE) combined with a robust clinical decision support system, bedside bar-code technology for medications, and, ideally, an electronic charting system.² Most of the many reviews on the impact of technology in reducing medication errors have found evidence that CPOE (with a clinical decision support system), and bar-coding applications have benefits in this regard.^{3,6}

In our view, the shift to automation of the medication-administration cycle is an inherently positive move, but some basic considerations need to be examined openly before the adoption of automated dispensing machines is accepted as a way to increase medication safety. Most important are the enormous cost of implementing this type of system, the magnitude of change to the medication delivery system, and the limited return on investment for such a system compared with available alternatives.^{4,6}

The Evidence

Pharmacists appreciate that evidence for opinions and beliefs must meet rigorous criteria if they are to be credible and valid. Evaluations of automated dispensing machine systems that are based only on increased safety and reduced costs have failed to generate an acceptable level of evidence. For example, a recent report from the Canadian Agency for Drugs and Technologies in Health³ reviewed this question from both clinical and economic perspectives. This systematic (clinical effectiveness) review cited the following major flaws, among others, in the literature that is used to justify such systems on the basis of improved safety outcomes for the patient:

- Studies were done with systems that are either no longer available on the market or that are available only in Europe.
- Study results appeared to depend on the patient care area where the device was used (e.g., one study showed an increase in errors in a cardiac intensive care unit).
- Definitions of outcomes were inconsistent between studies.
- Errors were counted differently in different studies.
- Observational study designs were used.
- Most studies were uncontrolled “before and after” studies (with participants not blinded, although the challenge of blinding is acknowledged.)
- Not all studies reported the use of statistical tests.
- Factors other than automation may have led to changes in work practices.

The authors of the review were reluctant to accept the included studies as evidence that automated dispensing machines reduce error, noting that the above and other factors could have affected error rates and noting also that risk reduction might have been overestimated. The authors offered the following conclusive statement: “We cannot reliably estimate how automation affects the rate of potential adverse drug events, adverse drug events, morbidity, and mortality because these outcomes were not measured.”³ The review clearly highlighted that the cost of the technology cannot be justified on the basis of improved medication safety at this time, without implementation of a more complete automation system (e.g., bar coding, CPOE, or medication profiles).

The Impact

Since the first implementation of automated dispensing machines by hospitals, there has been a growing number of reports of medication errors created by these systems.⁶⁻¹⁰ Not surprisingly, any change to a system brings with it new opportunities to create errors. A *Safety Bulletin* from the Institute for Safe Medication Practices Canada (ISMP Canada) considered this trend,² noting that the nature of the risks associated with these systems ranges from using the override function to bypass review by a pharmacist to misplacing medications in various locations of the machine. The ISMP Canada report made 24 recommendations to ensure that automated dispensing machine systems are used in a manner that will minimize the potential for medication errors.²

Many other reviews of automated dispensing machine systems have advocated similar recommendations or checklists based on reports of errors associated with the use of these systems.⁷⁻¹⁰ Interestingly, the Pennsylvania Patient Safety Reporting System noted that medication errors associated with automated dispensing machines accounted for about 15% of all errors reported.⁷ That group also listed 12 important criteria that should be in place to minimize the errors that such systems could potentially cause. A United States Pharmacopeia (USP) patient safety report noted that between July 2001 and December 2005, a startling 13 339 medication errors involving automated dispensing machines had been reported to the MEDMARX adverse-event reporting program.⁸ About 34% of the errors reached the patient, and 1.2% resulted in some level of patient harm. The authors suggested that the full potential for medication errors attributable to automated dispensing machines may not yet have been measured, especially in the case of systems implemented without supporting processes such as bar-code technology, adequate training, substantive changes in operating policies (including minimizing override provisions), and continuous multidisciplinary reviews.

Spending on the Right Technology?

An important aspect of planning for and acquiring an automated dispensing machine system is consideration of costs. Any automated medication “system” should probably include an automated dispensing machine. The question of priority for implementation should be raised when large sums of money are required to initiate such systems. As discussed above, evidence of enhanced patient safety to support the use of only an automated dispensing machine system is lacking. In addition, there is ample evidence that the prescribing stage is the point in the medication system where the majority of errors occur.⁹ It is also recognized that the most effective means to address errors at this stage should involve implementation of a CPOE system with an embedded clinical decision support system.^{3,9} This approach has been the focus of almost every comment on the use of technology to increase patient safety in the hospital system and is based on substantial evidence.

It is perhaps time for pharmacists to advocate for the technological interventions that have been proven most effective in decreasing medication errors. Although automated dispensing machines are an attractive addition to a medication system, they cannot achieve their maximum potential in improving patient safety without implementation of additional steps, as outlined by groups like ISMP Canada and the Pennsylvania Patient Safety Reporting System. In addition, the increased opportunities for creating new medication errors that occur with any automation need rigorous study.

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ON THE FRONT COVER

East Kootenay Regional Hospital, Cranbrook, British Columbia

The East Kootenay Regional Hospital is part of the Interior Health network of health care facilities, which spans the geographic area from the Okanagan to the Alberta



border. Within the East Kootenay Health Service Delivery Area, this hospital is the regional referral centre for 4 community hospitals (in Golden, Invermere, Fernie, and Creston), serving a total population of more than 79 000 residents. The East Kootenay Regional Hospital has 69 beds and offers 24-hour emergency services, general

medicine and surgery, obstetric and pediatric care, regional laboratory services, diagnostic imaging, intensive care, psychiatry, rehabilitation, internal medicine, ophthalmology, orthopedics, otolaryngology, urology, and chemotherapy. The hospital employs 6 pharmacists and 9 technicians who provide clinical, teaching, and distribution services for the regional hospital and the 4 community hospitals.

The photograph was taken by Darren Feere, BSc(Pharm), using a Canon Digital Elph 8 megapixel camera.

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