Review Article

The Practice of Automated Drug Dispensing Technology on the Reduction of Medication Errors in the Medication Process

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ABSTRACT

This review is used to describe the automated dispensing systems increasing opportunities for improving the health care system. Safe automated dispensing systems (ADS) were suitable for providing a patient's medication therapy when pharmacists are caregivers. This review highlights the use of time-saving technologies such as automated dispensing machines, automated dispensing cabinets, and robotic original pack dispensing systems which have been suggested as potential mechanisms for reducing medication errors, improve accuracy, safety, and efficiency of medication dispensing. The implementation of automated dispensing machines improves the quality of the medication distribution process as compared with Manual Dispensing System. This review also emphasizes the impact of new emerging technologies of an automated dispensing system (ADS) on reducing medication errors and ADE. The Automated dispensing system is a key strategy of improving patient safety through increasing interaction between the patient and pharmacist, resulting in a chance for pharmacists to carry out new clinical functions. This review focus on the practices of automated drug dispensing in different terms in order to reduce the medication errors drug medication process.

Keywords: Automated dispensing system, Medication error, Automated dispensing machine, Decentralized system, Automated dispensing cabinet, Robotic original pack dispensing system.

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INTRODUCTION

In recent years, Pharmacists includes various technologies for labour-intensive and time-consuming processes to prepare and distribute medicines. It is reported that both centralized dispensing pharmacies and inpatient care units will grow through the technology which automates drug distribution.[1] Safe automated dispensing systems (ADS) are used for ethical pharmacy practice by providing a patient's medication therapy. ADS are an appropriate way for patients to receive the medicine only when pharmacists are caregivers. The safest automated dispensing systems were achieved by the "five rights"— right drug, right dose, right patient, right route, and the right time.[2,3] In 1991, The University Hospital Consortium promotes a "technology statement" upon the automation of services which summarizes that "Strategic plan elements which increase personnel productivity are highly fascinating to attain the organization's financial objectives. In today's strategic plan, Drug delivery automation can be a necessary part of controlling personnel expenses in the hospital pharmacy and the nursing's budget part is responsible for the administration and charting of drugs.[4] Currently, automated drug distribution systems (ADDS) were manufactured by Pyxis, Inc., and Omnicell, Inc. was implying a change in drug distribution started in the 1960s in the United States as unit-dose systems. Unit-dose systems were replaced with a previous approach referred to as multiple-dose drug distribution systems. When nurses had whole responsibility for the overall medication system, from administering multiple doses of the drug to dose preparation termed as Multidose systems. Whereas, in Unit-dose systems, nurses provide single packaged and labelled doses with a duration of more than 8-hour intervals under the administration schedule.[5,6] Due to this, unit-dose systems reduced the chances of medication errors, time management of pharmacists as well as nurses, and dosing frequency is reduced. [7-10] Automated dispensing systems (ADS) were divided into three categories i.e., point-of-care, decentralized, and centralized. Decentralized systems generally occur outside the control of pharmacist's while the pharmacist must still identify correction of the various steps by ensuring the right drug dose availability in the right location in a dispensing cabinet through accessing the storage cabinet by the caregiver to which the right dose is accurately administered to the right patient. Point-of-care systems are as same as decentralized systems. Pharmacists were in direct control of the dispensing process in Centralized systems. ADS development involves three goals i.e., a) By utilizing rapid developing technology into a safe medication process, b) Direct patient care by the pharmacists, c) Minimization of cost. [11,12] Today, automation in drug dispensing includes packaging of drugs, controlling software, computer-assisted physician order

entry, dispensing cabinets, the automated generation of customizable forms and reports, and robotic handling. [13]

1.1 Automated Dispensing Technologies

There are various automated dispensing technologies present in the market such as

a) Automated Dispensing Machine (ADM),

b) Automated dispensing cabinets, and

c) Robotic original pack dispensing system.

1.1.1. Automated Dispensing Machine (ADMs)

The implementation of the Automated Dispensing Machine (ADMs) in the dispensing process involves improving the quality of the medication distribution process and the effective utilization of human resources. [14] It was reported that ADMs reduced the dispensing time of pharmacists [15-17] but pharmacists needed more time to provide more intelligent services like patient care-related activities.

Comparison between Manual Dispensing System/ Automated Dispensing System/ Modified Automated Dispensing System

Manual Dispensing System (Manual system)

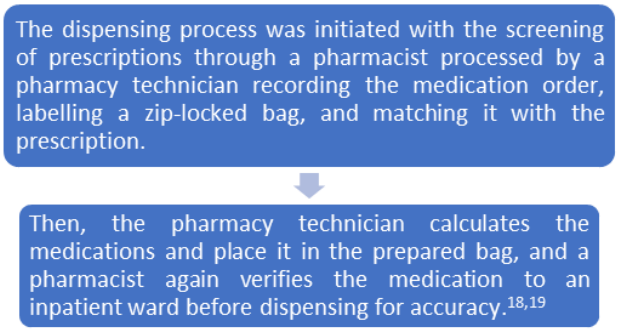

Figure 1: Work process of Manual Dispensing System.

Automated Dispensing System (ADM system)

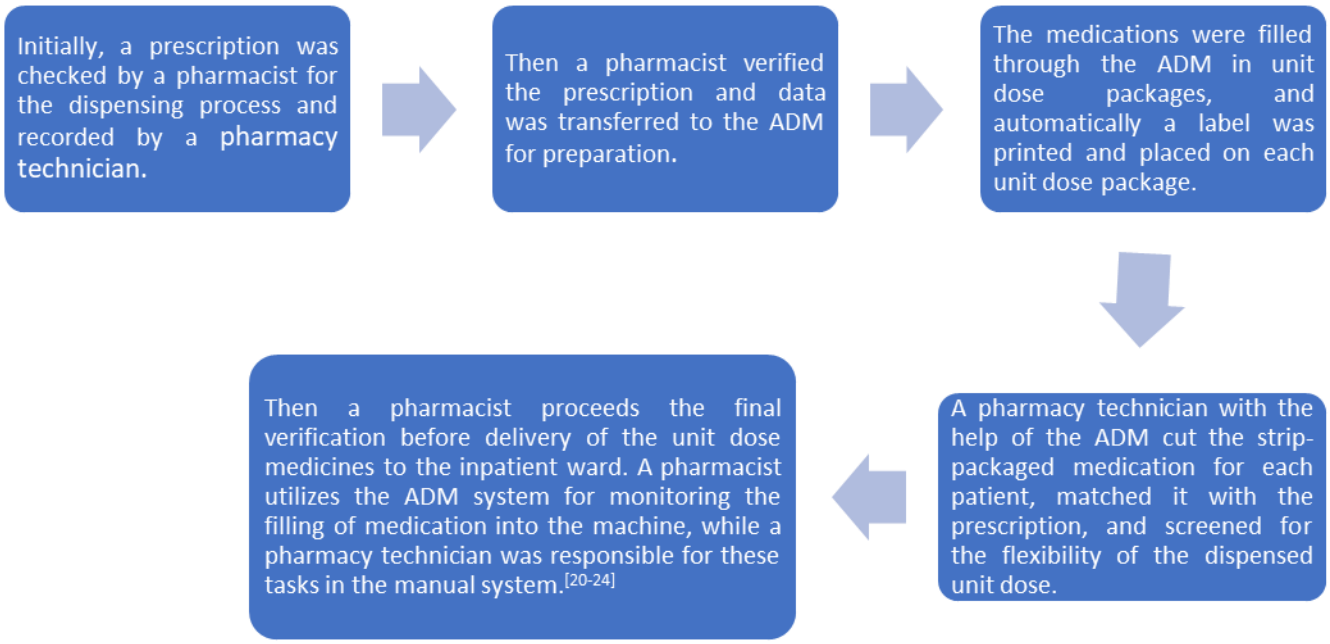

Figure 2: Work process of Automated Dispensing System.

Modified Automated Dispensing System (Modified ADM system)

The modified ADM system minimizes the dispensing process and reduces the human resource requirement along with improving the quality of patient care by utilizing the work process of the ADM system.

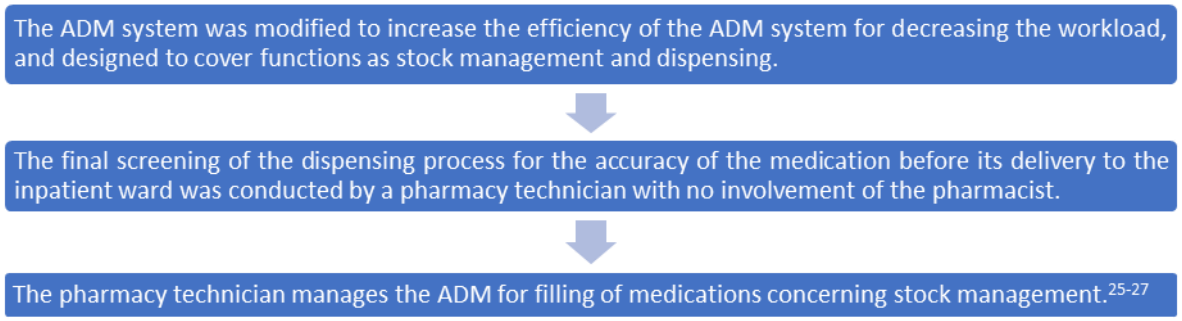

Figure 3: Work process of Modified Automated Dispensing System.

1.1.2. Automated dispensing cabinet (ADCs)

Automated dispensing cabinets were also referred to as automated distribution devices which were prepared not only to prevent the errors and replace human activity but also to support humans in clinical decision making. [14] ADCs must identify the risks and promote the safe practice of reducing medication errors. ADC was utilized for different decentralized drug distribution including in outpatient areas, like the emergency department.

ADC has the potential for providing safety advantages such as improving efficiency among pharmacy and nursing disciplines, and the capacity to monitor inventory and hinder drug deviation through accurate medication tracking and record-keeping. ADC was significant for the use of patient profiling systems to pull out medication which allows the withdrawal of medication after pharmacist order verification through the patient's primary nurse only by interfacing with the pharmacy information system.[28-30]

1.1.3. Robotic dispensing system

Robotic original pack dispensing system has been recommended for improving safety, performance, and enhancing the storage capacity to which it stores and retrieves automatically the medication depending upon the barcode on the product. The rate of dispensing errors was reduced by the implementation of a robotic original pack dispensing system and optimized stock management. While dispensing robots do not handle all the packages so, residual manual dispensing was also utilized in the post robotization phase but in both the phase the original packs were directly delivered by the technicians to the patient without previous labelling. At the pre-implementation phase, a barcode-controlled system was used for dispensing the drug manually by the technicians while the dispensing robot ROWA Vmax (ARX) was utilized at the post-implementation phase for dispensing the drug.[31-34]

1.2 Impact of technologies on reducing medication errors and ADEs

The new emerging technologies such as computerized medication administration records (CMARs), computerized physician order entry (CPOE), automated dispensing machines (ADMs), and barcoding has a potential effect in reducing medication errors and adverse drug events (ADEs)[35] as shown in **Fig 4**.

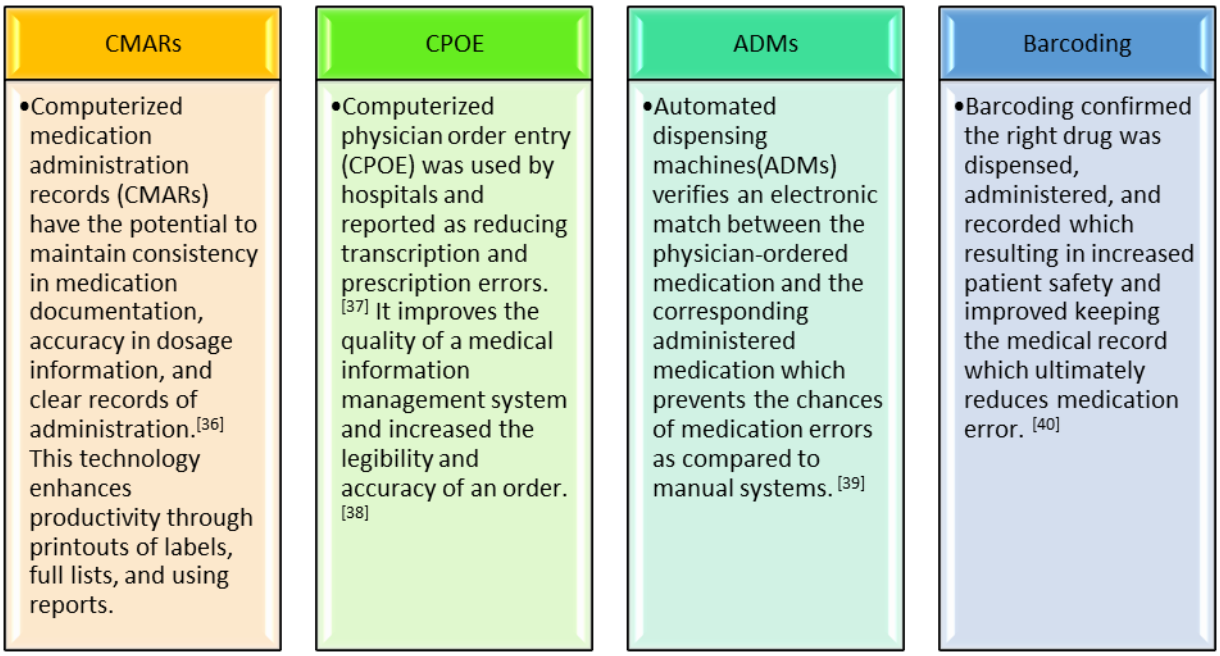

Figure 4: Effect of technologies on medication error and ADEs

1.3 Insight to reduce the medication error by the implementation of automated drug dispensing:

Chapuis *et al* evaluated the automated dispensing system which impacts the incidence of medication errors associated with preparation, administration, and picking of drugs in a medical intensive care unit and estimated the clinical significance of such errors and user satisfaction.

Design: Post-intervention and pre-intervention study consisting of control along with an intervention medical intensive care unit.

Setting: 2,000- bed university hospital was conducted under two medical intensive care units.

Patients: Adult medical intensive care patients.

Interventions: The implementation of an automated dispensing system was chosen randomly in a study unit after a 2-month observation, with other units was remaining under control. Measurements and Main

Results: The rate for overall error was indicated by percentages which were categories by an expert committee under the National coordinating Council for Medication

Error Reporting and Prevention**.** Self-administered questionnaires were assessed by nurses for user satisfaction. Hence, a total of 1,476 medications for 115 patients were observed. In this study, it was examined that after implementation of the automated dispensing system, a reduced percentage of total opportunities for error was observed compared to the control unit (13.5% and 18.6%, respectively; p <.05), therefore, no significant difference was noticed before the implementation of the automated dispensing system (20.4% and 19.3%, respectively; not significant). Thus, in this study, a significantly reduced percentage of total opportunities for error was noted before-and-after comparison (20.4% and 13.5%; p < .01). The impact of the automated dispensing system in reducing preparation error (p <.05) was analysed significantly for error. Finally, for working conditions, the mean was improved from1.0-0.8 to 2.5-0.8 on the four-point Likert scale.

Outcomes: overall medication errors accompanied to preparation, administration, and picking of drugs were reduced by the implementation of an automated dispensing system in the intensive care unit. Additionally, the new drug dispensation organization was favoured by more nurses.[41-50]

Cousein *et al* analysed the automated drug distribution system and their impact on medication errors (MEs).

Methods: Observational study before and after in a Valenciennes, France 40-bed short-stay geriatric unit within an 1800 bed general hospital. When the drug distribution system changed before and after from ward stock system (WSS) to a unit dose dispensing system (UDDS), thus researchers had examined the nurses' medication administration rounds and compared to the prescribed drugs through the integration of unit dose dispensing robot and automated medication dispensing cabinet (AMDC).

Results: It was evaluated that about 148 patients were observed total 615 opportunities of errors (OEs) treated during the ward stock system (WSS) period thereby; among 166 patients observed 783 OEs were treated during unit-dose dispensing system (UDDS) period. Thus, the two periods were compared and calculated by medication administration error (MAE). In addition, type of errors, risk reduction as well as the seriousness of errors was measured for the patients. Hence, an automated drug dispensing system was estimated and show results in a 53% reduction in MAEs where all type of error was minimized in the UDDS period than in the WSS period (P <0.001). Thus, there was a reduction of 79.1% in the wrong dose and 93.7% in wrong drug errors respectively.

Outcomes: The medication safety was improved among the elderly by the implementation of an automated UDDS due to the combining effect of unit dose dispensing robot and automated medication dispensing cabinet (AMDCs) significantly reduces discrepancies between ordered and administered drugs.[51-59]

Lisby *et al* investigate the type, frequency, and consequence of medication error in more stages of medication process including discharge summaries.

Design: three methods i.e. direct observations, unannounced control visits, and chart reviews were utilized to detect the errors in the medication process under cross-sectional study. Thus, all potential medication error and their consequences were evaluated by physicians and pharmacists in discharge summaries.

Setting: A randomly selected medical and surgical department at Aarhus University Hospital, Denmark.

Study participants: In this, the age group i.e. 18 or over (n=64) were eligible in hospital patients where nurses were dispensing and administering the drugs and physicians prescribing the drugs.

Main outcome measures: Clinical consequences of all detected errors and their frequency, type, and potential were compared with the total number of opportunities for error.

Results: Here, about 2467 opportunities for errors detected about 1065 errors in the medication process assessed as potential adverse drug events. Thus, the frequency of medication errors at each stage was ordering 39%, transcription: 56%, dispensing: 4%, administration: 41%, and at last discharge summaries: 76%. Hence, due to the lack of drug form, the omission of drug/dose, unordered drug and lack of identity control were common types of error occur throughout the medication process.

Outcomes: By the implementation of automated drug dispensing technologies in the medication process, the number of errors could be reduced through the involvement of simple changes of existing procedures and their quality was improved up to 50% reduced all errors in dose and prescriptions in the medication process.[60-68]

CONCLUSION

Automated dispensing systems revolutionize the health care system with the improvement in the quality of the medication dispensing process by utilizing time-saving automated dispensing technologies. The quality of the medication distribution process was improved with the implementation of the Automated Dispensing Machine (ADMs). Different automated dispensing technologies have the potential for reducing medication errors, improving safety, enhancing the efficiency, and accuracy of the dispensing process. Hence, this review concluded the practices of automated drug dispensing technologies on the reduction of medication error during the medication process as by the implementation of the automated dispensing system reduced overall medication errors related to picking, preparation, and administration of drugs. By the implementation of an automated UDDS due to the combining effect of unit dose dispensing robot and automated medication dispensing cabinet (AMDCs) significantly reduces discrepancies between ordered and administered drugs. By the implementation of automated

drug dispensing technologies in the medication process, the number of errors could be reduced through the involvement of simple changes of existing procedures, and their quality was improved up to 50% reduced all errors in dose and prescriptions in the medication process.

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