I. REPORT CHECKLIST

The following checklist must be completed and submitted with the project report. By checking an item, *the student and advisor(s) agree that the work has been done appropriately*.

_____1. If the research report will be or has been submitted for publication in a journal, provide the name of the journal here: _____

_____2. Project title is concise and clear; lists advisers, course no. & date submitted

_____3. Abstract is no more than 250 words and retains headings

_____4. Introduction provides a definition of the topic under study, the importance of the topic, and the issue addressed by the study and is no more than two (2) pages.

_____5. There is NO literature review section

_____6. Purpose(s) of project is clearly and concisely stated

_____7. Methods section uses headings and represents a summary of the methods used. (Actual methods used should be described if they were modified from the proposal.)

_____8. Data analysis described is appropriate and responds to the purpose.

_____9. Appropriate tables are included in the results section.

_____10. Text of results section interprets the findings reported in the tables, not repeating them.

_____11. The discussion section includes a description of the most important findings, and relates findings to the literature.

_____12. The final section of the discussion is the limitations section.

_____13. The conclusions respond to the purpose statement.

_____14. Reference list uses style from DI class (PhPr 861c) or is specific to journal.

_____15. Data collection/recording form(s) and/or questionnaire(s)are included in the appendix.

_____16. Information is placed in the appropriate section—introduction, methods, results, etc.

_____17. Report does not exceed 15 pages excluding tables & figures & appendices.

Date report submitted: _____Student: _____

Student (2): _____ ___ Student (3): _____
(List for group projects only (List for group projects only)

TITLE PAGE

Title of project:

Implementation of an Electronic Prescription System and its Effect on Perceived Error Rates, Efficiency and Difficulty of Use

Course title: PhPr 896B: Pharmacy Practice Project

Date: March 2, 2017

Faculty advisor: Terri Warholak, PhD, RPh

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ABSTRACT

Specific Aims

To evaluate the perceptions of the pharmacy staff on prescription errors, efficiency and difficulty of use before and after implementation of a new pharmacy computer system.

Subjects: Employees of El Rio Community Health Center outpatient pharmacies located at the Congress, Northwest, and El Pueblo Clinics.

Methods

This study was of a retrospective pre-post design. A 5-question survey on error rates and workflow efficiency was distributed to pharmacists and technicians 6 months after a new computer system had been implemented. Participants of the study included employees of El Rio Community Health Center outpatient pharmacies who were employed with El Rio during the time of transition between the old and new computer systems.

Main Results

Questionnaire responses were completed by 10 (41.7%) technicians and 6 (66.7%) pharmacists at three El Rio Clinics. There was an increase in perceived efficiency between the new (Liberty) (n=17, 94.4%) and old (QS1) (n=11, 61.1%) computer systems ($p<0.05$). There were no significant differences in perceived difficulty of use, most common types of errors, error rates, and time to fix detected errors.

Conclusions

While there were no significant differences between Liberty and QS1 in perceived difficulty of use, most common types of errors, error rates, and time to correct detected errors, there was a significant difference in the perceived efficiency, which may have beneficial implications.

Implementation of an Electronic Prescription System and its Effect on Perceived Error Rates, Efficiency and Difficulty of Use

INTRODUCTION

Electronic systems have been in wide use over the last 3 decades of pharmacy practice.[1] These systems generally have the capability of inputting hard copy prescriptions into digital form and the capability to receive electronic prescriptions (e-prescriptions) directly from licensed prescriber offices. However, electronic systems vary in terms of their capabilities and functions and not all systems can evaluate performance metrics.

Understanding when and how errors occur in community practice is critical to providing optimal patient care.[1] Prior studies have shown that e-prescribing aids in improving the quality and efficiency of health care services by reducing medication errors and overall healthcare costs.[1,2,3,4] Failing to implement an efficient e-prescribing system reduces workflow efficiency, increases health care costs, and decreases patient safety. Continued research on e-prescribing may identify more specific risks and benefits. These risks and benefits may provide insights into health care provider's' decisions to adopt and use e-prescribing in their practice.

This study was conducted at 3 separate El Rio community health centers in Tucson, Arizona. El Rio is a multi-center health system that provides primary care in collaboration with interdisciplinary teams made up of nurse practitioners, physicians, pharmacists, and more. El Rio consists of 13 centers across southern Arizona which includes 7 outpatient pharmacies with over 75 pharmacy employees.

While the former El Rio electronic computer system, QS1, had e-prescribing capability, it lacked pertinent features. One feature the system lacked was the ability to identify errors until the prescription was already filled leading to increased pharmacist intervention time and technician re-entry time. QS1 required technicians to erase the instructions for patient use that had been sent (auto-populated sigs), and retype them into appropriate required format, leading to additional errors and patient wait time. Therefore, a new system was needed to alleviate these drawbacks.

On June 13th, 2017, El Rio Community Health Center underwent a complete electronic system change from the QS1 system to the Liberty system. This study evaluates the perceptions of the pharmacy staff on the

effectiveness of the new (Liberty) electronic system functions in comparison to the old (QS1), in terms of prescription errors identified by the staff, efficiency, and ease of use.

METHODS

Design: This was an analytic, retrospective and interventional study, which used pretest-posttest to compare the QS1 (old) and Liberty (new) pharmacy computer systems.

Subjects: Subjects were eligible to participate in this study if they were employed with El Rio Community Health Center (Congress, El Pueblo, or Northwest locations) during the time of transition between the old and new computer systems. Participants were excluded if they did not primarily work in the outpatient pharmacy and if they didn't have experience using both computer systems. This study was approved by the University of Arizona Human Subjects Protection Program.

Measures: Data were collected from all El Rio employees using a paper-based pre-post questionnaire. The questionnaire included 5 questions regarding the El Rio computer system and 8 demographic questions. Questions regarding the computer systems included the perceived: system efficiency; level of difficulty of system use; 3 most common errors detected; number of errors detected per day; and amount of time it takes to correct detected errors. Demographic data were collected on age, gender, ethnicity, Spanish speaking ability, years employed with El Rio, years practicing pharmacy, and the highest level of education achieved. A copy of the questionnaire is attached in the Appendix.

Data obtained from the questionnaire responses were entered into an Excel spreadsheet for analysis and paper copies were shredded. Excel files were stored on a secure server with a password to access; only the students and advisers had access to the data files.

Treatment [or Intervention]

The computer system at El Rio was the independent variable. The dependent variables were perceived error rates, efficiency and difficulty of use. The intervention implemented by El Rio Community Health Center was a change from QS1 to Liberty computer system.

Data Collection:

The questionnaires were administered to El Rio employees 6 months after implementation of the new prescription software (Liberty) from January 31st, 2017 to February 20th, 2017. The questionnaires were administered during the Pharmacy's normal business hours and were collected the following days to weeks.

Data analysis: Based on the amount of employees at the three El Rio Community Health Center outpatient pharmacies (roughly 10-12 per pharmacy), we estimated our sample size to be around 30 subjects. With 30 subjects in the study, there would be adequate power to identify perceived differences between the two computer systems to indicate whether detection of errors and difficulty of use were improved and if the staff felt the new computer system was more efficient than the old one. To compare the efficiency and difficulty of use before and after the implementation of the new prescription software, all data were analyzed in aggregate. Comparison of the questionnaire responses was done using a Wilcoxon signed rank test.

The perceived number of errors detected per day and perceived time needed to fix detected errors were analyzed by calculating summary means and standard deviations, then compared using a paired t-test. The a-priori alpha level was 0.05.

RESULTS

The demographic characteristics of the El Rio employees are shown in Table 1. There were similar percent of male (7; 38.9%) and female (8; 44.4%) employees who completed the survey. There was a higher proportion of pharmacists (6; 66.7%) than technicians (10; 41.7%) who completed the survey. The most common participant ethnicities reported were Hispanic (13; 72.2%) and Caucasian (2; 11.1%).

The comparison between El Rio's old computer system, QS1, to their new computer system, Liberty, can be found in Table 2. There was a significant difference found in the perceived efficiency between the old and new computer systems ($p < 0.05$). However, there was no difference in the perceived difficulty of use between the new and old computer systems ($p > 0.05$). Before implementation of the new computer system, the three most common errors were perceived to be of wrong sig (13; 72.2%), wrong drug (8; 44.4%), and wrong directions (8; 44.4%). After implementation of the new computer system, the three most common errors were

perceived to be of wrong sig (14; 77.8%), wrong drug (8; 44.4%), and wrong patient (8; 44.4%). Based on these findings, there were no differences found in the type of errors between the old and new computer systems (p = 0.973). There were also no perceived differences found in the number of prescription errors caught per day with the new system (7.8, SD 11.2) compared to the old system (10.4 SD 18.2, p = 0.102). There was no perceived difference found in the perceived time to correct an error with the new computer system (4.3 min, SD 8.2 min) compared to the old system (4.9 min, SD 7.4 min, P = 0.086).

DISCUSSION

The primary finding of this study is that the pharmacy staff at El Rio Community Health Center outpatient pharmacy perceived the newly implemented computer system, Liberty, to be more efficient than the old computer system, QS1. This is an important finding, as efficiency is a crucial aspect that pharmacy systems always strive to improve upon. Another potential opportunity for improvement in pharmacy systems is the level of difficulty to use the system. Unfortunately, in this study there was no difference in difficulty of use perceived by the employees between the old and the new system. While this could indicate that there was no improvement in making the system easier to use, this could actually indicate a positive finding, in that the newer system was not any more difficult to use than the old system. Usually when new computer systems are implemented, it usually takes some time and training to get accustomed to using a new system and this could lead to higher difficulty of use. However, in this study the employees did not perceive a difference in difficulty with use of the new system compared to the old. Other findings that could prove to be beneficial was that there were no differences in the perceived number of prescription errors detected and type of errors found between the new and old computer systems. As determined in a previous study by Morales, Nguyen, et al., when a new pharmacy system is implemented, there is a window of time where there may be more errors made and detected as the system requires additional time initially to correct system defects , and the pharmacy staff need time as well to get accustomed to using the new system.[5] This was not the case in this study, as the employees did not perceive there to be a difference in the number of errors detected and also in the types of errors found between the old and new systems. As far as the time to correct errors between Liberty and QS1, there again was

no perceived difference, which is another finding which could prove to be beneficial, in that the pharmacy staff do not perceive that it is taking them longer to correct errors with Liberty compared to QS1. Not requiring additional time to correct errors ties in with improvement in efficiency of the new system.

As for the types of errors perceived to occur the most, similar results have been reported in the study by Warholak and Rupp.[1] When chain pharmacies were reviewed on the frequency and type of interventions that pharmacist made on e-prescriptions, it was found that the most common reason for intervention was to supplement omitted information such as missing directions, which was similar with the findings reported for the most common type of errors found with the Liberty system, wrong sig.[1] Warholak and Rupp found the median time per intervention to be 5 minutes. Similar results were found with the Liberty system, 4.29 minutes. The findings from the questionnaires provided subjective data in regards to the time spent per intervention, therefore further assessment would need to be completed in order to determine the actual time per intervention.

The most significant limitation to this study was the relatively small sample size (n = 18). Prior to conducting the study, it was determined that 30 subjects would be needed to provide adequate power. This is mostly due to lack of sufficient time to sample subjects. However, though there was an apparent lack of subjects, the results indicated a difference in efficiency between the old and new systems. Further sampling would yield more reliable and generalizable results.

Another limitation of this study was the subjectivity of answers. Both ease and identifiability of errors may be difficult to gauge based on a variety of confounders such as system preference, system familiarity, and job title (Pharmacist, Intern, Technician). For example, technicians rated lower perceivable error rates while pharmacists rated higher perceivable error rates. To minimize this limitation, we sampled after a 6-month period from time to launch of the new Liberty computer system. This way, employees had adequate time to become familiar with the nuances of both the old and new systems and provide reliable answers. However, the results of this study may still be influenced by this innate subjectivity.

Though perceived efficiency between the old and new computer system was found to be the only

significant difference, the results of this study may still be generalizable to other outpatient pharmacies that have had a recent computer system change.

CONCLUSIONS

While there were no perceived differences between Liberty and QS1 in difficulty of use, number of errors detected per day, types of errors, and time to correct errors, there was a perceived improvement in efficiency, which could prove to beneficial. While these findings do not indicate much difference between the new and old systems, this could be a benefit as no added difficulty in use, no added time to correct errors, and no increase in error rates occurred, with the implementation of new pharmacy computer system, whereas normally this is not the case.

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3) Zadeh P, Tremblay M. A review of the literature and proposed classification on e-prescribing: Functions, assimilation stages, benefits, concerns, and risks. Res Social Adm Pharm. 2016; 12:1-19
4) Koivunen M, Konitio R. Occupational stress and implementation of information technology among nurses working on acute psychiatric wards. Perspect Psychiatr Care. 2013; 49:41-49
5) Morales AE, Nguyen L, Ruddy TJ, Velasquez RN. The Effect of Auto-populated SIGs in Pharmacy Practice. Quality Improvement Project and Poster Presentation at the College of Pharmacy. Facilitators: Dr. Terri Warholak and Dr. Joshua Carzoli. Tucson, AZ.

Table 1. Demographic Information

Gender	Number of participants (n), percent (%)
Male Female Did not answer	7 (38.9) 8 (44.4) 3 (16.7)
Average Age in years	Years, Standard Deviation (SD)
Years	36.4 (11.7)
Job Title at El Rio	N (%)
Pharmacy Technician Pharmacy Intern Pharmacist Did not respond	10 (55.6) 0 (0) 6 (33.3) 2 (11.1)
Number of years employed with El Rio	N (%)
1 to 5 years 6 to 10 years 11 to 15 years 16 to 20 years >20 years Did not respond	8 (44.4) 2 (11.1) 5 (27.8) 1 (5.6) 0 (0) 2 (11.1)
Years practicing pharmacy	N (%)
1 to 5 years 6 to 10 years 11 to 15 years 16 to 20 years >20 years Did not respond	5 (27.8) 2 (11.1) 2 (11.1) 5 (27.8) 2 (11.1) 2 (11.1)
Ethnicity	N (%)
African American Asian/Pacific Islander Caucasian Hispanic Other Did not answer	0 (0) 0 (0) 2 (11.1) 13 (72.2) 0 (0) 3 (16.7)
Able to speak Spanish	N (%)
Yes No Did not respond	14 (77.8) 2 (11.1) 2 (11.1)

Highest Level of Education Completed	N (%)
High school diploma or GED equivalent	2 (11.1)
Associated Degree (including CPT certification)	6 (33.3)
Baccalaureate Degree (Including B.S. Pharm)	4 (22.2)
Masters	0 (0)
Doctorate Degree (PhD) or Professional Degree (i.e., PharmD)	3 (16.6)
Did not respond	3 (16.7)

SD: Standard deviation; GED: General Education Development ; CPT: Certified Pharmacist Technician; B.S.: Baccalaureate of Science; PhD: Doctorate of Philosophy; PharmD: Doctorate of Pharmacy.

Table 2. Comparison of The New (Liberty) vs Old (QS1) computer system

	Liberty (New System)	**QS1 (Old System)**	
Efficiency of the computer system	Number of responses (n), percent (%)	n (%)	p-value
Very Inefficient Inefficient Efficient Very Efficient N/A	0 (0) 0 (0) 17 (94.4) 1 (5.6) 0 (0)	1 (5.6) 4 (22.2) 11 (61.1) 2 (11.1) 0 (0)	p < 0.05
Level of difficulty of the computer system	n (%)	n (%)	p-value
Very Easy Easy Difficult Very Difficult N/A	0 (0) 15 (83.3) 2 (11.1) 0 (0) 0 (0)	0 (0) 12 (66.7) 5 (27.8) 0 (0) 0 (0)	p > 0.05
Most common types of errors found	n (%)	n (%)	p-value
Wrong Sig Wrong number of refills Wrong patient Wrong drug Wrong dose Wrong prescriber Wrong directions	14 (77.8) 6 (33.3) 8 (44.4) 8 (44.4) 5 (27.8) 2 (11.1) 5 (27.8)	13 (72.2) 6 (33.3) 6 (33.3) 8 (44.4) 6 (33.3) 3 (16.7) 8 (44.4)	p > 0.05
Average number of errors caught per day	Number of errors (N), Standard Deviation (SD)	N, SD	p-value
Number of Errors	7.8 (11.2)	10.4 (18.2)	p=0.102
Average time to correct an error in minutes	Minutes, SD	Minutes, SD	p-value
Minutes	4.3 (8.2)	4.9 (7.4)	p = 0.086

N/A: Not available; SD: Standard deviation.

Appendices

Instructions: *Please check the response that best represents your practices NOW having converted to the new system, on the "New system" column, and then check the response that best represents your practices prior to converting to the new system on the "Old System" column.*

Questionnaire

Question	New System	Old System
1) How would you rate the efficiency of your last and current electronic prescription system?	Very inefficient Inefficient Efficient Very Efficient N/A	Very inefficient Inefficient Efficient Very Efficient N/A
2) Describe the level of difficulty to use the last and current El Rio electronic system	Very Easy Easy Difficult Very Difficult N/A	Very Easy Easy Difficult Very Difficult N/A
3) Circle the 3 most common types of errors encountered	Wrong Sig Wrong Number of refills Wrong Patient Wrong Drug Wrong Dose Wrong Prescriber Wrong Directions	Wrong Sig Wrong Number of refills Wrong Patient Wrong Drug Wrong Dose Wrong Prescriber Wrong Directions
4) How many errors on average do you think you catch per day?	_____	_____
5) How long does it take on average to correct an error? (in minutes)	_____	_____

Demographic question Instructions: Please place a check next to the option that best matches your answer for each question below. Answer the questions to the best of your ability. If you are unable to answer, you may leave the boxes blank.

1) I identify my Gender as:

- ☐ Male
- ☐ Female
- ☐ _____

2) What is your age in years?

_____

3) What is your job title?

- ☐ Pharmacy Technician
- ☐ Pharmacy Intern
- ☐ Pharmacist
- ☐ Other, Please List Below

_____

4) How many years have you been employed with El Rio?

- ☐ 1-5 years
- ☐ 6-10 years
- ☐ 11-15 years
- ☐ 16-20 years
- ☐ >20 years

5) How many years have you been practicing pharmacy?

- ☐ 1-5 years
- ☐ 6-10 years
- ☐ 11-15 years
- ☐ 16-20 years
- ☐ >20 years

6) What is your ethnicity? (select all that apply)

- ☐ African American
- ☐ Asian/Pacific Islander
- ☐ Caucasian
- ☐ Hispanic
- ☐ Other, please specify below

_____

7) Do you speak Spanish?

- ☐ Yes
- ☐ No

8) What is your highest level of education? (Select one)

- ☐ High School Diploma or GED equivalent
- ☐ Associated Degree (Including CPT certification)
- ☐ Baccalaureate Degree (Including B.S. Pharm)
- ☐ Masters
- ☐ Doctoral(PhD) or Professional Degree (ie PharmD)