

Evidence Briefings on Interventions to Improve Medication Safety



Automated dispensing systems

Policy question: Do automated dispensing systems reduce dispensing and administration errors and improve efficiency?

Current evidence shows: Automated dispensing systems (ADS) have the potential to reduce certain types of medication errors such as omitted doses, but are less effective in reducing other types of errors. There is some evidence to suggest that ADS assist with storage capacity and stock control, but the evidence is conflicting regarding time saved following installation of ADS. Cost savings are related to better stock control.

Background

The use of automated dispensing systems (ADS), also known as automated dispensing cabinets (ADC), unit-based cabinets (UBC), automated dispensing devices (ADD), automated distribution cabinets and automated dispensing machines (ADM), in hospitals is increasing. In 2011, 40% of US hospital pharmacies had a decentralised inpatient medication distribution system and 89% of those used ADS¹. There are different types of ADS; ward-based ADS, pharmacy-based ADS and automated unit-dose dispensing systems (Table 1). Theoretical benefits of ADS are improved safety and efficiency, namely through reduced dis-

pensing times, improved storage capacity and stock control, more appropriate allocation of staff to tasks and reduced dispensing errors².

Table 1. Description of the three different types of automated dispensing systems included in this review (modified from James³)

Description	Examples of brands
Pharmacy-based ADS	
<ul style="list-style-type: none"> • Medications stored on designated shelves • Dispensing order entered, robotic arm or picking device selects medication from shelf and transfers to delivery station • Checked and labelled by pharmacy staff 	Rowa Speedcase PackPicker® PillPick® consisting of PillPicker (packaging), DrugNest (storage) and PickRing (dispensing)
Ward-based ADS	
<ul style="list-style-type: none"> • Medications stored in electronically controlled cabinet linked to computer • To access medications, nurse enters password and patient details • Drawer containing selected medication opened • Nurse administers medication • System tracks who accessed the cabinet and for whom medications were selected 	Pyxis MedStation™ MedSelect® McLaughlin
Automated unit-dose dispensing	
<ul style="list-style-type: none"> • Medications stored in calibrated canisters • When dispensing order entered, ADS ejects medication from the canister into strip-packing device which labels and seals the strip 	Baxter ATC-212

Methods

A literature search was undertaken to identify studies relating to automated dispensing systems in the hospital setting. Searches were performed in PubMed, Embase, and CINAHL. Google Scholar was used to identify grey literature. Conference abstracts, review articles, duplicates, commentaries and letters as well as articles describing implementation of ADS (e.g. guidelines for successful implementation) were excluded. The search was limited to English language articles published after 1980.

Results

The search yielded 981 potentially relevant published studies. Of the 28 articles that met the inclusion criteria, 17 were conducted in the US⁴⁻²⁰, nine in Europe^{2,3,21-27}, one in Saudi Arabia²⁸ and one was conducted in both the US and UK²⁹. No Australian evaluation studies have been published.

Pharmacy-based ADS

Medication safety aspects

Observational studies following implementation of ADS in UK hospital pharmacies have shown significant decreases in dispensing errors post ADS (from 0.64% to 0.28% in one study³; and from 1.2% to 0.6% and from 2.7% to 1.0% in a multisite study²). Other studies have found non-significant reductions in dispensing errors following implementation of ADS^{18,23} and one study found no reduction in dispensing errors¹⁴.

Storage capacity

Compared to traditional storage, installing ADS in hospital pharmacies appears to result in less occupied space and increased storage capacity^{2,23,25}. One study reported that storage capacity can be increased by 23% to 123% compared to traditional storage methods².

Time savings

Two studies^{2,3} reported significant reductions in median time taken for the pharmacy-based ADS to 'pick' medications compared to staff picking medications off shelves. Other studies have reported non-significant reductions in time taken to fill first dose orders¹⁸ and time taken to dispense medications²³.

Cost savings

One US study conducted in 2010 reported a net reduction of 2.0 technician full-time equivalents and

a reduction of US\$25,059 in inventory carrying cost following installation of an ADS¹⁸. A report from the King's College Hospital in the UK assessing the impact of ADS found that £534,000 was saved in reduced stock holdings (one-off saving) and £50,000 per year was saved in reduced expired medication expenditure²⁷.

Ward-based ADS

Medication safety aspects

Several observational studies have determined the impact of ward-based ADS on medication errors but results are inconsistent. Missed medication doses^{4,5,15,28} and administration of the wrong dosage form rates^{5,28} were reduced across different wards using different brands of ADS, while the administration of wrong doses was shown to increase^{4,5}. Administration of unauthorised doses and wrong timing events decreased in one study⁴ but increased in another⁵.

Using the ADS to prompt clinicians to adhere to guidelines was examined in two studies. ADS was associated with improved compliance with pneumonia guidelines²⁰ and antimicrobial prophylaxis guidelines⁶.

Time savings

One study reported that nurses spent significantly less time on medication-related activities, as well as charting or documenting, and significantly more time on patient interactions following ADS implementation.

Pharmacists spent significantly more time in floor-stock activities following implementation of this ADS¹³. In another study there was no change in time spent on nurse activities whereas pharmacists spent more time on clinical activities following ADS implementation⁸.

Cost savings

Potential cost savings following implementation of ward-based ADS have been evaluated in the US¹³ and Saudi Arabia²⁸. These evaluations have limited relevance to Australia and are not discussed further in this briefing.

Automated unit-dose dispensing systems

A US study of the automated unit-dose dispensing system Baxter ATC-212 showed reduced time taken to fill a medication cart, which in 1994, was estimated to save a total of US\$7,044 annually at one hospital¹⁰. This was despite the higher medication



Repacking system

acquisition costs for the automated system compared to the manual cart fill system. Another study found that using the Baxter ATC-212 computerised cart fill was more accurate (99.98%) than relying on manual filling (92.62% accurate)¹². One study evaluated the frequency and severity of medication errors (defined as a dose of medication administered that deviated from the prescription) in one UK and two German hospitals. In the UK hospital, the wards had 80% of medications in ward stock with the remainder dispensed for individual patients and a pharmacist visited the ward twice daily. In Germany one hospital was using a traditional system i.e. large floor stock ordered twice weekly by nurses and twice yearly visits by a pharmacist, whereas the other German hospital was using the Baxter ATC-212 and was visited by a pharmacist twice daily. The study found that using the Baxter ATC-212 was associated with lower error rates (2.4%) compared to the traditional German system (5.1%) and the UK system (8.0%)²⁶. Another study compared the number of medication errors (defined as a dose administered (or omitted) that deviated from the written medication order) that occurred on one ward in a US hospital using a unit-dose drug distribution system with one ward in a UK hospital using a ward-based supply system in combination with several visits per day by a pharmacist²⁹. The study found a higher rate of medication errors in the US hospital compared to the UK hospital (6.9% vs. 3.0%).

Staff opinions

A number of studies evaluating staff attitudes towards ADS have been published^{2 3 7 13 21 22 30-34}. Reasons cited for using ADS were potential efficiency gains, whereas implementation costs and safety concerns were reasons cited for not implementing ADS⁷.

Before-and-after studies show that staff attitudes tend to improve towards ADS after implementation^{2 21 22}. An attitude difference between nurses and pharmacy technicians has been observed, with nurses having more positive perceptions about the ADS regarding their effects on time and medication availability. Pharmacy technicians reported negative perceptions of a ward-based ADS on the time to fill floor-stock items¹³.

In addition to the papers summarised here on quality and safety aspects, a number of case studies³⁵⁻⁴¹,

opinion pieces⁴²⁻⁵³ and conference abstracts⁵⁴⁻⁶⁵ have been published which may be of interest to some readers.

Conclusion

ADS are effective in reducing the number of omitted doses, but are less effective in reducing other types of errors. The evidence for improved patient outcomes with ADS is scarce. Compared to traditional storage of medications in pharmacies, installation of pharmacy-based ADS appears to increase storage capacity and reduce the time taken to fill prescriptions. Studies evaluating time savings following implementation of ward-based ADS report inconsistent findings. Whether these findings translate to the Australian setting, where individual patient dispensing is common, remains to be evaluated. Most studies were small observational studies evaluating one brand of ADS



Ward-based ADS

conducted at a single site without a control groups. These studies have limited generalisability. Qualitative studies evaluating staff attitudes before and after implementation of ADS show improved attitudes over time.

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