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Pharmacy automation in King Abdulaziz University hospital : A genuine pilot treatise in the female section

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ABSTRACT

Possible dispensing and medication errors threatening patients in different hospital units may result from the overstressed working environment in the pharmacy throughout the day. Among the responsibility of a hospital pharmacy is the development of a safe optimized method for drug preparation, dispensing and distribution among inpatients in the different hospital wards. The main aim of the current study lies in the implementation of an automated pharmacy unit in the female medical ward as a pilot study with the objective of further generalization of the trial throughout the different departments of the hospital. The designed unit was instilled and integrated with the general hospital system. This process aimed at centralizing the dispensing process of drugs in the female medical ward. Several parameters were monitored and compared before and after automation throughout the trial period including time taken from the start of medication order until its delivery to the patient. Sample size was calculated from the needed unit orders/ day to cover the medical need of 62 beds in the ward.Results revealed that the application of an automated system in the female medical unit saved time and effort with a decrease in personal load and possible error. Automated dispensing units with the possibility of decentralized medication distribution system provides computer-controlled storage, dispensing and tracking of medications within the different hospital domains and diminishes the possibility of medication error to a great extent.

INTRODUCTION

Patient care have been always related to safety measures taken, decreasing possible risks while at the meantime improvement of strategies for drug administration, equipment usage and clinical practice are being considered.[1] The possible dispensing and medication errors threatening patients may result if the only choice was utilizing manpower for the entire work accomplishment.[2] This would lead to an over pressure workload which by turn may result in time shortage accompanied byan un-satisfactory impact on the professionalism of the job performed.[3, 4]One of the major responsibilityof ahospital pharmacylies in the processes of developing a safe optimized method for drug preparation, dispensing as well as distribution among inpatients and outpatients in different departments.[5] At the beginning of the second millennium , several survey studies were conducted and aimed at investigating pharmacy practice in hospitals in several countries.[6-8] While few studies have been accomplished in Saudi Arabia for the assessment of the actual role of pharmacists in the hospital pharmacy up to the year 2010, several attempts have been performed since then for evaluating the effective role of hospital pharmacists on drug management and improvement of medication use within their domains.[9, 10] Automated Pharmacy System can be defined as a pharmacy sub-store machine/device installed within the nursing unit that perform operations or activities relative to storage, packaging, dispensing, and distribution of medications while at the meantime is able to collect, control and maintain all transaction information. Hospital pharmacy automation was implemented in most hospitals throughout the world to overcome the problems resulting from normal human errors while optimizing drug preparation, dispensing and distribution systems, saving time, effort. Automation allowed for the functional cooperation between the medical health care team of physicians, pharmacists, nurses and pharmacy technicians. [11] Appropriate, accurate and time

controlled distribution of medications by the automated distribution systems to patients helped the pharmacist in the perfect performance of the required tasks with improved capabilities and efficacy. It offered enough time for the pharmacist to review patient-specific medication orders, select appropriate medication doses and deliver them to the required patient care unit at an appropriate time. [11, 12] Automated systems comprise mechanical or electronic means that allow human capabilities to be more focused on observation and decision making with less physical efforts. However, automation must prove its outcomes as being safe for patients, accommodate the complex tasks within the hospital, and be able to reflect an appropriate long term effect on investment.[13] The hospital must therefore develop a well-established comprehensive policy for the procedures adopted in the automated distribution of medications and related supplies in a safe manner to both inpatients and outpatients. [14]

The main goal of the current study was to implement the use of an automated pharmacy unit in the female medical ward at King Abdulaziz University hospital, KAUH. This study investigated the effect of its use on the enhancement of the process of medication auditing, dispensing, storage and distribution while decreasing time, expenses, and possible hazards resulting from medication or delivery errors. Another important goal focused on determining the possibility of generalizing this trial to all departments of the hospital.

METHODS

Study procedure, recruitment and information:

The study started by observing, determining and checking all the possible phases implemented in the process of medication dispensing from the main pharmacy to the different hospital units, King Abdulaziz University in Jeddah.

Pharmacy unit dose preparation:

The workflow for the manual preparation of a unit dose medication for inpatient individual was assigned to the in-charged pharmacy staff involved where different steps are presented in Fig.1

Due to the tedious, effort and time wasting method adopted, the pharmacy has initiated a pilot study for automated medication dispensing for the female medical nursing ward. This ward was chosen based on its high inpatient admission rate, total number of 62 beds, high demand of medication delivery and great numbers of medication preparation with considerable drug order frequency rate.

Study setting and cabinet design:

The Omnicell® cabinet for the female medicated nursing unit was ordered with a special internal design to organize the drugs according to quantity, size and or capacity to place the medication in each corresponding bin. The medication unit was launched and tried out at the female medical unit on April 2014 in order to set up and maximize its operation. Fig. 2&3 show the detailed structure of the installed Omnicell ® medication unit. The cabinet stored unit dose medications that covers at least 85% of the required medications by the female medical ward.

Drug selection:

The classification and category of the selected drugs to store inside the cabinet was based on the statistic report of weekly medication consumption throughout year 2013 which was collected from both; unit dose order and floor stock reports (Phoenix system, hospital electronic system).

Types of medication:

The Pharmacy and Nursing department made a medication list (270 medication) according to patient care area of specialty. Types of medication inside the automated cabinet were classified as follows:

Control Level 6

Comprised all regular prescribed medication to the admitted patient and or those transferred to female medical unit by the physician and approved by the pharmacist.

Control Level 2

Included all narcotic and controlled medication approved by Saudi Food and Drug Authority, (SFDA).The authorized nurse

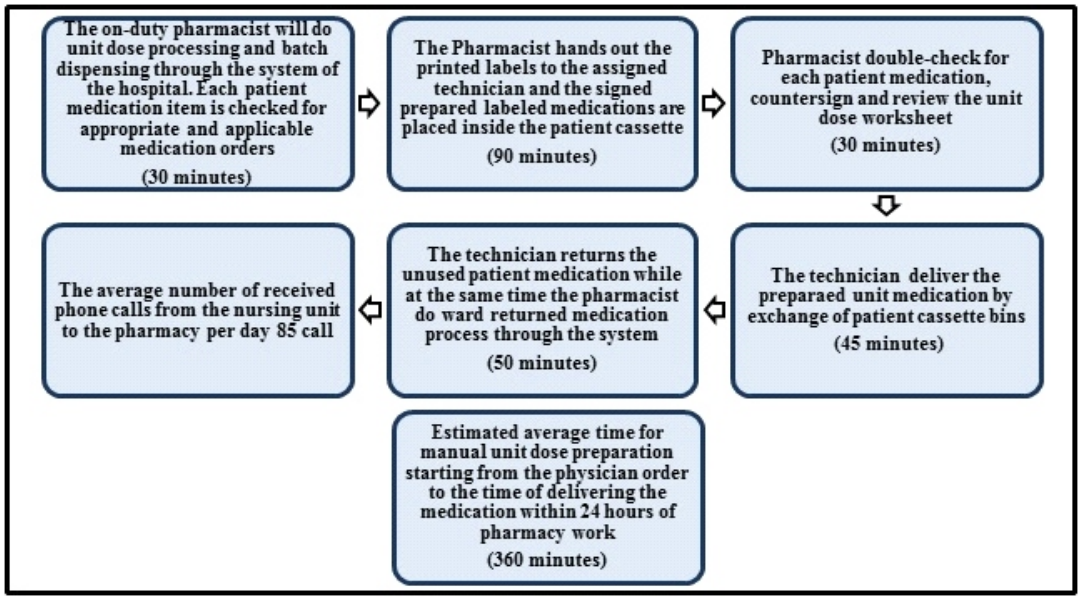
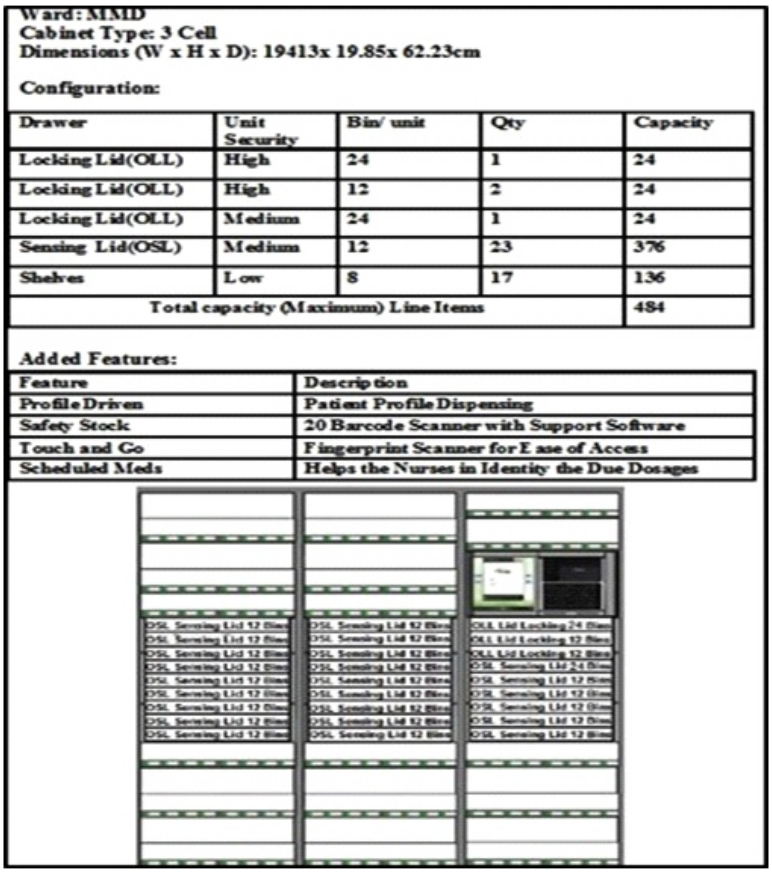


Figure 1: Protocol of the pharmacy supply to the female medical ward before implementation of the automated system

Table 1. : List of override medications used during emergency cases were also supplied to the ward

Number	Medication
1	Premixed Potassium Chloride 20 mEq + Dextrose 5% in 0.9% normal saline/ L
2	Premixed Potassium Chloride 20 mEq + Dextrose 5% in 0.45% normal saline/L
3	Adrenaline / Epinephrine 1:1000 Amp
4	Dextrose 50% Vial, 50 mL
5	Digoxin 0.5 mg/2mL Amp. (LANOXIN®)
6	Dobutamine HCl 250 mg Vial
7	Vasopressin 20 units /mL Amp.
8	Dopamine HCl 200 mg/5mL Vial
9	Phytomenadione / Vitamin K1 10 mg/mL Amp.


Ward: MMD
Cabinet Type: 3 Cell
Dimensions (W x H x D): 19413x 19.85x 62.23cm

Configuration:

Drawer	Unit Security	Bin/ unit	Qty	Capacity
Locking Lid(OLL)	High	24	1	24
Locking Lid(OLL)	High	12	2	24
Locking Lid(OLL)	Medium	24	1	24
Sensing Lid(OSL)	Medium	12	23	376
Shelves	Low	8	17	136
Total capacity (Maximum) Line Items				484

Added Features:

Feature	Description
Profile Driven	Patient Profile Dispensing
Safety Stock	20 Barcode Scanner with Support Software
Touch and Go	Fingerprint Scanner for Ease of Access
Scheduled Meds	Helps the Nurses in Identity the Due Dosages

Figure 2: Design of the ordered Omnicell® unit for the female medical ward.

can dispense these medications directly from cabinet with another staff as witness and perform medication bins cycle count.

Override Medications

List of override medications used during emergency cases were also supplied to the ward,

System integration process:

The pharmacy gathered the entire requirements for the operation and integration of the Omnicell® unit to the hospital system with the collaboration and assistance of the IT and Phoenix department.This integration allowed for full control with a closed system of inventory and accurate patient medication information. Seven interfaces were implemented between Omnicell® and Phoenix that covers patient profiling, material management and interface which complies with Health Level 7 (HL7) standards.

Figure 3: Photographic representation of the Omnicell® unit in the female medical ward

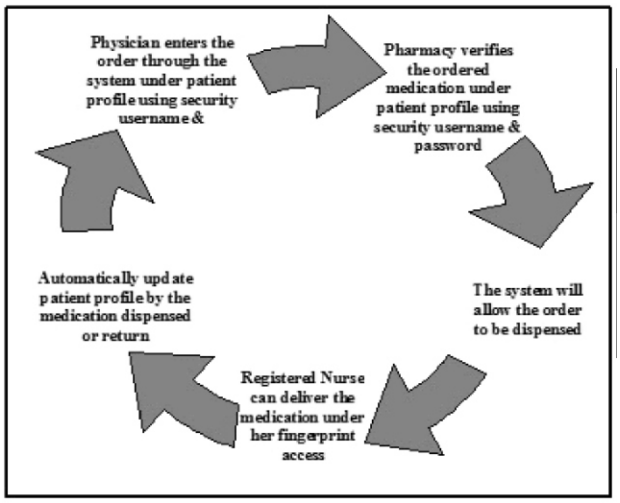


Figure 4: Integrated pharmacy workflow protocol after operating the automated unit in the female medical ward

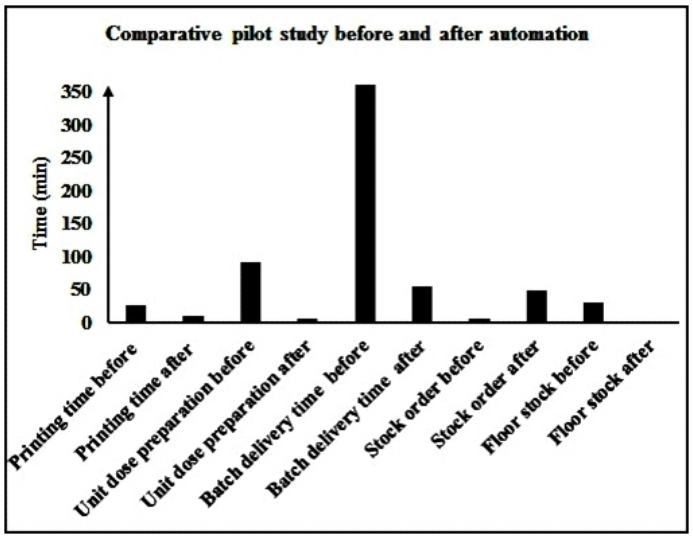


Figure 5: Comparative pilot study before and after automation.

These interfaces were divided into two main groups:

- ***Interfaces from Phoenix system to Omnicell :***

1. Admission, Discharge and Transfer (ADT)

Messages sent from Phoenix to the Omnicell system. This allowedthe Omnicell® cabinet to maintain an up-to date demographic and visit information about the patients.

2. Medication Order information (RXP)

Messages sent from Phoenixto the Omnicell® system whenever a patient's medication order is created, modified, discontinued or cancelled.

3. The formulary update (RXF)

This integration supported the security of hospital formulary database. Whenever the drug formulary was updated or modified in the main store,automatic update to all pharmacy sub-stores were done.

4. Advance Shipping Notice (ASN)

It comprised item delivery quantity, item Batch number and item Expiry date.

- ***Interfaces from Omnicell to Phoenix :***

1. Medication Order information (RXC)

It allowed Phoenix to hold an updated patients profile whenever a medication was dispensed or returned to Omnicell® cabinet.

2. Cabinet store update messages (ZPM)

This supported the Phoenix to control information in all sub-stores automated pharmacy for assigned bin, unassigned bin, dispensed medication, returned medication and cycle count.

3. Stock requisition request (ORD)

A message is sent from Phoenix to Omnicell® system to calculate the reorder quantities for each item including; item requested quantity and restock source store

Workflow protocol after automation:

The proposed workflow protocol after automationis shown in Fig4.

Authorized access and privileges:

Specific responsibilities and privileges for all personnel involved in operating or using the automated pharmacy system was clearly set for security and safety measures. Staff members having the authority access and privileges comprised; pharmacy automation system coordinator, all authorized physicians, all authorized pharmacists, authorized nurses assigned by means of the pharmacy automation system coordinator and floorstock authorized pharmacist

Restock the automated pharmacy:

The standard inventory quantity for all medications wasset at minimum for 3 days and maximum for 7 days. The pharmacy has selected one day to perform normal restocking procedures (supply enough medication for one week) and two days for critical restocking procedures (supply critical shortage in stock for 3 days).

Monitoring of the workflow of the automated pharmacy:

The pharmacy automation coordinator monitored the specific reports that were pre-selected through Omnicell® system. In KAUH, selected schedule reports are sent automatically via e-mail notice including transaction report, discrepancy audit report, discrepancy report, returned medication report,par usage report, dispensing Practices report,medication order overridden report and null transaction report

Study variables:

Sample size

The sample size for the pilot study was calculated from a four week long period before and after automation. To ensure an appropriate big enough sample size for the different variables chosen, it was decided to perform a daily check on medically prepared stocks; unit dose preparation ordered by the medical ward and received calls from the nursing unit per day. The number of unit dose ordered and prepared by the pharmacy per day from the medical ward to cover the needs of 62 beds averaged in number to be 535.5±7.6 order / day (average of≈ 16065 order /month of the study before and after automation implementation). This number represented the sample size for the study and all calculations were based on it.

Printing morning batch, unitary dose preparation, and batch delivery time:

Data were gathered and collected based on the cumulative time required by the Pharmacy to print the unit dose batch at morning, prepare unitary dose and batch delivery time. Batch delivery system included the time required by the pharmacy to check the order in the system and print the medication label accordingly. Results were calculated as mean time (min) ± SD.

Average number of phone calls:

Determination of the average number of phone calls received from the nursing unit to the pharmacy during unit dose preparation was also determined before and after automation. Results were calculated as mean number/ day ± SD.

Floor stock medication order and preparation:

Time required for floor stock medication requests was monitored for one month before and after automation. Time required for the preparation of the required floor stock medication was also calculated. In the study, the cumulative time taken in min was calculated for the re-stocking of the floor stock medication order. This was done by the collaboration of the assigned nurse and the pharmacy. The assigned female medical nurse was responsible to check and count the required medication to order for floor stock where time required was calculated in minutes. The time required for pharmacy to prepare the floor stock medication to female medical ward before implementation of automated pharmacy was also calculated. Results were calculated as mean time(min) ± SD.

Percentage returned medication:

Percentage of the amount of returned medication from the nursing unit to the pharmacy was monitored before and after automation. Average percentage throughout the month was calculated ± SD.

Dispensing and distribution errors:

The study analyzed the errors occurring in each stage of the dispensing system.

Statistical analysis

All results were compared before and after automation using SPSS Advance Statistics, (SPSS Inc., Chicago, Illinois).

RESULTS

The study focused on the implementation of a medication automated unit serving the in- hospital patients' needs located in the female medical ward. The system was integrated with the main hospital system for more control and follow up.

Several points for evaluation of the success of the system were taken in consideration and monitored for a period of 4 weeks of continuous work. These items of evaluation were compared before and after application of the automated system.

Printing morning batch, unitary dose preparation, and batch delivery time:

Fig. 5 shows the cumulative results of the studied parameters before and after the implementation of automation. The average time required for printing an order of medication averaged from 24.9± 3.309 and 7.4± 1.79 min before and after automation respectively. On the other hand, time required to prepare unitary dose was calculated in average to be 89.3± 2.49 and 4.63± 1.066 min before and after automation respectively. The time required by the pharmacy starting from checking the physician order through the system to its delivery from the pharmacy to the nursing unit was determined to be 359.96± 11.34 and 52.46± 9.89 min before and after automation respectively. All results showed statistically high significant difference applying the student's t-test and one- way analysis of variance at p- level >0.01.

Average number of phone calls:

The average number of phone calls done by the nursing unit during the preparation of a unit dose was calculated before and after automation and found to be 85.43± 3.339 and 6.86± 1.96calls respectively, All results showed statistically high significant difference applying the student's t-test and one- way analysis of variance at p- level > 0.01.

Floor stock medication order and preparation:

The time required for the pharmacy to prepare the floor stock medication to female medical unit before and after implementation of the automated pharmacy was calculated and shown to be 5.083± 3.88 and 46.58± 28.21 min respectively, Fig

5. Results showed statistically significant difference applying the student's t-test and one- way analysis of variance at p- level > 0.01.

Percentage returned medication:

The percentage (%) medication return was reduced significantly after automation implementation. It was calculated before and after automation to be 26.38 ± 17.72 and0.282± 0.399 respectively.

Dispensing and distribution errors:

Error before and after automation was insignificant ranging from 0 to 1 error/ day. No significant difference in error was observed after applying the automation system in the female medical ward.

DISCUSSION

Based on the current results it was observed that implementing an automated medication unit in the female medical ward allowed for a significant decrease in time taken and personal error in each process involved in the delivery of medication to the patients.This is in accordance with several previous trials of applying similar automated systems or robotic ones.[13, 15] This could be explained based on applying a more closed controlled system integrated with the main hospital system. Other factor may be involved is the decrease in human effort that resulted by turn in a more accurate and focused productivity. However, the female medical unit floor stock requisition was done every Sunday and Tuesday (twice per week) manually before automation. After automation, the Omnicell® required to be refilled three times per week; every Tuesday to prepare the normal quantity of medication and every Thursday and Sunday to prepare the critical quantity of medication. The time after automation implementation was calculated by adding the time required for preparing medication to the time of filling the cabinet. This increased by turn the time required for the refilling of the cabinet after implementing automation. A Comparative Report was done on the cumulative time required by nurses for performing medication ordering of floor stock before and after the automated pharmacy was installed. After implementation of the automated pharmacy, the floor stock requisition merged automatically with the pharmacy, which subsequently decreased the workload on the nurses. Moreover, pharmacy automation in this study have focused on the fact that clinical pharmacy in hospital settings must be practiced under a well organized system. Clinical pharmacists acted as a very useful member of the health care team as previously been demonstrated in previous studies.[16]

Ethical considerations:

The study didn't involve patients and thereby no ethical approval by the ethics committee was required. However, at the beginning of the study,all medical personnel involved in the dispensing and distribution process mandatory had to attend an educational session to be aware of the steps required for the study.

CONCLUSION

Improving patient safety has always been a key focus in any hospital settings. Automated dispensing machines with the possibility of decentralized medication distribution system provided computer-controlled storage, dispensing and tracking of medications within the different hospital domains. From the current study, several achievements for the development of the King Abdulaziz hospital pharmacy were observed including:

- Improvement of patient safety measures was achieved through the enhancement of the availability of the first-dose and time controlled administration of medications. The application of automation aided in the tighter control for medication dispensing. The system allowed for the access of only one medication with high potential for mix-up at a time. These medications included the look-alike, sound alike drugs and those having different potencies.

- Enhancement of the efficiency of medication distribution, providing a well-secured medication storage in patient care units with a complete electronic tracking of the used medications was observed. This was accompanied by a remarkable decrease in the pharmacy and nursing staff workload.

- Prevention of the potential diversity through the generated different reports was also accomplished.

Finally the authors would like to point out that for the benefit of medical automation to be fully realized, the involved medical members must be well- educated and well acquainted to the immediate benefits and limits of using an automated system.

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