

## RESEARCH ARTICLE

## OPEN ACCESS

# The Experience of Using an Automated Dispensing System to Improve Medication Safety and Management at King Abdul aziz University Hospital

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## Abstract

**Background:** The use of automated dispensing systems has been lauded for improving patient safety within the processes of healthcare. Adverse drug events, for example, are a common manifestation of faults in the service delivery of a pharmacy department that endanger patient safety. Even though automation may reduce the occurrence of such errors, concerns have been raised about the efficiency and safety of the automated systems since a large number of patients still suffer medication associated injuries. Though the use of these systems is common in some developed countries, there is paucity of safety and efficacy data from the Arab nations. We therefore report our experience using automated dispensing systems in all our units at the KAUH following a successful pilot run of this technology. **Materials and methods:** We installed the automated dispensing system and monitored the number of controlled and uncontrolled medications used before and after the automation, the incidence of wrong bin opening and the number of IV medication preparations after the installation of the system. **Results:** The number of controlled and uncontrolled medications dispensed in KAUH generally reduced. The decrease in the number of uncontrolled medication was statistically significant, p value 0.004. We also observed an increase in the number of IV medication preparations consequent to reduced workload and improvement in staff utilization. After installation of the automated dispensing system there was a high incidence of wrong bin opening, which reduced gradually after the first two months. **Conclusion:** The process of automating the services of a pharmacy department using ADS technology increases the efficiency at which medications are controlled, improves accuracy of patient drug profiling, minimizes inappropriate dispensing and distribution and provides better utilization of human resource at the ever busy pharmacy department. However, the process of switching into an automated system may have multiple challenges all of which should be addressed through training of the personnel.

**Key words:** Automated Dispensing Cabinet (ADC), Hospital Pharmacy, Medication distribution, Automated Dispensing System (ADS), Hospital Information System (HIS), Information Technology (IT).

## INTRODUCTION

Patient safety has become a major public health concern. The landmark report '*To err is Human- Building a safer health system*' not only explored but also emphasized on patient safety within the processes of healthcare.<sup>[1]</sup> It is widely acknowledged that healthcare can inadvertently harm patients and a median of 9.2% of all hospital admissions suffer at least one adverse event worldwide.<sup>[2]</sup> Adverse drug events (ADEs) associated



with medication are a chief contributor to overall patient harm. These events are thought to arise from inappropriate administration of medication,<sup>[2,3]</sup> a responsibility that falls under a hospital's department of pharmacy.

Automated dispensing systems (ADS), also known as automated dispensing cabinets (ADC) or automated dispensing devices (ADD), have been put forward as technologies that help increase the effectiveness of hospital pharmacies and potentially reduce the rate and risk of ADEs.<sup>[4,5]</sup> Over the past decade, the use of this technology in hospital pharmacies has been on the rise with 97% of US hospital pharmacies using ADS as of 2014.<sup>[6]</sup> This increase serves to indicate the benefits of an ADS including improved safety and efficiency through reduced dispensing times, improved storage capacity and stock control, more appropriate allocation of staff to tasks with minimal time wastage and reduced dispensing errors.<sup>[7]</sup> Frequent drug stock-outs and expiry attributable to poor quantification and coordination practices<sup>[8]</sup> can also be managed using the ADS.

Despite the relative effectiveness of the ADS, patient safety with this medication dispensing system still raises concerns<sup>[9]</sup> According to a report by the IOM of the National Academies 2006, 1.5 million people per year in the United States are injured due to medication errors associated with automated dispensing systems, which cost an estimate of billions of dollars in treatment annually.<sup>[10]</sup> These errors often involve administration of wrong medication and stocking/storage errors or failure to consider patients with allergies to certain medication.

King Abdulaziz University Hospital (KAUH) is a 1001 bed capacity hospital with an average daily discharge = 15 patients, an average length of stay = 3.8 days and a turnover = 10,023 patient monthly; which creates a high volume of medication orders a day. Our pharmacy department not only dispenses and distributes medications but also prepares admixtures of medications especially cytotoxics. As a follow up to a successful pilot run that sought to determine the feasibility of using an ADS at KAUH pharmacy department, we rolled out installation of the automated systems in all 16 medical units of the hospital and determined the efficiency of the automated system at larger setup. We sought to determine the efficiency and safety of the ADS by comparing the pre and post ADS dispensing and preparation of medications. Goal: To determine the efficiency of an automated dispensing system in the medication management system and patient care at KAUH.

## Objective

Before and after the implementation of the ADS, we sought:

- To determine the total consumption of all medications
- To determine the consumption of controlled drugs
- To determine the consumption of uncontrolled drugs
- To determine the frequency of inappropriate access to medication
- To determine the number of injectable IV preparations

## MATERIAL AND METHODS

**Background on the implementation of the Automated Dispensing system:** An extensive review of the operations of the KAUH pharmacy department was done and the following issues were established; Poor communication between prescriber and pharmacy when discontinuing. Accumulation of drugs at units' level as a result of 24 h dispatch as opposed to a need basis. A delay in the delivery of medication to other hospital units with the average time of delivery being 5-6 h. Inconsistent and insufficient pharmacy staffing. Lot number monitoring of medications from pharmacy to patient. The process of automated pharmacy at KAUH was deliberated on by a committee, designed and improved so as to allow a smooth switch from a manual to an automated drug dispensing system. The automated dispensing system process designed is as shown (Figure 1).

Installation of the ADS was followed by data transfer, filing and reconciliation of medication information and later integration with the Health Information System (HIS). A pilot study was done in one of our female medical unit and involved 62 patients with a high volume

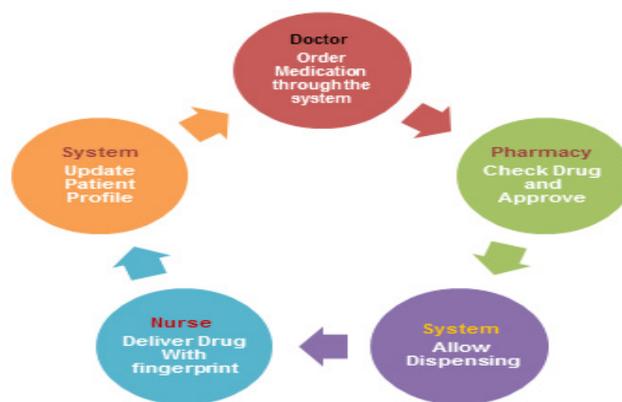


Figure 1: Flow chart showing the Automated Dispensing System (ADS) installed at KAUH.

of medication requirements (16065 orders per month). Real time information transfer was established and during the process we identified the need to reinforce training among staff members especially the nurses who would more often handle the technology. We also noted the need for supervising and management staff to run and maintain the ADS technology. The main results of the pilot study included a reduction in delivery time, reduced work related stress among the staff members and a reduction in the number of returned medication.

### Rolling out the ADS technology to all hospital units

Within four weeks all necessary adjustments were done and the ADS inculcated into the main Health Information System (HIS) at KAUH. The IT department and the software providers (Phoenix) integrated the requirements of the ADS to the hospital's server. The program was then rolled out to all 16 units of the hospital and a total of 22 drug dispensing cabinets were set up. Three-cell cabinets were put up in each of the bigger medical units, two-cell cabinets in the medium units and one-cell cabinet in the smaller medical units. A total of 957 types of drugs to be kept in the cabinets were classified and stored as per the guidelines of the Saudi Food and Drug Authority, and in accordance with the consumption pattern of each unit. A test run was then done to observe the accuracy and real time processing of the technology. Seven interfaces were created between the ADS and the HIS and all were compliant with the Health Level 7 (HL7) standards.<sup>[11]</sup>

Responsibilities as well as access privileges for all personnel involved in operating the Automated Dispensing System were clearly defined for security and safety measures. Staff members with authority\privileges to access comprised of; Pharmacy Automation System Coordinator, Physicians, Pharmacists and Nurses. Specific reports from the ADS were monitored; All Transactions, Discrepancy Audit, Discrepancy, Returned Medication, Par Usage, Dispensing Practices, Medication Order Overrides and Null Transactions.

We sought to compare the pre and post ADS dispensing/distribution and IV preparations. We collected data on the above mentioned objectives over five months prior to the implementation of the ADS and for five month period after the installation of the ADS to all 16 units. Some variables were studied over a year, other over 5 months while others were only studied for a month as indicated in the results section. The data were expressed in percentages and one way ANOVA and t-test were used to analyze the difference in means between the pre and post ADS data.

## RESULTS

The implementation of the Automated Dispensing System (ADS) was not without challenges. Some of the challenges included;

Inability to integrate lot numbering from the previous manual system to the new automated system.

Slight discrepancy between actual counts of medications versus the documented figures.

Human resource challenges in terms of administration during the phasing out and concurrent implementation of the automated system.

Standard cabinets may not be appropriate for all units. They should be customized to suit the variety of medications common in the respective units.

### Comparison of Total Monthly Consumption of Medications (Dispensed) before and after implementation of ADS

There was a general reduction in the total dispensed medications after the installation of the ADS technology, save for a slight increase observed in the SICU, PICU and Iso. The reduction in dispensed medications was greatest in the medical, surgical, and pediatric units, which are high volume stock units with frequent medications misuse; in addition to CCU (Figure 2). Even though a significant reduction occurred in the high volume floor stock units, the difference between before and after implementation of automation pharmacy was not statistically significant ( $p=0.089$ , t-test). However, this difference resulted in approximately 300,000 Saudi Riyal per month cost savings.

Inventory Levels of Controlled Medication at Unit Level:

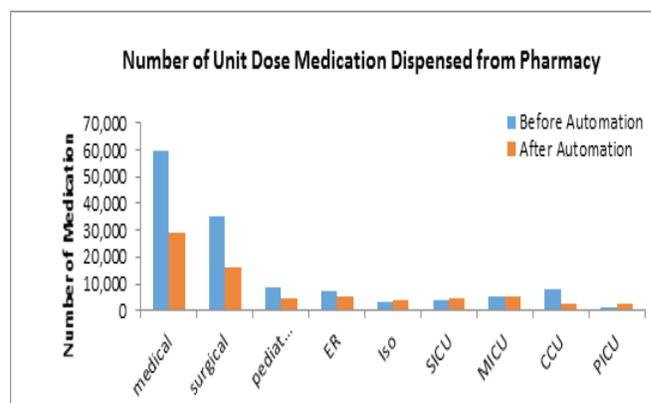


Figure 2: Bar chart showing the total number of medications dispensed to all units in KAUH.

The number of total number of controlled medications dispensed over the period of five months reduced greatly across all the major hospital units with the pediatric unit posting the greatest reduction (Figure 3). The difference between the dispensed controlled medication before and after implementation of ADS was statistically significant ( $p=0.004$ , t-test).

Monthly Consumption (Dispensed) of Uncontrolled Drugs: Floor stocked medications that are usually administered directly by nurses to patients without any pharmacy review or update in patient’s profile are called uncontrolled drugs. Prior to automation, the total medication dispensed monthly without pharmacy control was high and reduced significantly after implementation of the ADS (Figure 4).

Percentage of Inappropriate Access Medication by “Wrong bin” Opening: Wrong bin opening is defined as taking undue advantage of ADC by inappropriately opening a different location to obtain medications. There was an initial high incidence of wrong bin opening across majority of the hospital units during the first three months of automating the pharmacy. This was then followed by a steady reduction in the occurrence of wrong bin opening in Pediatric Medical Unit 1 showing the greatest reduction in inappropriate access to medication over the five months (Figure 5).

Comparison of Injectable IV Preparations prepared by pharmacy over a period of one year before and after ADS: The number of injectable IV preparations made in 2014, before automation, was 163,346 units. After the automation of services at the pharmacy department, the number rose significantly to 253,158 in 2015, which was a 65% increase (Figure 6).

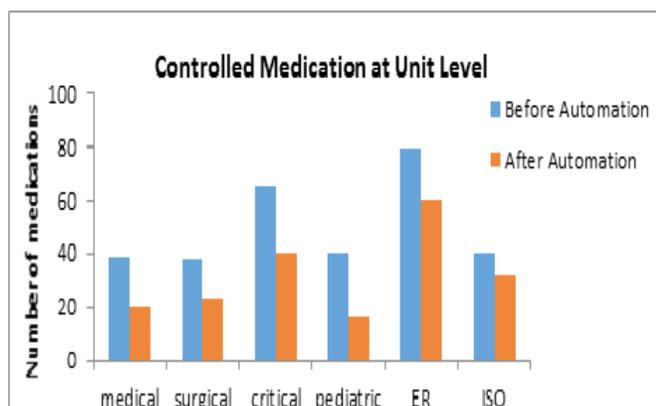


Figure 3: Bar chart showing the number of controlled medications dispensed to units before and after automation.

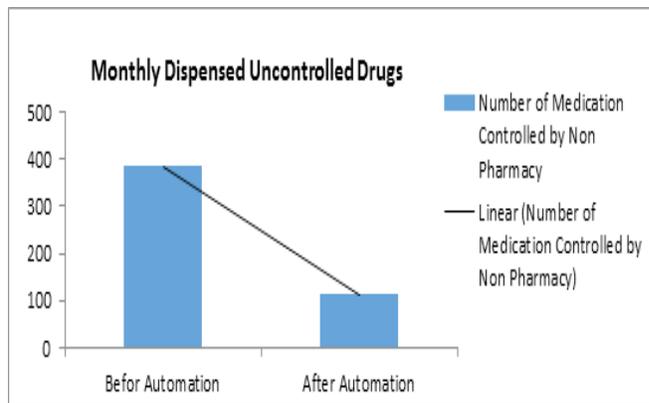


Figure 4: Bar chart displaying the number of controlled medications dispensed before and after automation.

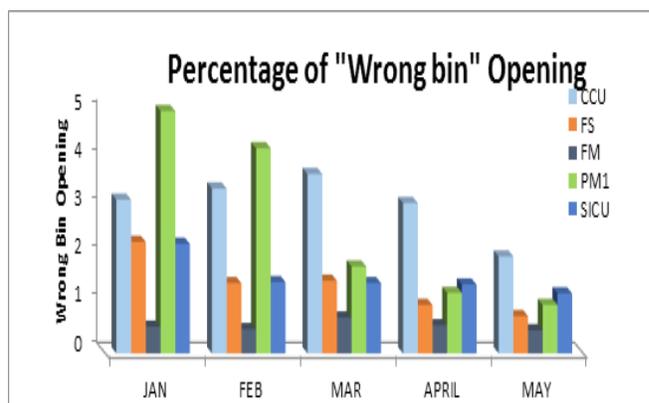


Figure 5: A bar chart showing the percentage incidence of wrong bin opening after automation.

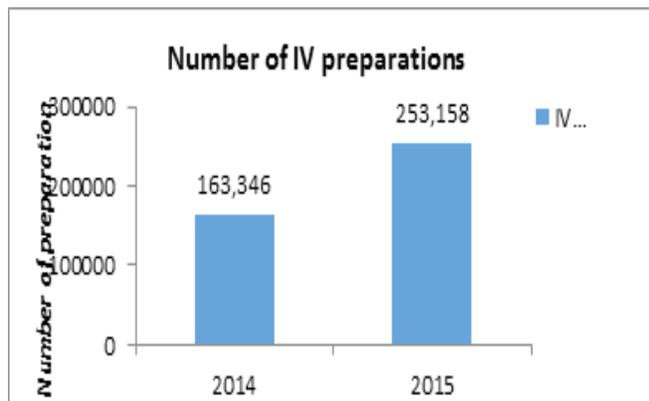


Figure 6: A bar chart representation of the number of IV medication preparations a year before and after automation.

## DISCUSSION

Automated Dispensing Systems are automated technologies that dispense and distribute medications and document these transactions at a pharmacy. The use of such systems has gained popularity due to the efficiency and relative safety it confers in healthcare management.<sup>[4,12]</sup> Most hospital

pharmacies have set out to install ADS in a previously non automated setup, a process that rarely goes without challenges. In our case, we grappled with difficulties in harmonizing lot tracking, human resource inadequacy in terms of running an ADS while at the same time phasing out the non-automated system and discrepancies between actual and documented medications. “Lot tracking” integration was not supported by the system version in use initially, which required an update to fix. We recommend that before initiating the process of setting up an ADS, a hospital’s Health Information System (HIS) should be able to support the Health Level Seven (HL7) interface so as to ease the process of integration. Cabinets should be designed based on patients’ medication needs and the bed capacity of the unit they will serve. A multidisciplinary approach should be used in order to ensure a smooth transition and adequate human resource for the new system and a fall back policy/ disaster plan should be in place to help identify issues as they arise and address them.

We observed a reduction in the total number of medications dispensed on a monthly basis after the introduction of the ADS. Hospital units that had high volume floor stock had greater reduction in dispensed medications compared to those with lower volume floor stocks. This, we hypothesize, may be attributable to the reduction in the number of repeat orders or duplicated delivery of medications as a result of delayed distribution of medications in a non-automated system. Repeat orders and duplicated deliveries result in surplus medications in the hospital units which are often returned if not used. To corroborate this observation, the number of returned medications was noted to reduce to a measly 0.02% compared to 15% in the pilot study. The high number of returned medications before the automation was thought to arise from delivery of a patient’s whole day dose to the units as opposed to dose delivery on a need basis as is the case in automated pharmacy. A need basis in the delivery of medication ensures that prescribed doses are given to the patients and no extra medication is delivered to a patient’s unit.<sup>[13]</sup> This reduced wastage and saves patients a lot of money in terms of hospital fees. The installation of the ADS, therefore, creates accountability of medications dispensed and distributed to the hospital units and reduces patients hospital bills.<sup>[14]</sup>

There was a reduction in controlled and uncontrolled medication after the automation of the dispensing process. High volume floor stocks had a 60% reduction while low volume floor stock had a minimum reduction of 20% in the number of controlled medications dispensed. This reduction in dispensed controlled as well as uncontrolled medications goes a long way to reduce the number of adverse drug events

(ADEs) associated with patients’ medications.<sup>[15]</sup>

After installation of the ADS, we noted a high incidence of wrong bin opening. This may potentially result in administration of wrong medications and subsequent ADEs. The ADS can be difficult to go about in the initial stages due to inadequate training of the personnel but with subsequent use it becomes friendlier. Indeed, two months after the automation of all services at the pharmacy, the cases of wrong bin opening reduced significantly. This observation illustrates the initial difficulty coping with the automated system and emphasizes on the benefit of continuous training to the staff accessing the system.<sup>[16]</sup>

In addition to increased efficiency in dispensing and distribution of patents medicines, the ADS system reduced the workload in the pharmacy department and allowed some staff member to be reassigned into preparation of IV medications. This led to a 65% increase in the number of prepared IV medications. Implementation of an ADS is known to reduce the demand of human labor in a pharmacy<sup>[17]</sup> By installation of the ADS, there was better utilization of human resource at the department and this translated to improved accuracy in patient drug profiling and lot number tracking.

## CONCLUSION

The process of automating the services of a pharmacy department using ADS technology increases the efficiency at which medications are controlled, improves accuracy of patient drug profiling, minimizes inappropriate dispensing and distribution and provides better utilization of human resource at the ever busy pharmacy department. However, the process of switching into an automated system may have multiple challenges all of which should be addressed through training of the personnel.

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