Evaluation of Medication Turnaround Time Following Implementation of Scanning Digital Prescriber Order Technology

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This report has been written by me and has not received any previous academic credit at this or any other institution.

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Executive Summary

This internship project is a retrospective summative evaluation to assess medication turnaround time (the time between medication order composition to the time the medication is delivered to the nursing unit) before and after implementation of digital scanning prescriber order technology for all medications and antibiotics only in three Capital Health sites.

The data in this evaluation study obtained from Pharmacy Information System (Centricity® Pharmacy) and screened for initial inclusion criteria and then audited for physician composition time, nurse scan or fax time and patient medication administration time. These times were collected from Horizon Patient Folder (HPF) digital record and Centricity® Pharmacy System. Two turnaround times were analyzed: total turnaround time (time from order composition to patient administration time) Phase 1 turnaround time (time from order composition to pharmacy verification). Medications were categorized to three groups: all medications, antibiotics and non-antibiotics. Lack of composition time was the main reason for exclusion. Included orders were analyzed first for median values (inter-quartile range) and again using Mann-Whitney U test for significant difference between turnaround time before and after implementation of the prescriber order scanning technology.

The study results showed a significant reduction in total turnaround time by 9% (P=0.04) and Phase 1 turnaround time by 21% (P=0.03) for all medications.

Implementation of innovative technology, such as digital scanning prescriber technology, achieved an improvement in medication turnaround time. This improvement may be associated with increase in patient safety, quality of care and reduced costs.

Based on the evaluation study findings, the main health informatics proposed recommendations are:

- Establishing a policy for defining and standardizing medication turnaround times and time for first dose antibiotics.
- Emphasizing the importance of proper documentation of composition time by the physicians and fax/scan time by the nurses through education and policy enforcement.
- Designating a space for documenting the composition time by the prescribers in forms related to medication prescribing such as medication reconciliation forms and pre-printed medication orders.
- Future implementation of technologies such as Computerized Prescriber Order Entry (CPOE) to reduce medication turnaround time and improve patient safety.

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1 Introduction

Evaluation of a Health Information System is an essential component in the information system life cycle. It will assess whether the objectives behind installing this system are accomplished or not.

Medication turnaround time can be defined as the time between when a medication order is composed, either written or electronically recorded, and the time the medication is delivered to the nursing unit. Reducing medication turnaround time can improve efficiency, patient safety and quality of care (Neville & Nodwell, 2012).

The objectives of this internship project are: (a) to assess and evaluate implementation of an innovative scanning digital physician order technology, which is called Order Connect®, in order to determine its effect on improving medication turnaround time; and (b) to evaluate improvement in medication turnaround time for first dose of antibiotics.

The findings of this project will help to determine the medication turnaround times for the Capital Health sites and will be used to establish a policy for defining and standardizing the medication turnaround times. Furthermore, they will show the impact of implementing new technologies on patient safety and will support the future implementation of computerized physician order entry and electronic health record.

The strong knowledge gained from the basics and theory learned and implemented practically along with the author's previous working experience in pharmacy had a great contribution for the success of this internship project and accomplishment of a satisfactory results.

2 Description of the Organization

Capital District Health Authority (Capital Health) provides health services to almost half a million residents of Nova Scotia with an average spending of $2 million per day. Capital Health also provides specialized tertiary care to the rest of Atlantic Canada. Capital Health is composed of nine hospitals distributed across the Province of Nova Scotia. These hospitals are: QEII Health Science Centre, Cobequid Community Health Center, Dartmouth General Hospital, East Coast Forensic Hospital, Eastern Shore Memorial Hospital, Hants Community Hospital, Masquodoboit Valley Memorial Hospital, the Nova Scotia Hospital, and Twin Oaks Memorial Hospital (Capital Health, 2012).

Capital Health provides an excellent environment for education and research through partnership with universities and other health care organizations such as IWK Health Center (Capital Health, 2012).

The Pharmacy Department at Capital Health provides high quality care for patients. This includes medication dispensing, unit dose service, intravenous admixture, clinical services, training, research and education. Pharmacy has its own electronic information system which is called Centricity® Pharmacy designed by General Electric Company. Centricity® is mainly used

by Pharmacy staff. It contains all medication-related information for patients receiving inpatient health care at Capital Health (Pharmacy Department, 2012).

3   Internship work performed

3.1   Job description

The internship project was performed at Victoria General site of Capital Health. The author's job title was "pharmacy intern" under clinical pharmacy. The main responsibilities were: helping in defining and understanding the scope and objectives of the project, preparing brief updates of the project progress for meetings with the supervisors, collecting the data through auditing, sending the audited orders for a second reviewer on a regular basis, analyzing the data and interpreting results.

3.2   Scanning Digital Physician Order Technology Evaluation Study

3.2.1   Literature review

Medication turnaround time can be defined according to the literature as time when the medication was ordered by the physician or health care provider to the medication delivery to patient (Jensen, 2006; Wietholter, Sitterson, & Allison, 2009). There is a direct association between reducing medication turnaround time and patient safety. The quicker the medication delivery process is; the better patient outcome will be accomplished. This will also be reflected on the quality of care and reduction of cost (Naylor et al., 2011). With the emerging of information technologies in health care field, many health care organizations raced to adopt different kind of technologies to improve the workflow and health care processes; such as e-Prescribing, Digital Scanning and Computerized Physician Order Entry (Cunningham, Geller, & Clarke, 2008). With departments such as pharmacy that have a heavy workload to supply medications to all other areas within health care organization; the use of technologies and automation of routine preparations will have tremendous impact on patient outcomes by re-allocating pharmacists to patient-centered care. Furthermore, this will reduce human related errors and improve the efficiency and productivity particularly in times of staff shortage (Sikri et al., 2006).

Evaluation of health information systems (HIS) is an essential part to be done before and after implementation to ensure that the information system is meeting the objectives of its use. The process of evaluation can be defined as "the act of measuring or exploring properties of a health information system (in planning, development, implementation, or operation), the result of which informs a decision to be made concerning that system in a specific context" (Ammenwerth, et al., 2004, p. 480).

 Evaluation in healthcare is a complex process since it has to answer questions related to safety and effectiveness as well as efficiency from different perspectives: clinical, administrative and decision making (Friedman & Wyatt, 2006).

Health information system evaluation process starts with an evaluation question that will be the basic for defining the scope of evaluation and the determining the objectives of the stakeholder. Depending on the stage of HIS in the system life cycle, either summative or formative evaluation can be applied. Summative evaluation is used when the system is installed and working in the environment while formative evaluation is used when the system is at the early stage of development and not installed for formal operation yet (Yusof et al., 2008).

There are various evaluation frameworks in the literature that address multiple aspects of HIS, including technical, organizational and clinical. The direction now is not to focus only on technical dimension in evaluation but more of how the information system is integrated into the clinical workflow and its impact on patient outcomes and quality of care. Therefore, generic framework is preferred to be used for identifying the evaluation dimension than specific ones depending on the objectives to be achieved because it is comprehensive to cover all dimensions. (Lau, Hagens, & Muttitt, 2007; Yusof et al., 2008).

There are two approaches for evaluation: objectivist and subjectivist approaches. The decision to use either approach depends on the evaluation questions and objectives. The objectivist approach deals with objective assessment of data and variables with numerical outcomes; a good example is the randomized controlled trials. The subjectivist approach deals with user and expert opinions regarding a system with emphasis on the verbal description as a basis to analyze and evaluate the information system from various prospective. (Yusof et al., 2008). Evaluation methods can be either quantitative, qualitative or mixed of both based on the measurements and how comprehensive the evaluation intended to be.

3.2.2 Method and design

This evaluation study examines medication orders collected for inpatients admitted to three Capital Health sites: Dartmouth General (DGH), Halifax Infirmary (HI) (including Veterans Memorial Building and Abbie Lane), and Victoria General (VG). A retrospective objectivist-approach evaluation was performed for comparing medication turnaround time before and after implementation of a Scanning Digital Physician Order Technology (SDPOT) which is called Centricity® Pharmacy fax connects system.

Before the installation of SDPOT, hand written physician orders used to be sent to the Pharmacy by nurses through fax machine as well as through porters that carried the physician orders copies to the Pharmacy at scheduled times. The orders received, by fax or porter, were sorted based on priority and entered into the Pharmacy Information System (Centricity® Pharmacy) by pharmacists. After that, medications were prepared and delivered to the ward via porter service on an hourly basis. Due to limitations associated with paper-based physician orders such as poor quality fax image, illegible orders that resulted in phone calls to nursing units, possible medication errors and delays in medication deliveries. The SDPOT was implemented in June 2011 in Capital Health sites. The goals of SDPOT (Neville & Nodwell, 2012) were:

- Eliminate problems associated with paper-based system. This will decrease medication turnaround time, decrease transcription errors and eliminate lost orders due to lost paper.
- Eliminate medication order pickup by the porter service.

- Attach the electronic fax file to specific Centricity Pharmacy orders for later review/audit inquiries.
- Improve the legibility of written orders on paper by utilizing the magnification feature on electronic fax orders.
- Facilitate the decentralization of pharmacists with the ability of pharmacists to review fax order queues at any computer.

With this technology, physician orders are received by pharmacy once the nurse faxes the order. Once received, it appears on the computer screen in a fax order queue; order status such as "stat" will be shown next to the scanned order; orders are verified, entered in Centricity® Pharmacy and processed by a pharmacist. Each work station has two computer screens to facilitate order entry. For each medication entered in Centricity, the relevant scanned order image is attached and can be viewed along with the comment notes written by the pharmacist. Diagram (1) and (2)-Appendix A shows Pharmacy work flow before and after SDPOT implementation.

Orders included in the study were:

- Physician orders composed in the time between June 6-10, 2011 for pre implementation phase (period 1) and September 26-30, 2011 for post implementation phase (period 2). The period 2 was chosen to be three months after implementation to ensure the technology was operating smoothly and users were familiar with it.

- Orders for patients admitted to one of the included sites and discharged by the time of auditing so the electronic chart would be available for review.

- Orders composed by an authorized prescriber and verified by Pharmacy and administered to patients in the same day.

- Orders for new medications, an increase in dosage or frequency, or a route of administration change.

- Medication orders signed by an authorized prescriber with a date and time.

- For medication order sets, the first medication will be included.

Orders not eligible for the study were:

- Orders composed during weekends or when the Pharmacy is closed.

- As needed medication orders (PRN)

- Self administered medication orders (SELF)

- Orders for patient's own medication (POM)

- Emergency department or pre-admission orders

- Total Parenteral Nutrition (TPN) or chemotherapy orders.

Weekend orders were not included due to reduced number of staff available which could affect turnaround time. Orders verified during the first morning hours of Pharmacy operation were excluded as well since morning hours are primarily devoted for entering orders written overnight while the pharmacy is closed.

3.2.3 Data Collection and Statistical analysis

Data were obtained from the Centricity® Pharmacy Information System and Horizon Patient Folder™ (HPF), Capital Health's digital health record.

Reports for all orders processed by the pharmacy during the previously mentioned periods, June and September 2011, were exported from the Pharmacy Information System with the order processing time.

The exported orders were screened for initial inclusion criteria: new orders versus refills, outpatient orders, negative or zero quantities, locations outside the selected hospitals, chemotherapy, as needed "PRN" orders, orders with directions or patient administered orders, and outside pre-determined Pharmacy hours of operation. These initially screened orders were then sorted alphabetically. Orders were then screened by reviewing each order in the digital health record and digital attached fax (for period 2) for additional inclusion criteria. These were prescriber composition time, medication order sets, and orders clarified by a pharmacist.

Orders were screened by patient name in alphabetical order until the desired sample size was met. Data collected were the prescriber order composition time, the nurse scan or fax order time, the nurse's transcription time (if the order composition time was unavailable), and patient medication administration time.

The included audited orders were grouped into three categories in order to examine the turnaround time for the first dose of antibiotics separately. The three categories are:

- All medications: includes non-antibiotics and antibiotics

- Antibiotics

- Non-antibiotics

Orders where the patient administration time occurred before pharmacy verification time were removed from the analysis of total turnaround time.

Analysis of turnaround time included two phases:

- Total turnaround time, which is the time from order composition to patient medication administration time.

- Phase 1 turnaround time, which is time from order composition to pharmacy verification.

All data was entered in an Excel spreadsheet and analyzed using SPSS.

A sample size calculation (Brant, 2012) indicated that a total of 296 orders would be needed in each group with a two-tailed α of <0.05 and 90% power. We estimated the turn-around time from order composition to pharmacy verification before implementation to be 4 hours and the new technology decreased the time by 25% to 3 hours with a standard deviation of 225 minutes. (Wietholter, Sitterson, & Allison, 2009)

The number of orders to be audited was distributed among the three sites according to the number of patient days for each hospital. See Table 1. Other factors like Pharmacy staffing and hours of operation were considered as well.

Table 1: Number of Orders Required Based on Patient Days.

Site	Patient-days in 2010-2011	Number of orders audited per period	Total number of orders audited
Dartmouth General	49,625 (20%)	60	120
Halifax Infirmary	132,586 (52%)	156	312
Victoria General	69,898 (28%)	84	168
Total	252,109 (100%)	300	600

The data were not normally distributed so medians and inter-quartile ranges (IQR) were calculated. Differences in medians from Period 1 and Period 2 were analyzed using the Mann-Whitney test for Phase 1 and total turnaround time for all medications, antibiotics only and for all non-antibiotics.

3.2.4 Results

After excluding orders that did not meet the initial inclusion criteria, there were 5491 orders available in Period 1 and 4300 orders available in Period 2 that could be screened for a prescriber's order composition time. In Period 1, 2766 orders were screened to obtain a total of 356 included orders while in Period 2, 1702 orders were screened to obtain 304 orders. Table 2 shows the number of orders initially screened.

Table 2: the Number of Orders Screened for each Site.

Initial screened orders for auditing				
Site	Period 1		Period 2	
	Screened	Eligible	Screened	Eligible
DGH	518	52	284	60
HI	1563	214	866	159
VG	685	88	552	85
Total	2766	356	1702	304

DGH= Dartmouth General Hospital; HI= Halifax Infirmary; VG= Victoria General

We were unable to obtain the pre-specified number of orders for the DGH site in period 1 due to the lack of a prescriber composition time.

The main reasons for exclusion during the screening process were:

- Absence of order composition time (36% in Period 1 and 75% in Period 2)
- Missing orders in period 1 (29%) mainly because the orders were not found in the physician order section but in the medication reconciliation section in the HPF. This exclusion became almost zero in Period 2 because data collection methods changed and all orders were attached to the faxed orders.
- Orders that were part of medication order sets (14% in Period 1 and 2).
- Other infrequent excluded reasons included: orders clarified by a pharmacist, orders written after pharmacy hours, absence of digital patient record, and decrease in dosage or frequency.

The median (IQR) total turn-around time in period 1 for all medications was 5 hours and 29 minutes (0.29, 10.29) and reduced to 4 hours and 59 minutes (0.28, 8.9) in period 2; this was a significant reduction of 9% (p= 0.04). Table 3 summarizes the results for each site. Table 4 shows the reduction of turnaround times for each medication category for all sites.

The median for phase I turn-around time, which is order composition to pharmacy verification, for all medications was 2 hours and 13 minutes (0.28, 4.54) in period 1 and reduced to 1 hour and 45 minutes (1.56, 4.46) in period 2. The turnaround time decreased significantly by 21% (p= 0.03). See tables 3 and 4

The total turn-around time and phase 1 turn-around time were also estimated for medication group independently for comparison. It was found that total turn-around time for non-antibiotics

was reduced from a median of 5 hours and 42 minutes (0.41, 10.43) to 4 hours and 59 minutes (0.09, 9.09) in the second period. This also was a significant reduction of 13% (p=0.03). However, phase I turn-around time for the same medication group decreased from 2 hours and 16 minutes (0.39,4.71) to 1 hour and 57 minutes (1.61, 4.75). This 14% reduction which was not significant, (p=0.19). See tables 3 and 4

The antibiotic group total turn-around time slightly decreased from 4 hours and 45 minutes (0.13, 9.03) to 4 hours and 37 minutes (1.1, 7.64) (p= 0.69). Phase 1 turn-around time for the same group was reduced from 1 hour and 49 minutes (0.57, 3.55) to 1 hour and 23 minutes (0.25, 2.71). This 24% decrease in time was not significant (p=0.07). See tables 3 and 4

Table 3: Turnaround Times -in hours- for each Medication Type

Medication Type	Phase 1*			Total turn-around time**		
	Period 1	Period 2	P-value	Period 1	Period 2	P-value
Total	2:13 (0.28 ,4.54)	1:45 (1.56, 4.46)	0.036	5:29 (0.29, 10.29)	4:59 (0.28, 8.9)	0.04
DGH	1:34	3:08	-	8:07	4:05	-
HI	2:35	1:47	-	5:05	5:20	-
VG	1:49	1:09	-	5:30	4:45	-
Antibiotics	1:49 (0.57,3.55)	1:23 (0.25, 2.71)	0.07	4:45 (0.13, 9.03)	4:37 (1.1, 7.64)	0.694
Non-antibiotics	2:16 (0.39,4.71)	1:57 (1.61,4.75)	0.198	5:42 (0.41, 10.43)	4:59 (0.09, 9.09)	0.034

*Phase 1: time from order composition to pharmacy verification

**Total turnaround time: time from order composition to patient administration

Table (4): Reduction in Turnaround Times for each Medication Category

Type	Phase 1 turnaround time		Total turnaround time	
	% time reduction	P-value	% time reduction	P-value
All medication	21%	0.03	9%	0.04
Antibiotics	24%	0.07	3%	0.69
Non-antibiotics	14%	0.19	13%	0.03

3.3 Discussion

This study evaluated the medication turnaround time before and after implementation of SDPOT. A significant reduction of turnaround time was achieved for all medications and for non-antibiotics occurred. Before the installation of Scanning Technology, nurses had to fax the orders or send paper copies via porters to the Pharmacy where pharmacists had to sort orders to separate "stat" orders from regular ones. The major delaying factors for medication delivery were the porter service (delivery of orders from nursing unit to pharmacy) and nurses not pulling orders from the patient chart to send to pharmacy as soon as the order was composed. Furthermore, poor fax images threaten patient safety by increasing the risk for medication errors. Based on the data collected and analyzed in this study, the median turnaround time was reduced by 30 minutes. This reduction should have a direct effect on patient safety and quality of care through quickly identifying "stat" orders that need to be given a priority over other orders in the fax/scan queue by pharmacists. In addition, the ability to receive orders on time with digital image would prevent delays due to porter delivery and reduce the risk for medication errors because of poor fax quality image. Antibiotic turn-around time did not significantly change, although this is likely due to the small sample size.

By analyzing the total turn-around time for all medications of each site, we found that the HI site's Phase 1 turn-around time decreased by 38 minutes but the total turn-around time increased by 15 minutes. It is unknown which process was longer in Period 2 versus Period 1, for example: the time to dispense medications in pharmacy, the time to deliver the medications to the nursing unit, or administration to the patient. Medication dispensing is affected by staffing, number of medications to process, and the number of medications stocked by the nursing unit (and therefore is not dispensed). Delivery times are also affected by porter service levels. To our knowledge, these two intervals did not change from one period to the next. Patient administration times are dependent on the physician order, the frequency of administration, and whether the patient is receiving a stat dose or can wait for the next standard administration time. For example, warfarin doses are given at 1700, regardless of when the order was composed or when the dose was delivered from pharmacy. An exception would be if the dose was not available at 1700, the nurse would administer it as soon as received from pharmacy. The other scenario observed was if the medication was wardstock, in this case the nurse was able to administer the dose on time despite pharmacy sending the dose at a later hour.

Another factor that is administering the first dose in the next day, usually first morning doses of chronic diseases medication as Aspirin, was more common in period 1 than period 2. The documented time on the next day was not included in the turn-around time calculations since it was not given on the same day of order composition. These previously mentioned factors would be a major contribution in increasing the total turn-around time for HI site.

One of the major exclusion reasons for orders was absence of order composition time. A significant finding was that orders on preprinted physician's orders (PPOs) and medication reconciliation forms were almost exclusively not timed because there is not a blank space to record this data. These forms are extensively utilized at all sites and resulted in many excluded orders. Another major reason for exclusion in most sites was absence of medication orders. This category included all orders that were written in pages missing in electronic patient record

from HPF, and orders were referred to medication reconciliation form since this form was not included in the Physician order section of the digital record.

The study has some limitations. First, the time documented on the scanned fax image was not accurate due to technical issues related to inaccurate clock times of the digital fax machine. This waived the ability to compare turnaround time from scanning to the fax queue and when the pharmacy verified the order and decreases our ability to compare our turnaround time with other published literature. Second, review of scanned fax image in Pharmacy Information System (Centricity®) and the orders and medication administration records in the digital chart was not a completely clear image and may be open to interpretation. We minimized this issue by having a second auditor to review the recorded time for all the included orders. The third limitation was the time challenge to audit all the initially screened orders; the system downtime, when HPF is not available or accessible, or orders missing from HPF could be factors for delaying the data collection process as well. Finally, absence of previous studies done in-house that address measurement of turnaround time, and unavailability of clear turnaround time policy could be a limitation because there is no benchmarking to rely on for comparing results and overcome challenges faced in study design, such as sample size determination.

3.4 Activities performed

The author's main role in this evaluation project was to actively participate in all project meetings with the work supervisor and the project leader, perform the data collection from HPF and Centricity, report any issues or challenges to the stakeholders, and conduct the statistical analysis and interpretation of results. The author also shared in preparing the final project report that will be presented to the Pharmacy Department decision makers.

During this internship experience, the author had the opportunity to participate in academic activities such as being a co-author and presenter of a project poster that will be presented at the Advanced Health Informatics Conference 2012, Toronto, Ontario. Also, the project poster will be presented at the Graduate Research Day at Dalhousie University that will take place in May 2012.

At the data analysis stage, the author attended an introductory SPSS workshop organized by Integrated Health Research Trainee Partnership (IHRTP) and IWK Interdisciplinary Research Team (IDR). This workshop was a great opportunity to learn about new statistical software that was available at the Pharmacy Department. This helped the author to efficiently perform the analysis step of the project.

The author was invited to attend the Pharmacy Managers' Operations meeting to present the results of the study and to obtain the Department's decision makers' feedback. A discussion regarding the importance of medication turnaround time estimation took place at the meeting and recommendations were requested based on the results and findings of the study. At a later date, the author will participate in the Pharmacy's educational rounds as a speaker to present the project to other Pharmacy staff.

4 Relation of work with Health Informatics

Evaluation of Health Information Systems has been an integral part of the Health Informatics field for two main reasons: first, to ensure that these systems are fulfilling their objectives of installation and second, to identify the gaps in the systems and improve their functionalities on a continuous basis. In this project, the author and the project team at Capital Health conducted an evaluation of Scanning Digital Physician Order Technology six months after its installation in order to ensure fulfillment of its objective to reduce turn-around time and improve patient safety.

This evaluation project has a strong relationship with the Health Informatics field because it involved a direct application of a blend of knowledge and skills gained during the program's courses. For instance, the project planning, defining the scope, identifying possible risks and project time line were applied based on skills from Project Management course (HINF 6300). The study methodology and design was based on knowledge obtained from Research Methods course (HINF 6020) and an elective course, Methods in Clinical Trials (CH&E 6024). Furthermore, the course on Statistics for Health Informatics (HINF 6030) greatly supported the author in the process of data collection and statistical analysis of the data along with interpretation of results. Two courses were essential in defining the principles of evaluation studies and providing practical guidelines for each evaluation step, which are Health Information Systems and Issues (HINF 6110) and an elective course, Health Program Planning and Evaluation (NURS 5893). Finally, Health Information Flow and Use (HINF 6101), and Health Information Flow and Standards (HINF 6102) helped the author in critically analyzing the system being evaluated from various aspects along with the workflow and information sharing in order to identify the possible gaps and propose an effective solution.

An extensive literature review performed on evaluation of Health Information Systems helped the author establish concrete basics for formation of evaluation research question, define various phases of evaluation study and plan a successful execution of the evaluation study.

5 Problem identification and proposed solution

5.1 Description of the problem

Even though the evaluation's results showed an improvement in medication turn-around time, there is still a need for further improvement to achieve better patient care. SDPOT did overcome various challenges and reduce staff frustration during peak hours; however, some drawbacks were identified. Health Informatics can provide solutions to overcome these problems.

The following gaps were identified in the Pharmacy Information System (Centricity®) and SDPOT (Order Connect®) upon observing the Pharmacy workflow and feedback from pharmacists at inpatient dispensary unit:

- Absence of sending confirmation message to the nurse upon faxing/scanning the physician order to the Pharmacy. This might lead to multiple faxing of the same order and therefore, could contribute to possible errors in order verification.

- Manual refresh of the fax queue screen by the pharmacist could be a minimal delaying factor in processing the orders and contributes to inconsistency in following queue orders as the pharmacist may be performing multiple tasks away from the computer station.

- Modification of orders removed from the fax queue after being processed could be a challenge and time-consuming for pharmacists. This step requires that pharmacists print the order and fax it again to the pharmacy, so the order would appear in the fax queue for re-processing or modification.

- Lack of regular update in Centricity® of medication names and multiple strengths list that is available in the pharmacy. This could delay the verification of orders particularly for pharmacists who are unfamiliar with available medications in the dispensary. Extra steps will be required to check availability with pharmacy technicians, including modifying the order and re-printing of the medication label.

5.2 Recommended solution

Based on the previously mentioned gaps and the evaluation study findings regarding the medication turnaround time, Health Informatics proposed solutions are:

In the short term, upgrading of Pharmacy Information System (Centricity®) and SDPOT (Order Connect) can include adjusting or adding functionalities such as:

- Sending a brief conformation message or alert to the nurse once the fax has been sent and the order has been placed in the pharmacy fax queue.

- Automatic refresh of the fax queue over specific time intervals so the pharmacist can be updated continuously with number of orders left and new incoming orders while performing other tasks. The "stat" orders can be flagged to distinguish these orders from regular ones and attract the attention of the pharmacist.

- Adding features in Centricity which allows the pharmacist to modify orders after they are removed from the fax queue, or providing flexibility to adding an order back to the fax queue after it is removed. This would increase the work efficiency and reduce frustration of staff during busy working hours.

- Continuously updating the medication names and strengths in Centricity® with what is available in the dispensary through linking or synchronizing the order verification module of Centricity® with the stock management module.

In the long term, installation of Computerized Prescriber Order Entry (CPOE) is recommended health informatics solution for the department. CPOE was proven to reduce the medication turn-around time by nearly 90% (Wietholter, Sitterson, & Allison, 2009) for all medications and approximately 60% for the first dose of antibiotics (Cunningham, Geller, & Clarke, 2008). This technology will also have a great impact on order processing time by the pharmacist; will improve patient safety by eliminating hand-written orders, and will save costs (Wess, et al., 2007).

By installing the CPOE, orders will be directly placed in the system by prescribers and will be sent to the Pharmacy within fractions of seconds. The workload and workflow for both Nursing and Pharmacy will be improved. Errors due to unclear hand writing or fax images will be greatly reduced because medications will be typed with all necessary medications-related information and filled in a clear way. Communication will also improve since less time will be spent by the pharmacist clarifying the faxed order. Furthermore, CPOE will have the ability to notify the prescriber of drug interactions, allergy alerts, adverse drug events and non-formulary medications; particularly, if the CPOE is accompanied by Clinical Decision Support System (CDSS) that could recommend alternative therapies based on updated evidence-based information at the stage of medication order entry (Eslami, De Keizer, & Abu-Hanna, 2008). This will greatly reduce the risk associated with medication errors and adverse drug events that can be factors compromising patient safety (Doormaal, et al., 2009).

6 Conclusion

This internship evaluation study showed a decrease in medication turnaround time of 30 minutes with installation of SDPOT. This should improve patient safety and reduce cost. The internship experience through this project utilized the gained knowledge from theory and applied it practically to conduct this evaluation study.

7 Recommendation

The installation of SDPOT has proven to reduce the medication turnaround time in this study. However, some drawbacks were identified during conducting the evaluation study. The following are some proposed recommendations based on the finding of the study:

- Establishing of a policy for defining and standardizing medication turnaround times.
- Improving documentation by emphasizing the importance of documenting composition time and encouraging the nursing staff to write the fax/scan time on physician order form.
- Allocating a designated space for time documentation on the pre-printed orders that are related to medication prescribing such as medication reconciliation forms.
- Considering the future implementation of Computerized Physician Order Entry (CPOE) since it has proven to reduce medication turnaround time to a great extent.

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Appendix A

Diagram (1): Pharmacy workflow before implementation of Scanning Digital Prescriber Order Technology
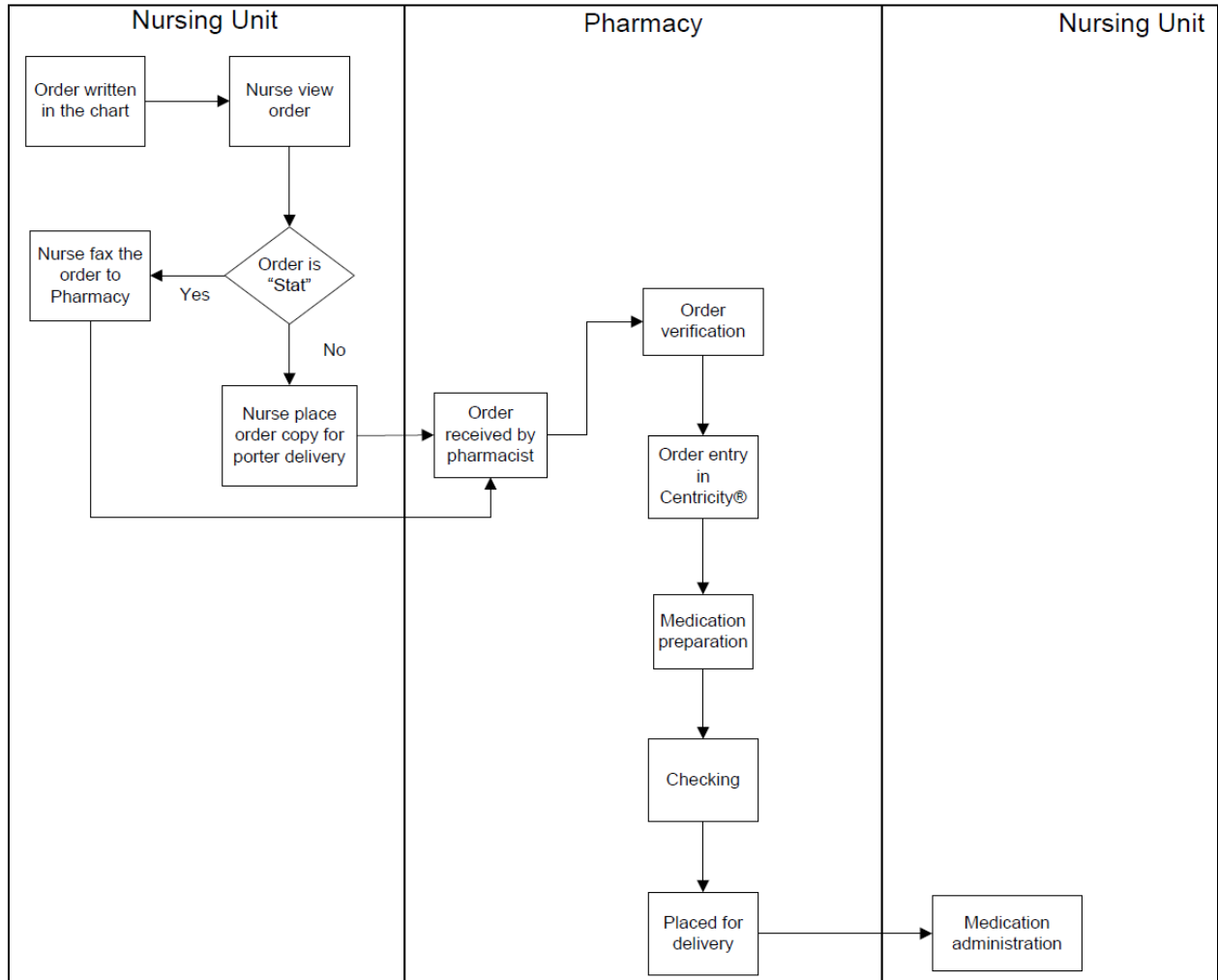
Diagram (2): Pharmacy workflow after implementation of Scanning Digital Prescriber Order Technology