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ORIGINAL ARTICLE

Using an integrated information system to reduce interruptions and the number of non-relevant contacts in the inpatient pharmacy at tertiary hospital

Saleh Binobaid [a,*], Mohammed Almeziny [b], Ip-Shing Fan [a]

[a] Manufacturing and Materials Department, Cranfield University, Cranfield, UK
[b] Pharmacy Department, Prince Sultan Military Medical City, Riyadh, Saudi Arabia

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Medication errors

Abstract Patient care is provided by a multidisciplinary team of healthcare professionals intended for high-quality and safe patient care. Accordingly, the team must work synergistically and communicate efficiently. In many hospitals, nursing and pharmacy communication relies mainly on telephone calls. In fact, numerous studies have reported telephone calls as a source of interruption for both pharmacy and nursing operations; therefore, the workload increases and the chance of errors raises.

This report describes the implementation of an integrated information system that possibly can reduce telephone calls through providing real-time tracking capabilities and sorting prescriptions urgency, thus significantly improving traceability of all prescriptions inside pharmacy.

The research design is based on a quasi-experiment using pre-post testing using the continuous improvement approach. The improvement project is performed using a six-step method. A survey was conducted in Prince Sultan Military Medical City (PSMMC) to measure the volume and types of telephone calls before and after implementation to evaluate the impact of the new system. Beforehand of the system implementation, during the two-week measurement period, all pharmacies received 4466 calls and the majority were follow-up calls. Subsequently of the integrated system

* Corresponding author at: Building 50, Manufacturing and Materials Department, Cranfield University, Cranfield, UK.
E-mail addresses: s.a.binobaid@cranfield.ac.uk (S. Binobaid), almuzaini@psmmc.med.sa (M. Almeziny), i.s.fan@cranfield.ac.uk (I.-S. Fan).
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rollout, there was a significant reduction ($p > 0.001$) in the volume of telephone calls to 2630 calls; besides, the calls nature turned out to be more professional inquiries ($p > 0.001$). As a result, avoidable interruptions and workload were decreased.

1. Introduction

A multidisciplinary team of healthcare professionals provides patient care, with each individual possessing an unique skill set appropriate to his/her assigned duties. For high-quality and safe patient care, the team must work synergistically, remain focused, and efficiently communicate. Hospitals rely upon communication across departmental boundaries for effective functioning (O'Daniel and Rosenstein, 2008).

Many studies have examined the association between interruptions, such as telephone calls, and medication errors. One previous study (Kistner et al., 1994) suggested that a reduced number of interruptions during prescription filling was an important factor in error reduction. In addition, another study (Nichols et al., 2008) suggested that most errors were due to distraction caused by interruptions during routine tasks. Nevertheless, other studies (Antoniadis et al., 2014; Beso et al., 2005; Hiom et al., 2006; Lea et al., 2015) have not linked the rate of errors with high volumes of telephone calls received in the pharmacy. Flynn et al. performed a study to examine the impact of interruptions and distractions on dispensing errors in an ambulatory care pharmacy and found that interruptions and distractions for timer periods longer than a half-hour were associated with dispensing errors (Flynn et al., 1999). Work interruptions during skill-based tasks may also affect performance and lead to errors and failures (Reason, 1990). In addition, in a knowledge-based task, nurses must rely on conscious analytical processes and stored knowledge to resolve problems. At this level of performance, task performance is negatively affected by work interruption (Hollands and Wickens, 2012). Many attempts have been made to overcome this problem. Wright et al. conducted a study to evaluate the impact of a nurse communication manager (NCM) to reduce the number of non-relevant contacts, and these authors found that NCM implementation reduced the number of non-relevant contacts. As a result, the nurses may have more time to perform direct patient care (Wright et al., 2015). However, this intervention may be considered impractical because hospital services are performed 24 h a day, 7 days a week. Moreover, the employment of additional staff to cover the working hours represents a costly solution.

Pharmacy and nursing staff must communicate regularly to solve all difficulties and serve their patients. Telephone calls are a significant workload in a hospital inpatient pharmacy, and pharmacists accept that interruptions are the norm in their work setting. Accordingly, in an inpatient pharmacy, the chance of a pharmacist completing a task without being interrupted is rare. Usually the interruptions are the result of frequent telephone calls, particularly from nurses and physicians (Biron et al., 2009; Malone et al., 2007). In many references, the telephone calls are listed as one source of interruption, as these frequent interruptions can have a significant effect on memory. For example, interruptions may result in loss of concentration leading to medication errors and increased turnaround time (TAT) (Hohenhaus and Powell, 2008; Kistner et al., 1994; Nichols et al., 2008; Sørensen and Brahe, 2014). A common factor that leads to medication errors, in more than 50% of incidents involving pharmacist errors, is distraction. Pharmacists' reports have shown that their errors are due mainly to telephone call interruptions (62%) (Tang et al., 2007). Communication via telephone calls has many advantages, such as being personal, immediate, effective, interactive, confidential, and safe. By contrast, this approach has many disadvantages, such as being difficult to document. McCluskey reported that more than 400 calls were received daily at the Riverside Methodist Hospital inpatient pharmacy and that the average duration of a telephone call was 3 min, causing delays and increased TAT (McCluskey, 2012).

In Prince Sultan Military Medical City (PSMMC), communication between the nursing staff and the pharmacy relies primarily on telephone calls. The pharmacy administration has received many complaints about unattended calls, and investigations revealed an enormous volume of calls. As a result, many pharmacists are unable to answer telephone calls.

The aim of this study was to develop solutions to reduce the magnitude of telephone calls to reduce workload for pharmacy and nursing staff.

2. Methodology (materials and methods)

2.1. Design

A quasi-experiment with pre-post testing.

2.2. Method

The strategies adapted in the improvement project were as follows:

- The task group was formulated from all involved parties to cover all issues related to practice, and it involved nursing and pharmacy staff to ensure that the experiment fit the purpose, together with the information technology (IT) department to determine the feasibility of these solutions.
- The solution was designed to improve the workflow rather than working harder.
- To make major changes, start by making practical small improvements.
- The data-driven design, key performance indicators (KPIs) and required benchmark data were clearly defined and measured e.g., volume and type of telephone calls.
- The task group met on a weekly basis to review and refine all processes and overcome all obstacles to improve the products, services, and processes.

- Systematic management and all meetings and comments of the end users were documented.

The improvement project adopted a six-step continuous improvement approach. The first step consisted of problem analysis, including data collection and analysis data. A new form was designed to measure and classify the incoming calls. The second step consisted of the proposed solution. The third step was developing a new working process supported by paper forms to ensure that a good method of working was designed. These forms assisted in the understanding of the project requirements as well as being the first phase of the IT system development. The fourth step consisted of creating IT systems to support the pharmacy and the nursing team to assess the technology. The fifth step was the integration of the pharmacy and nursing systems to automate the improved work process. The sixth step consists of the ongoing continuous improvement and enhancement of the integrated systems. Fig. 1 illustrates these six steps.

2.3. Data collection

Systematic analysis of the telephone call communication problem was the foundation of the improvement project. A survey was conducted in PSMMC to measure the volume and type of telephone calls to manage this problem and reduce its impact on the pharmacy and nursing staff. A data collection form was developed as shown in Fig. 2. The telecommunication department provided the details of incoming and outgoing calls for the pharmacy extensions. Collected data were classified according to telephone call types. Based on the high volume of calls requiring follow-ups, a communication tracking system was designed and created by the IT department to enhance communication between the pharmacy and nursing departments and reduce the interruptions for both parties. The IT development was divided into three phases and is described in the results section. After the system was implemented, the results were evaluated using a review survey to measure changes in the number and types of calls.

2.4. Data analysis

Descriptive statistics were generated using Microsoft Excel 2007. T-test was used to measure the differences prior and post implementation.

3. Results and discussion

3.1. Problem analysis

Telephone call data were obtained from the telecommunication department from 09/02/2015 to 23/02/2015. The data indicated that 3328 calls were received by the inpatient pharmacy and 1138 calls were made, with a total of 4466 calls. The peak time for receiving calls was between 2:30 pm and 5:00 pm on Monday and Tuesday. The average duration was 00:01:12, which was shorter than the average duration reported in the McCluskey study, which was 3 min (McCluskey, 2012). The total duration was 17:00:21 h during the 2 weeks of monitoring.

To distinguish the types of received calls, a sample of 296 calls was analyzed according to type. The types of calls were categorized as confirmation of receiving the prescription, follow-up, IV discontinuations, missing dose, as needed medications, professional inquiries and other. The number of calls according to their category is presented in Table 1. Nurses commonly consider pharmacists as a resource regarding the therapeutic and adverse effects of medications, and as a result, the pharmacy receives many calls to clarify issues related to medication administration, including illuminating unusual medications, how to make up IV medications, the appropriateness of an unclear medication prescription, the method of administering an unfamiliar dose, crushing particular tablets and the organization of discharge medications. Frequently, these conversations lead to better patient care (Manias et al., 2005).

The most common type of phone call was follow-up, with 112 calls. This result suggested that the pharmacy lacks an efficient system of prescription tracking and that the nurses could not track the status of their patients' medication prescriptions. The time spent tracking the status of medication prescriptions can be more efficiently used by both the pharmacy staff and nursing staff. In addition, efficiency could also be improved by reducing the number of telephone calls. Sørensen and Brahe, 2014 classified the interruption into acceptable or unacceptable, such as when a colleague enquires for information that is readily available in the patient's records. Nevertheless, interruptions can be considered avoidable or unavoidable.

3.2. Proposed solution

Many studies have confirmed the benefits of computerized prescriber order entry (COPE) for minimizing medication errors and enhancing communication among healthcare professionals (Doolan and Bates, 2002; DW et al., 1998; Evans et al., 1998). PSMMC is planning to implement a new health information system (HIS), which includes a COPE. However, this is a long-term project, and the specified HIS does not include a communication and prescription tracking system. Thus, an IT development project was initiated to address the immediate necessity for a pharmacy-nursing bidirectional communication system. The proposed system sends prescriptions, provides online status for prescription progress and documents any communication between the pharmacy and nursing staff. Lochbihler concluded that by implementing dose-tracking technology in the Cleveland Clinic, they increased the efficiency of the drug distribution process. Furthermore, real-time tracking capabilities speed up and ease the identification

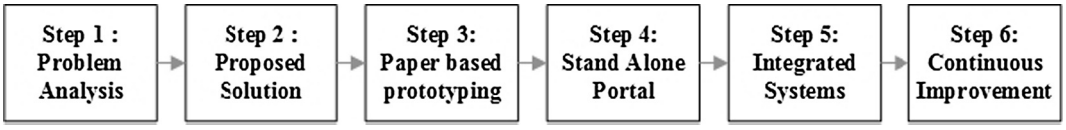


Figure 1 Project steps.

Analysis of phone calls received from nursing by inpatient pharmacy department.

Date: Location: IP IV Building 5 IP Oral Building 5 IP IV Building 2 IP Oral Building 2 ED IV Pharmacy ED Oral Pharmacy

Time	Ward	Type of call										
		Conf	Follow-up	Time received	Type of Rx (S,A,R)	Refill medications	Missing dose	IV D/C	Professional inquiries	Wrong profiling	Other	Specify

Figure 2 Data collection form.

Table 1 Analysis of the types of telephone calls received from the nursing staff in PSMMC prior and after the implementation project.

	Duration		*P* value
	Before	After	
Average (HH:MM:SS)	00:01:12	00:01:43	> 0.001
Mode (HH:MM:SS)	00:00:21	00:00:56	
Standard deviation (HH:MM:SS)	00:01:10	00:01:36	
Minimum (HH:MM:SS)	00:00:00	00:00:00	
Maximum (HH:MM:SS)	00:22:25	00:26:27	
Sum (HH:MM:SS)	17:00:21	04:42:30	> 0.001
Count (Calls)	4465	2630	> 0.001

of medication locations, and their reporting system helped improve the drug distribution process and ensured that doses were delivered in a timely manner (Lochbihler et al., 2011). In similar approach at the Auckland District Health Board, the inpatient pharmacy planned to implement a tracking system for prescriptions during the dispensing process to control the number of interruptions. The aim of this system was to provide the status of a prescription at any point during the dispensing process (Subramoney, 2009).

Andersen examined important barriers to implementing drug-prescribing sheets for recording both drug prescriptions and drug administration, as experienced by nurses and physicians. The author identified organizational difficulties faced by healthcare professionals when using drug-prescribing sheets for recording both drug prescriptions and drug administration. These difficulties could be summarized as a lack of knowledge of procedures, inadequate dissemination of knowledge, and poor cooperation and skepticism among those who put drug handling into practice, which are expected to have an impact on the quality of health care (Andersen, 2002).

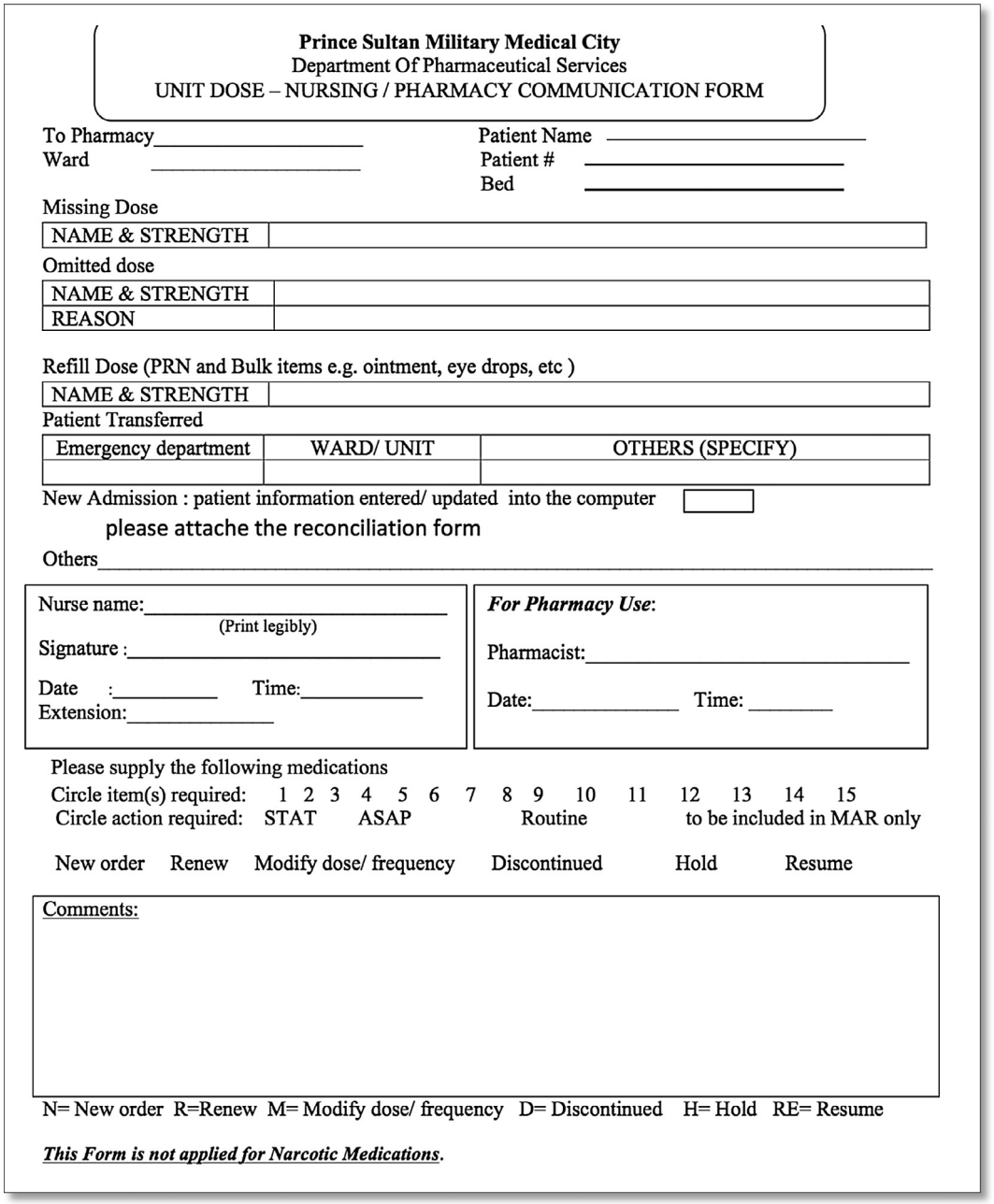
IT solutions can significantly enhance teamwork among clinical professionals by improving information transfer, workflow, and communication, resulting in marked improvements in patient safety and overall the quality of care (Doolan and Bates, 2002; Meadows and Chaiken, 2003; O'Daniel and Rosenstein, 2008). Furthermore, (Poon et al., 2006) a previous study concluded that the implementation of bar code technology decreases the medication errors in healthcare. Moreover, in industries outside the healthcare barcode, technology eases and accelerates the transactions of these industries.

3.3. Paper-based prototyping

The third step in system development was developing paper-based communication forms to be used as prototypes for the communication and tracking program, as well as to be used as a temporary solution until the program implementation is completed, as shown in Figs. 3 and 4. The paper-based communication forms underwent many changes based on the feedback of nurses and pharmacists.

From the problem analysis and paper-based prototyping steps, the multi-department task group specified the following requirements for the new IT solution. Meanwhile, a working system is to be developed based on the following requirements:

- The software must be web-based.
- It should be able to recognize the patient's bar-coded label to minimize the amount of data entry by nurses.
- No extra resources should be required to update and maintain.
- It should enhance and speed up the communication between the pharmacy and nursing units and vice versa.
- It should document the communication between pharmacies and nursing staff. The documents should include the subject, time, personal details and the required action(s).
- It should track and retrieve all communications.
- It should send online messages to nurses when the pharmacy is requesting any information or action(s) in regard to patients and vice versa.
- It should be capable of attaching a file with the messages.
- It should eliminate paper and manual documentation.
- Ability to review prior messages sent to other user.



Prince Sultan Military Medical City
Department Of Pharmaceutical Services
UNIT DOSE – NURSING / PHARMACY COMMUNICATION FORM

To Pharmacy_____ Patient Name _____
Ward _____ Patient # _____
Bed _____

Missing Dose

NAME & STRENGTH	

Omitted dose

NAME & STRENGTH	
REASON	

Refill Dose (PRN and Bulk items e.g. ointment, eye drops, etc)

NAME & STRENGTH	

Patient Transferred

Emergency department	WARD/ UNIT	OTHERS (SPECIFY)

New Admission : patient information entered/ updated into the computer ☐
please attache the reconciliation form

Others_____

Nurse name:_____
(Print legibly)
Signature :_____
Date :_____ Time:_____
Extension:_____

For Pharmacy Use:
Pharmacist:_____
Date:_____ Time: _____

Please supply the following medications
Circle item(s) required: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Circle action required: STAT ASAP Routine to be included in MAR only

New order Renew Modify dose/ frequency Discontinued Hold Resume

Comments:

N= New order R=Renew M= Modify dose/ frequency D= Discontinued H= Hold RE= Resume

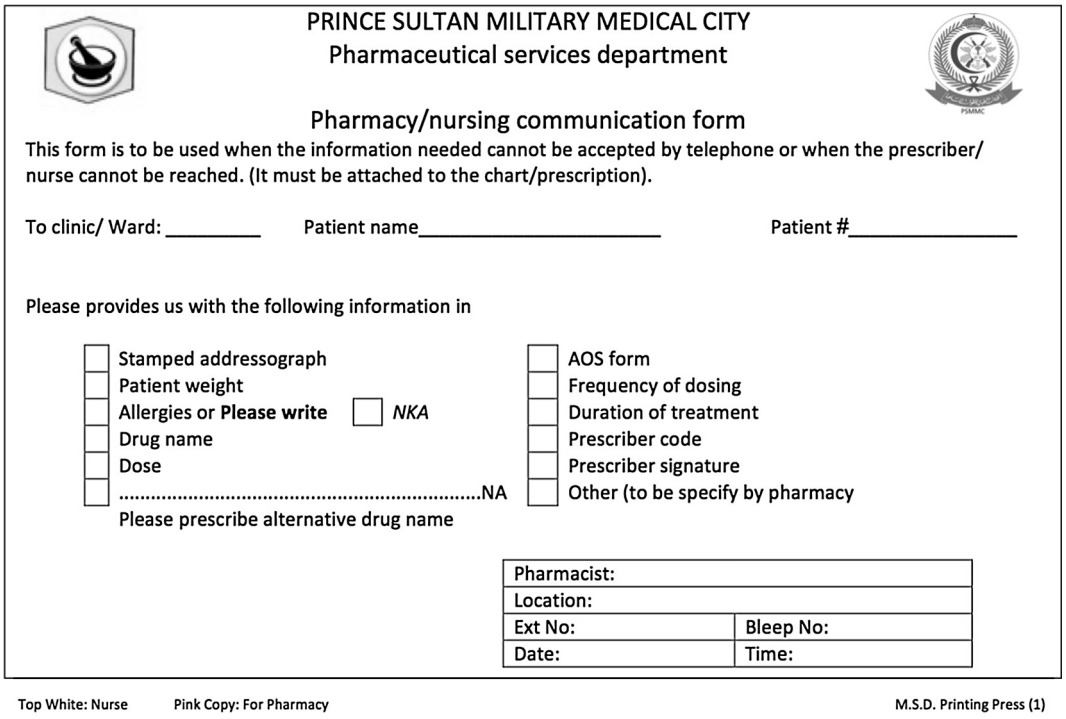
This Form is not applied for Narcotic Medications.

Figure 3 Nursing pharmacy communication form.

- Capacity to sort prior messages according to reference number, unit, patient number, patient name, reason, user name, location, time and date.
- Capacity to generate reports about workload, TAT, and workflow.
- Capacity to print or export reports into popular PC spreadsheets, database and word processing file formats.
- Able to integrate, in time, with all new PSMMC HIS modules, including COPE, pharmacy system and the electronic medication administration record (eMAR).

3.4. Stand-alone portals

The IT department developed computer-based systems to automate the paper forms, initially as two stand-alone systems accessed through web portals: one for the pharmacy (Pharmatal) and one for the nurses (Nurtal). The program was piloted in one ward before being rolled out to the rest of the hospital. This step has a minimal impact on the volume of telephone calls.



PRINCE SULTAN MILITARY MEDICAL CITY
Pharmaceutical services department

Pharmacy/nursing communication form

This form is to be used when the information needed cannot be accepted by telephone or when the prescriber/ nurse cannot be reached. (It must be attached to the chart/prescription).

To clinic/ Ward: _____ Patient name_____ Patient #_____

Please provides us with the following information in

- ☐ Stamped addressograph
- ☐ Patient weight
- ☐ Allergies or **Please write** ☐ *NKA*
- ☐ Drug name
- ☐ Dose
- ☐ .....NA
  Please prescribe alternative drug name
- ☐ AOS form
- ☐ Frequency of dosing
- ☐ Duration of treatment
- ☐ Prescriber code
- ☐ Prescriber signature
- ☐ Other (to be specify by pharmacy

Pharmacist:	
Location:	
Ext No:	Bleep No:
Date:	Time:

Top White: Nurse Pink Copy: For Pharmacy M.S.D. Printing Press (1)

Figure 4 Pharmacy nursing communication.

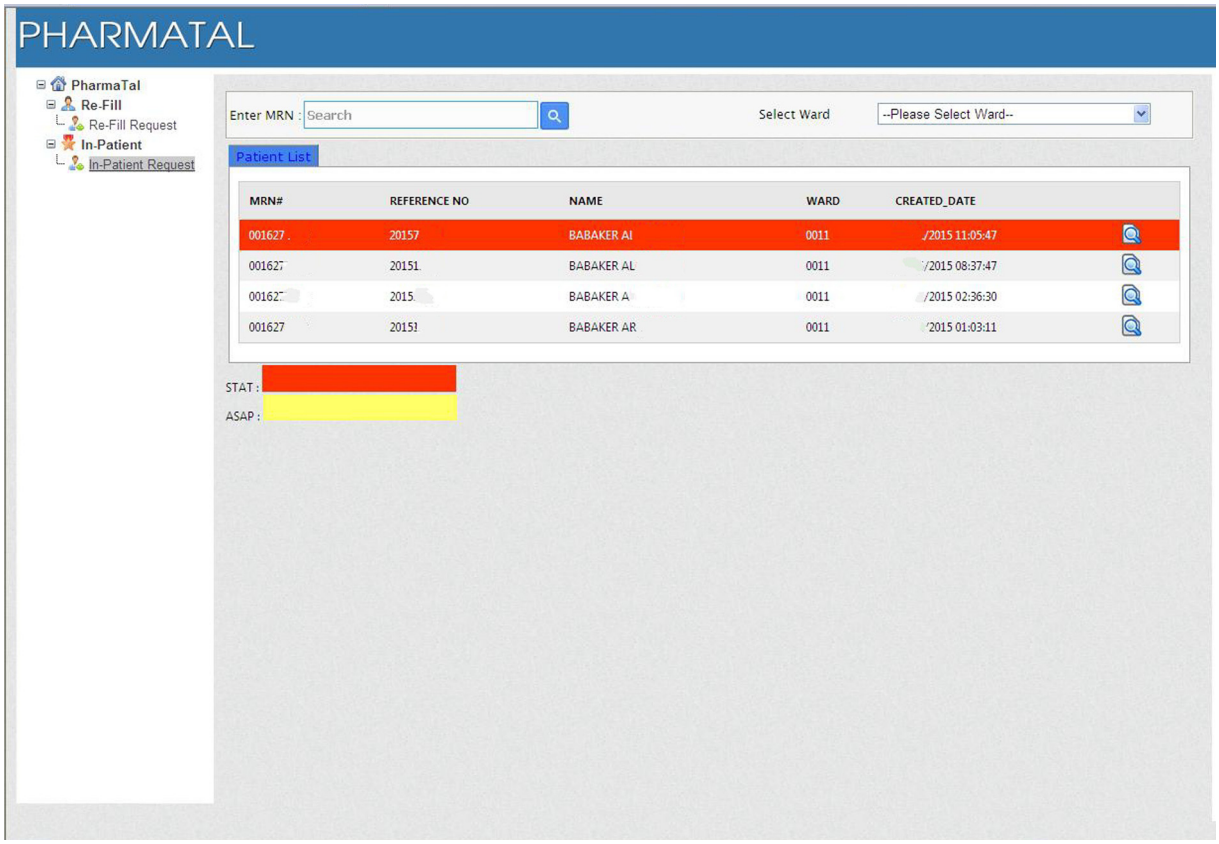


Figure 5 Patient list sorted according to the priority color coding, with red for STAT and yellow for ASAP medications.

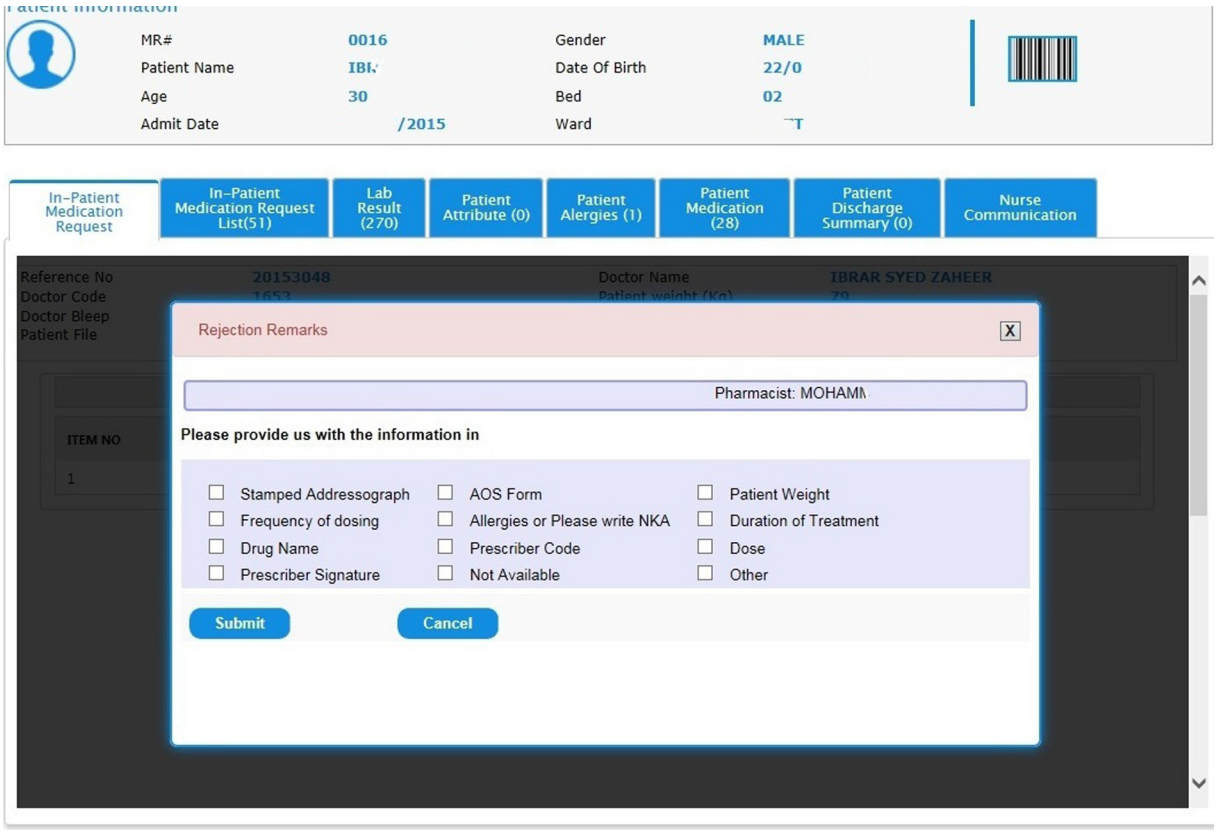


Figure 6 The electronic pharmacy nursing communication form.

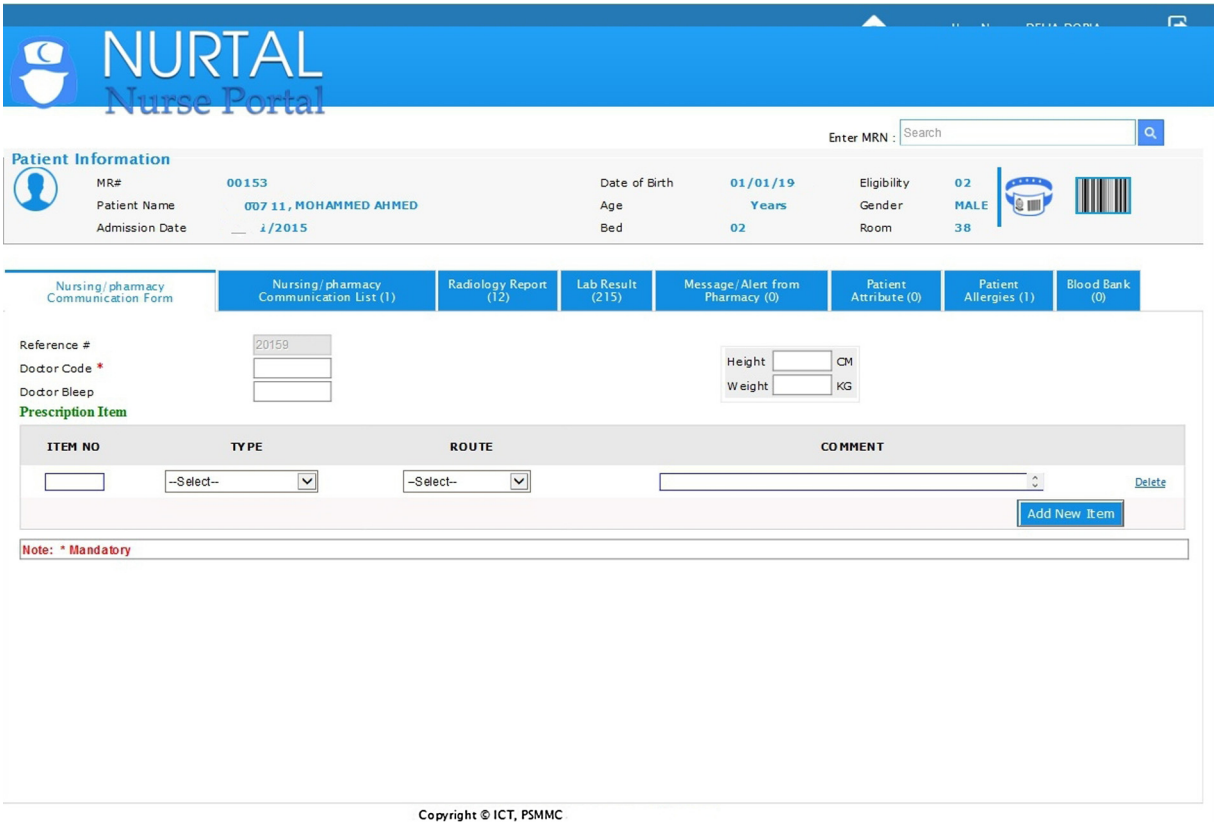


Figure 7 Nursing pharmacy communication screen where the nurse selects the urgency, route and writes comments.

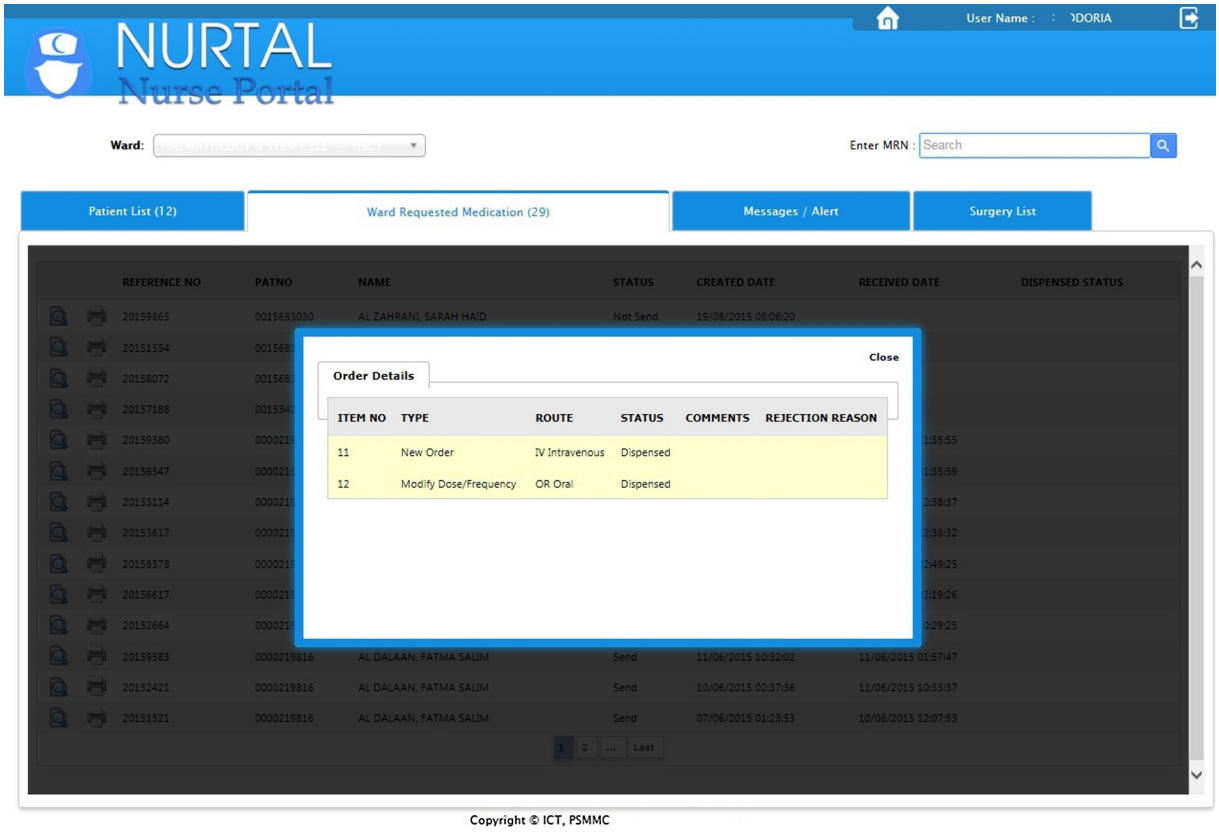


Figure 8 The pop-up screen that shows the request status.

Table 2 Analysis of telephone call duration (minutes) prior and after implementation.

Type	Number		*P* value
	Before	After	
Confirmation	40	9	>0.001
Follow-up	112	56	>0.001
IV discontinuations	1	6	0.02
Missing dose	14	19	0.2
PRN medications	13	19	0.05
Professional inquiries	21	116	>0.001
Other	79	62	0.03
(Blank)	16	13	
Grand Total	296	300	

3.5. Integrated systems

The pharmacy receives many types of prescriptions, such as STAT, as soon as possible (ASAP) and routine prescriptions. STAT prescriptions are prescriptions that are lifesaving and require immediate processing; any delay may expose the patient to a risk of death. ASAP prescriptions are prescriptions for medications that need to improve patient comfort, such as painkillers. Routine prescriptions are prescriptions that does not meet the previous definitions. The integrated system provides the platform for managed communication between the pharmacy and nurses. Fig. 5 shows the pharmacist screen lists the patient sorted according to their priority color coding, red for STAT and yellow for ASAP medications, providing the capability to track all urgent prescriptions. The system includes the patient information screen, which allows the pharmacist to access to the patient's laboratory results, attributes, allergies, drug profiles, previous discharge summaries and inpatient requests. In addition, in a dashboard the inpatient requests are listed and the image of the scanned prescription is displayed, with the capability of enlarging the scanned prescription.

The pharmacy nursing communication form has been transferred into an electronic form as shown in Fig. 6. This screen is used to send the communication from the pharmacy to the nursing station.

In the nursing interfacing screen Nurtal, Fig. 7 demonstrates the nursing/pharmacy screen the nurse can select the scanned prescription and indicate the urgency of the prescription and nurse comments. The Nurtal contains a dashboard to list all pharmacy requests. If the nurse needs to know the status of the request, the nurse can click on the request, and then a pop-up screen will show the request status, as shown in Fig. 8.

3.5.1. Post-implementation analysis

After rollout of the integrated system, the telecommunication department provided data for telephone calls from 05/10/2015 to 20/10/2015. The results revealed a significant reduction ($p > 0.001$) in the received calls from 3328 to 1796 calls. The outgoing calls decreased from 1138 to 834 calls, with a total of 2630 calls. The receiving call peak time did not change and remained between 2:30 pm and 5:00 pm. This may be explained as a result of the nursing shift change at

3:00 pm on Monday and Tuesday. The average duration of calls increased significantly ($p > 0.001$) from 00:01:12 to 00:01:43, and this may be due to the change in the more professional nature of the inquiries.

To measure the impact of the system on the types of received calls, a sample of 300 calls was analyzed according to type. The proportion of professional inquiries was increased due to the reduction of other types of calls. The total duration was 04:42:30 h as a result of the total call reduction. The proportion of confirmation calls, follow-up calls, calls to request supplies for missing doses and to inform about IV discontinuations decreased. All changes in the types of calls were significant except for the change in the calls to request supply for missing doses that was not significant with $p < 0.2$. The system reduced the necessity to call the pharmacy for regular cases. Table 2 shows the results of telephone call duration (minutes) prior and after implementation.

3.6. Continuous improvement

During implementation, the project encountered situations that needed enhancements. For example, upon patient arrival to the nurse station, the nurse prints the patient identification label, which includes a barcode, and this label is attached to the prescription. However, the Nurtal system has its own barcode. Thus, integration of the two barcode systems was a solution requirement. There were also occasional system/connection failures, leading to not all communications being received. A further compatibility problem was the Zero client computers used in many hospital locations, which are not compatible with the Zebra printers needed. Finally, the system response may be slowed because of congestion in the hospital network infrastructure, and the prolonged technical response time may compromise patient care. To solve these issues, the task group meets weekly to direct improvements.

At the moment, the system tracks only the profiling activity and does not track the dispensing of medications. The task force plans to establish a checkpoint in the pharmacy to scan all medications when they leave the pharmacy.

Further work to integrate the system with all hospital IT systems is underway to achieve full integration by 2017. Moreover, determining the satisfaction and opinion of users for enhancements will be performed periodically.

4. Conclusions

In this study, issues of safety in the pharmacy were highlighted because medication safety is a major concern. The link between medication errors and different types of interruptions was studied; however, there were no general agreements about the extent of their association. Telephone interruptions during medication handling are considered a significant factor causing medication error, as well increasing workload and TAT. On a regular basis, the inpatient pharmacy receives a large number of telephone call inquiries about the status of prescriptions. Processing high prescription volumes in an atmosphere where interruptions are the norm can lead to medication errors. The developed communication software (Pharmatal/Nurtal) may represent a possible solution to enhance communication among the pharmacy, nursing and other healthcare professionals. Healthcare professionals can augment their working processes by utilizing technology to decrease and prevent medication errors. Indeed, the implementation of Pharmatal/Nurtal, which can send prescriptions, provide an online status of prescription progress and activate communication between the pharmacy and nursing staff, was successful. The system was tested in one ward before being rolled out to the rest of the hospital. By implementing Pharmatal/Nurtal, the number of telephone calls was reduced and the types of calls shifted to more professional inquiries.

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