THE IMPACT OF STANDARDIZED PEDIATRIC OPIOID AND ANTIBIOTIC MEDICATIONS ON MEDICATION ADJUSTMENTS AND STAFF SATISFACTION

By

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CERTIFICATE OF APPROVAL

This is to certify that the Master's thesis of

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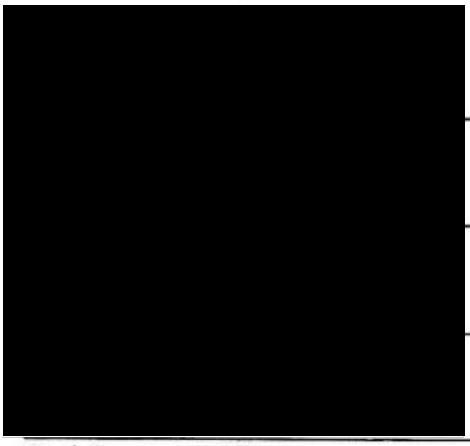
has been approved



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Abstract

Background: Pediatric patients are at risk for morbidity and mortality secondary to medication dosing errors. Unlike with adult dosing, most pediatric medications require weight-based dosing, which increases the need for dosing precision. A common problem is that there are a variety of options for prescribing and dispensing medication(s) for children which raise practice behaviors of providers regarding medication dosing to the forefront of concerns. The adverse effects of some of these prescribed medication classes in pediatrics heighten the level of concern. The two most common prescribed medications in the pediatric population include opioid derivatives and antibiotics. Inaccurate prescribing of both categories of medications can cause significant adverse outcomes including death in children. The purpose of this pre-intervention and post-intervention research study was to evaluate prescriber adherence and satisfaction with a clinical decision support tool which rounded 16 commonly prescribed medications to pre-determined standardized values in order to better facilitate prescribing and dispensing efforts by physicians and pharmacists. **Methods:** Data were collected from the electronic medical record on all pediatric patients with antibiotic and opioid orders written between October 2016 and April 2017, by using reporting tools to generate reports using a limited subset of variables within the pediatric tertiary care hospital's electronic health record (EHR). Chart extraction was done to obtain medication doses ordered, order location, and date of medication order. Our hypothesis was that standardization of medications would lead to improved staff satisfaction and a greater acceptance of standardized medications doses as outlined by the standardization tables. **Results**: A total of 75 hospital staff (38 pediatric hospitalists, 12 pharmacists, 11 pharmacy technicians, and 14 pediatric residents) were recruited for the study. Twenty-eight staff (38% of surveys distributed) completed the pre-survey and eleven staff (15%) completed the post surveys. Staff satisfaction remained similar pre and post intervention. Standardization led to an significant increase in percentage of physician accepted rates in the following medications pre and post standardization: amoxicillin 600mg/5ml (chi-squared 4.727, p=0.038) , amoxicillin-clavulanic acid 400mg/5ml (chi-squared 4.387, p=0.047), azithromycin 200mg/5ml (chi-squared 12.161, p=0.001), cefdinir 250mg/5ml (chi-squared 5.197, p=0.029), cephalexin 250mg/5ml (chi-squared 9.596, p= 0.002) , oxycodone 5mg/5ml (chi-squared 79.073, p=0.0001), morphine 2mg/ml (chi-squared 36.023, p=0.0001), fentanyl 50mcg/ml (chi-squared 142.99, p=0.0001). Review of survey respondents' comments revealed that while most pharmacists wanted to see more standardization options, physicians wanted tighter ranges and more freedom in ordering. **Conclusion:** This quality improvement project involving implementation of standardized medication doses for a subset of antibiotic and opioids revealed that a) the medication standardization process is not a detriment to staff satisfaction and b) there was an increased acceptance of standardized medication doses. However, when compared to the literature, this study had a lower staff medication acceptance rate of recommended doses likely due to less educational support provided to staff prior to Go-Live. In addition, low survey responses likely hindered the ability to determine if medication standardization had a significant impact on staff satisfaction.

1 Introduction and Background

1.1 Medication Safety and Errors in General

Medication errors in infants and children are significant risk factors for healthcare providers as they can lead to significant morbidity and mortality in this age group. In addition, medication errors can result in a financial burden for families, healthcare providers, and healthcare institutions, which are all facing increasing costs of healthcare. The unique needs of children compounded with their varying weights and various medication concentrations pose a safety and quality of care challenge for healthcare providers and institutions. To help evaluate the safety and quality of care provided for patients and/or residents, The Joint Commission created National Patient Safety Goals which focus on following principles: 1) identifying patient correctly; 2) improving the safety of using medication; 3) reducing the harm associated with clinical systems, 4) reducing the risk of healthcare associated infections; 5) preventing patients from falling; 6) preventing healthcare associated pressure ulcers; and 7) identifying patient safety risks (National Patient Safety Goals). In addition, the Institute of Medicine (IOM) proposed a safety practice of standardizing doses in the pediatric population and raised awareness of the seriousness of preventable medication errors in its 1999 *To Err is Human report* (Institute of Medicine, 1999).

1.2 A Literature Review of Medication Safety and Errors in Pediatrics

Folli (1987) published a study titled Medication Error Prevention by Clinical Pharmacists In Two Children's Hospitals which recorded the frequency of erroneous medication orders and potential harms caused at two pediatric hospitals. The overall goal of the study was to determine if pharmacists could be instrumental in preventing harm. During

a six-month period, 479 errors were detected. Most of the errors were noted to be in children aged 2 years and less. The common medications that were ordered erroneously include: antibiotics, theophylline, digoxin, fluids, chemotherapy drugs and analgesics. This study found that neonatal patients received the least amount of erroneous medication orders while patients in the pediatric intensive care unit received the most erroneous orders. The study also noted that clinicians with less experience were most likely to make errors. Additionally, the data showed that while interns made 4.46 errors for every 1000 orders, attending physicians made 1.78 errors for every 1000 orders.

A study by Kaushal et al. (2001) was one of the first studies to medication errors rates and adverse drug events in the pediatric population. The study was a prospective cohort study involving 1120 patients who were admitted to two different academic centers in April and May 1999. In their review of 10,778 medications, 616 (5.7%) medication errors were reported. The highest number of errors were reported in the neonatal intensive care units. Most of the drug errors were noted to occur during drug ordering (79%) as a result of incorrect dosing (34%).

1.3 Prevalence of Medication Errors in Pediatrics

The prevalence rate of medication errors in pediatrics was found to be as high as 1 error in every 6.4 orders (Marino, Reinhardt, Eichelberger, & Steingard, 2000). Otero, Leyton, Mariani, Ceriani-Cernadas & a patient safety committee (2008) examined the prevalence rate of medication dosing errors among neonatal and pediatric inpatients and noted it to be 11.4% (201 of 1764) and 7.3% (199 of 2732), respectively. Most medication errors in infants and children occur in the inpatient setting (Otero et al., 2008). A systematic

review by Miller, Robinson, Lubomski, Rinke & Pronovost (2007) found that up to 37% of errors in the medication use continuum were related to prescribing errors and 5 to 58% of errors were due to issues with dispensing. These authors also found that there were 100 to 400 prescriber related errors per 1000 patients.

1.4 Challenges in Pediatric Dosing

There are many factors that are thought to contribute to the challenges in pediatric dosing. From a systematic level, the pharmacokinetics and pharmacodynamics are different between pediatrics and adults. Pharmacokinetics differences between pediatrics and adults include differences in gastric emptying rate and drug absorption surface area. In fact, pharmacokinetics ultimately leads to the need for dose differences between pediatric and adult dosing (Ivanovska, Rademaker, van Dijk, & Mantel-Teeuwisse, 2014). McPhillips et al. (2005) described several factors that likely contribute to medication dosing errors in pediatrics. These factors included 1) ability to obtain and record the correct weight, 2) ability to convert the weight from pounds to kilograms, 3) ability of provider to make rapid calculations, 4) ability to order medications with correct concentration and dosage, given various concentration options, and 5) ability to divide medication into multiple dosing which is frequently prescribed in pediatrics. Therefore, it is important to minimize errors along these steps to prevent potential dosing errors which may lead to patient morbidity and/or mortality.

1.5 Ordering Properties of Opioids and Antibiotics

Antibiotics and opioids are two of the most heavily ordered classes of medications at the community hospital; therefore, these two classes of drugs were the focus of this study. This utilization pattern is consistent with findings in the literature that revealed large

utilization of antibiotics and opioids in pediatric settings. Alanazi, Tully & Lewis (2016) postulated that opioids are the most frequent class of medications associated with prescribing errors, with sedatives being the number two class. It is well known that over-dosing and under-dosing of opioids pose patient safety issues. For example, if a patient is under-dosed, they may experience undue pain, while an overdosed patient may experience respiratory and other systems compromise and ultimately death. Studies have shown that antibiotics are often sub-therapeutically dosed mostly for the following two reasons: 1) weight is ignored when calculating the dose, and 2) physicians compute ½ of the adult dose (Aseeri 2013). This practice can lead to a patient developing resistance to an antibiotic or morbidity due to inadequate treatment of an infection, as well as additional length of hospital stay.

1.6 Prevalence of Dosing Errors

Aseeri (2013) conducted a study evaluating the rate of dosing errors before and after implementation of a standardized dosing table and weight documentation. The study involved retrospective analysis of 300 antibiotic prescriptions at a tertiary hospital in Saudi Arabia with 106 pediatric beds. Pre-implementation data were collected over a two-week period from the inpatient, outpatient and emergency setting. Metrics analyzed include dosing errors, dosing intervals and whether weight was approximately documented on prescriptions. The authors defined dosing error as a dose that was below 90% the recommended minimum daily dose or orders above 110% the recommended maximum daily dose. Pre-implementation data showed that dosing errors were approximately 34.5%. The authors standardized pediatric doses for ten oral and five intravenous (IV) antibiotics and educated physicians on importance of ordering the

standardized doses. The implementation process and policy adoption took two months. Three months later, a random sample of antibiotic orders was re-evaluated. Approximately 62% of physicians were compliant with the standardization policy. Dosing errors were noted to decrease from 34.3% to 5.06%. A limitation of this study is that the hospital did not have computerized physician order entry (CPOE) so they relied on physician usage of notecards to remember the standard doses. Another limitation of this study is that it was done at a single site.

Larson, Sauve, Senkungu, Arifeen & Brant (2015) conducted a cross-sectional study with the objective of evaluating if dispersible tablets could be dispensed to improve over/under-dosing of medications. A second objective was to create four band categories based upon the World Health Organization/United National International Children's Emergency Fund (UNI-CEF) weight and height growth standards from Uganda and Bangladesh matched to pediatric age. Other objectives were to determine a fixed dose tablet and to check validity. Validity was met if 95% of the children less than five years of age received the dose within the correct therapeutic range. Dispersible tablets were of interest as they are easy to transport, requires no calculations and appeal to rural communities. The following medications were evaluated: paracetamol, iron sulfate, amoxicillin, trimethoprim/sulfamethoxazole, ciprofloxacin and co-arthemether. Four weight bands were created for the six medications. Fixed doses were determined by graphing the upper and lower limits of doses with weights on the x-axis and medication dose (milligram) on the y-axis. The best-fit dose was the selected as the one that would allow for the largest percentage of patients to receive the therapeutic dose within each

dose range. After selection of the therapeutic dose, validity was computed. The study found that weight bands can successfully be created for children 1-59 months of age that allows them to receive therapeutic dosing.

Al-Turkait and Khan (2015) evaluated the usefulness of dose-banding in reducing errors within the Accident and Emergency Department. A one-week audit conducted in the department pre-implementation determined a dosing error rate of 9.4%. A dose banding schedule was then developed for common analgesics and antibiotics. After implementation and a two-week training period, the department was re-audited. A total of 450 medications orders were made by physicians. Of the 450, only 194 followed the dose banding schedule. The error rate among physicians that utilized the dose banding schedule was zero.

1.7 Potential Standardization Approaches

Prevention of medication errors in the inpatient setting requires a better process for medication prescribing, dispensing, and administration. Standardization of medication doses has been proposed as a mechanism for tighter control of medication dosing in infants and children thereby decreasing variability and lessening the chance of error. Dose standardization is a system whereby doses of oral medications are calculated on an individualized basis within defined ranges or bands that are rounded up or down to predetermined standard doses. (Plumridge & Sewell, 2001). The maximum variation of the adjustment between the standard dose and the doses constituting each band is usually between 0-15%.

MacKay et al. (2009) proposed standardization as a mechanism for promoting safety, care improvement, and cost containment within healthcare institutions. Other benefits of dose standardization including the ability to draw up standard syringes, a reduction in waste, and patient waiting times, increased cost effectiveness and improved pharmacy workflow. Some of the concerns regarding this technology are reduced jobs and that systematic dose-banding errors might add to pre-existing random errors (Sewell, 2006).

2 Study

2.1 Purpose of the Study

The purpose of this study was to examine medication standardization practices at a community hospital and to examine whether a clinical decision support tool improved satisfaction among physicians, pharmacist, and pharmacy technicians. This study also examined ordering behaviors of the following standardization of the most commonly ordered medications: amoxicillin, amoxicillin-clavulanic acid, cephalexin, cefdinir, azithromycin, oxycodone, morphine, and fentanyl.

2.2 Research Questions

The following research questions were explored: a) Is there a relationship between hospital staff (physician, pharmacy, pharmacy technicians) satisfaction and degree of medication standardizations? And b) Will standardization options be accepted by physicians?

2.3 Assumptions

1. Physicians, pharmacists, and residents have decision-making capacity
2. Small changes in the doses would be acceptable

a. Currently, per hospital policy, pharmacists can round +/-10% of ordered dose

2.4 Hypothesis

There is a positive relationship between staff satisfaction as measured by Likert scales and dose standardization of a subset of antibiotics and opioids. It was also hypothesized that staff acceptance of standardized medications would improve after standardization.

3 Methodology

3.1 Setting

The study was conducted at a tertiary care pediatric community hospital in the Northwest region of the United States. The hospital contains approximately 165 patient beds including 25 Day Surgery beds, 24 Pediatric Intensive Care Unit beds and a 22 room Emergency Department. The hospital features many specialists including clinicians in neurology, cardiology, neonatology and rehabilitation. Additionally, the hospital has a large catchment area and pediatrics admission rate totaling approximately 17,000 a year.

3.2 Subjects

Inpatient pediatric physicians, pharmacists, pharmacy technicians, and residents were recruited from an established hospital-controlled list of the respective staff at the hospital. All staff meeting the study's criteria were informed about the study via hospital secured email and were invited to participate. The letter stated that participation in the study was completely voluntary, that participants could withdraw from the study at any time, and that all data would be kept confidential. In addition, the letter addressed the benefits of participation in the study. Staff that were interested in participating in the study were asked to complete the surveys.

The IRB entitled Standardized Pediatric Dosing (STUDY00016297) was approved January 24, 2017, by the academic hospital. The study was also approved by the community hospital (IRB #00000678) on December 28, 2017. As two IRB's were completed, the academic hospital waived their IRB oversight.

3.3 Sampling

The study was conducted between October 1, 2016, and April 24, 2017. Orders written within the pediatric inpatient setting were evaluated. Orders were excluded from patients admitted to the hematology/oncology service and postoperative surgery service. A query was run to find charts meeting criteria for this study. Pre-standardization dosing data were collected from October 1 to December 31, 2016, and post-standardization dosing data were collected from March 14 to April 24, 2017. The Go-Live date for the medication standardization implementation within the electronic health record was March 13, 2017. Reporting tools utilized include SlicerDicer, Web Intelligence, Reporting Database, Reporting Workbench and the pharmacy's clinical coordinator reporting system. .Standardization data were analyzed within Excel (Microsoft, Redmond, WA) and using SPSS version 24 statistics software (IBM, Armonk, NY). The initial pre-standardization survey was distributed on February 20, 2017, and the initial post-standardization survey was distributed on May 1, 2017. Reminders were sent to staff on February 27th and March 6th to complete the pre-survey and May 8th and May 15th to complete the post-survey. The pre-survey that was distributed to participants is located in Appendix B and the post-survey that was distributed is located in Appendix C. Survey responses were measured using a Likert scale in addition to some open-ended exit survey

questions. Survey data were analyzed within the academic hospital's Research Electric Data Capture (RedCap) and using SPSS.

An understanding of how various demographics influence ordering behaviors was also important to this study. Demographics that were collected on physicians (attending physicians/residents) included years of employment at the hospital, year of graduation from a professional school and resident level of training.

To determine if there was consistency in acceptance of rounded doses, the physician orders were exported into a spreadsheet using the pharmacy's clinical coordinator reporting system. The expected standardized dose based on the standardization tables was compared to the dose that the patient received. If the doses matched, then it was deemed that the physician accepted the dose or if involving the pre-standardized data, that the dose given matched the future standardization tables. If the doses did not match, then it was indicative that the physician did not accept the recommended standardized dose or in case of pre-standardization data, that the dose was not consistent with the future standardization tables. It was estimated that there would be approximately 1000 charts reviewed and 25 physicians, pharmacists and pharmacy technicians enrolled in the study.

3.4 Inclusion criteria:

To be included in this study, the order must: a) have been placed between October 2016 and April 2017, b) have involved patients from 30 days old to 18 years of age, and c) have been prescribed an opioid or antibiotic that was dose standardized.

All hospital-based pediatricians, pediatrics residents, pediatric pharmacist, and pharmacy technicians were included in the study.

3.5 Exclusion criteria:

Charts were excluded from the study if they involved patients admitted to the pediatric hematology/oncology service. The decision was made to exclude immunocompromised patients as they often require dose adjustment compared to the general population.

Pharmacists or pharmacy technicians not involved in the compilation of pediatric medications were excluded.

3.6 Delimitations

1. The sample size was limited to healthcare staff (attending physicians, residents, medical students, pharmacists, pharmacy technicians) who worked pediatric inpatient shifts or who were involved in pediatric inpatient medication preparation between October 2016 and April 2017.
2. Data were collected from healthcare staff only
3. The sample was limited to healthcare staff within one hospital

4 Interventions and Environment

4.1 Interventions

The intervention involved standardizing eight commonly utilized antibiotics and three commonly ordered opioid within the hospital's electronic health record interface. Figure 1 below shows the list of medications standardized along with their ERX number, which is their medication identification number within the EHR. Medications followed by THP

were Take Home Packs that were ordered in the emergency department at the time of discharge for the patient to go home with following assessment.

Figure 1: List of Opioid and Antibiotic Medications Standardized

Amoxicillin 250mg/5ml Oral Susp. Med # 454
Amoxicillin 400mg/5ml Oral Susp THP. Med # 22009018
Amoxicillin 400mg/5ml Oral Susp. Med # 25246
Amoxicillin-Clavulanate 250mg/5ml Oral Susp. Med # 98229
Amoxicillin-Clavulanate 400mg/5ml Oral Susp THP. Med # 2009000
Amoxicillin-Clavulanate 400mg/5ml Susp. Med # 33230
Amoxicillin-Clavulanate 600mg/5ml Oral Susp THP. Med # 2009035
Amoxicillin-Clavulanate 600mg/5ml Oral Susp. Med # 31177
Azithromycin 200mg/5ml Oral Soln. Med # 15797
Cefdinir 250mg/5ml Oral Susp THP. Med # 2009054
Cefdinir 250mg/5ml Oral Susp. Med # 39522
Cephalexin 250mg/5ml Oral Susp THP. Med # 2009022
Cephalexin 250mg/5ml Oral Susp. Med # 9502
Fentanyl Citrate 50mcg/ml Inj Soln. Med # 101644
Morphine 2mg/ml Syringe. Med # 200611
Oxycodone 5mg/5ml Oral Soln. Med # 10813

The standard doses, lower and upper bound were set by evaluating the commonly ordered pediatric medication doses and generating a boundary within 10-15% of these ordered doses. Dosing ranges were established by comparing frequency of previously ordered dosages, and consideration of drug dispensing tools (i.e. size of available syringes). Syringes available at the hospital in the following sizes: 1 ml, 3 ml, 5 ml, 10 ml and 20 ml. Efforts were made to keep dose ranges within 15% for antibiotics and under 10% for opioids. Efforts were also made to try to have dose standard consistency with as many medications as possible. After the standardization tables were developed, they received approval from various clinical departments including pediatric surgery, pediatric emergency medicine, and the hospital's quality organizations. Following approval, the dosing tables were implemented into the hospital's electronic health record and computer order entry system. Physicians were notified by their department chairs and via email

regarding the medication standardization Go-Live date and details of the project. While the standardization of these 16 medications occurred automatically upon physician order entry and physicians were encouraged to use the standardized dose, they also had the option to adjust the dosage prior to acceptance of the dose. The standardization tables located in Appendix A were included as a link with each medication order that was standardized

Appendix D shows the standardization process for cefdinir 250mg/5ml for a 10 kilogram (kg) patient. The pre-standardization amount of cefdinir 250mg/5ml given to a 10kg pediatric patient was 1.4ml (70mg) as demonstrated in D1. The standardization table created as well as the electronic health record's data entry are shown in Appendix D.2 and D.3. Following the standardization process, the same 10kg pediatric patient was dosed 1.5ml (75mg) as the initial calculated dose fell between 69.01mg and 86mg. The output of the standardization process for cefdinir 250mg/5ml for the 10-kg patient is shown in Appendix D.4.

5 Data Collection

5.1 Data Management Plan

The data were coded and a master list was maintained. Information deleted included patient MRN number and CSN (visit number). After coding, data were only indirectly identifiable via the use of the master list that was destroyed after all analyses were completed. Data were stored in Excel spreadsheets within Box.com which had a business agreement with the academic center providing a Health Insurance Portability and Accountability Act (HIPAA) protected online storage system. The principal investigator was responsible for the data. As Box.com was utilized, the data were not transported but

shared between the investigators in a secure-password protected folder. The academic institutions RedCap system was used to manage and distribute the surveys.

6 Analysis

6.1 Statistical Analysis

Data analysis began with a review of data and descriptive statistics (i.e., means, modes, medians, SDs, frequencies, ranges). The distribution of demographic and clinical characteristics was summarized descriptively using count and percentage for binary variables and mean and standard deviation or median and interquartile range for quantitative measures. Descriptive statistics and effect sizes on pre- and post-test data were obtained. A Chi-squared test or Fisher's exact test was performed for each of the pre- and post-test outcome measures of each medication. A significance level of 0.05 was set.

7 Results

7.1 Demographics

A total of 75 hospital staff (38 pediatric hospitalists, 12 pharmacists, 11 pharmacy technicians, and 14 pediatric residents) were recruited for the study. Twenty-eight individuals completed the pre-survey. A total of 11 participants completed the entire study. Participants who were lost to attrition (N=17) were included in the baseline analysis. No demographics were collected on subjects that did not participate in the initial survey (N=56). The hospital staff ranged in age from 18 to 64 years old with most participants who completed the study with ages between 25 to 34 years old. The majority of participants were pharmacists and pharmacy technicians (N=7, 63%). Most of the staff had worked at the hospital from three months to fifteen years with a mean of five years.

Table 1: Demographics of Hospital Staff

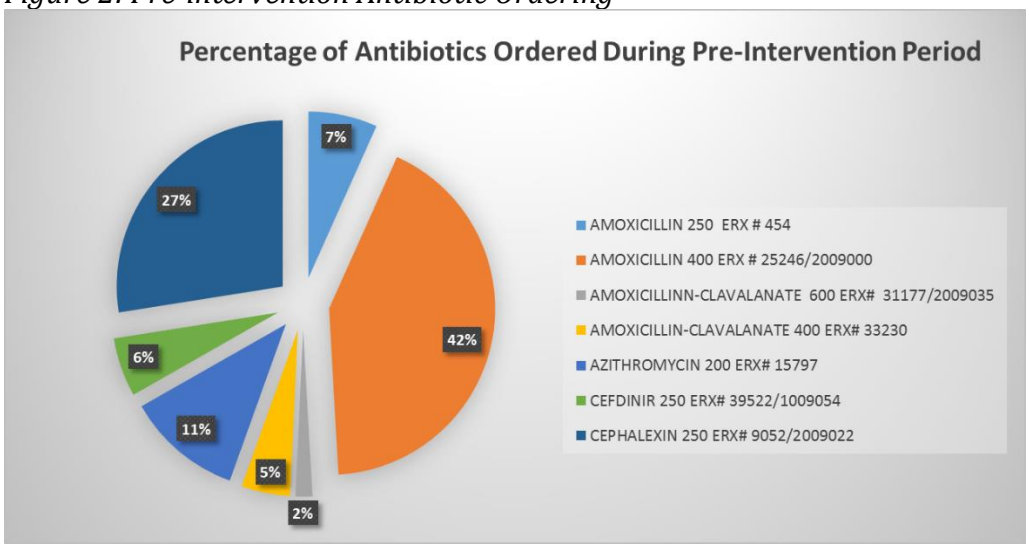
Demographic Characteristics of Hospital Staff				
	Pre-Data (n=28)		**Post-Data (n=11)**	
Age Range	**#**	**%**	**#**	**%**
Attending/Residents				
18 to 24 years	1	3%		
25 to 34 years	4	14%	3	27%
35 to 44 years	4	14%	1	9%
45 to 54 years	1	3%		
55 to 64 years	3	10%	1	9%
Over 65 years	0	0%		
Pharmacist/Pharmacy Technicians				
18 to 24 years	0	0%	0	0%
25 to 34 years	5	17%	1	9%
35 to 44 years	5	17%	4	36%
45 to 54 years	4	14%	1	9%
55 to 64 years	2	7%	0	0%
Over 65 years	0	0%	0	0%
Year Graduated From Professional School	**#**	**%**	**#**	**%**
Attending/Residents				
>=2000	8	28%	4	36%
<2000	5	17%	1	9%
Pharmacist/Pharmacy Technicians				
>=2000	8	28%	5	45%
<2000	6	21%	1	9%
unanswered	2	7%	0	0%
Years Working at the Community Hospital	**average (years)**		**average (years)**	
Attending/Residents	5 years		3.4 years	
Pharmacist/Pharmacy Technicians	6 years		6 years	

7.2 Pre-Data: Antibiotics

Data on pre-dose standardization antibiotic orders were obtained from the hospital's EHR. A total of 611 orders of the included antibiotics were ordered during the three-month inpatient pre-intervention period from October to December 2016. The most commonly ordered antibiotics were amoxicillin 400mg/5ml (42%), and cephalexin 250mg/5ml (27%). Of the 611 antibiotic orders, 34% were rounded by the system, and

25% were consistent with the dose standardization tables. Figure 2 below shows the percentage of each antibiotic ordered within this three month time period.

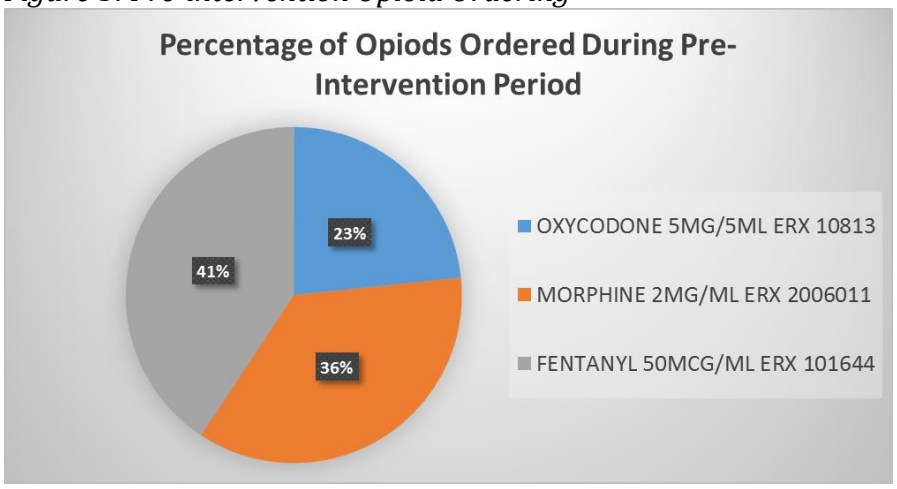
Figure 2: Pre-intervention Antibiotic Ordering



7.3 Pre-Data: Opioids

A total of 3,328 orders were placed for morphine, oxycodone, and fentanyl during the three-month inpatient pre-intervention period from October to December 2016. The most frequently ordered opioid was Fentanyl (41%). Of the 3,328 opioids ordered, 41% were rounded by the system, and 37% of the low doses were consistent with the dose standardization tables. Figure 3 below shows the percentage of each opioid ordered within this three month time period.

Figure 3: Pre-intervention Opioid Ordering



7.4 Pre-Data: Survey

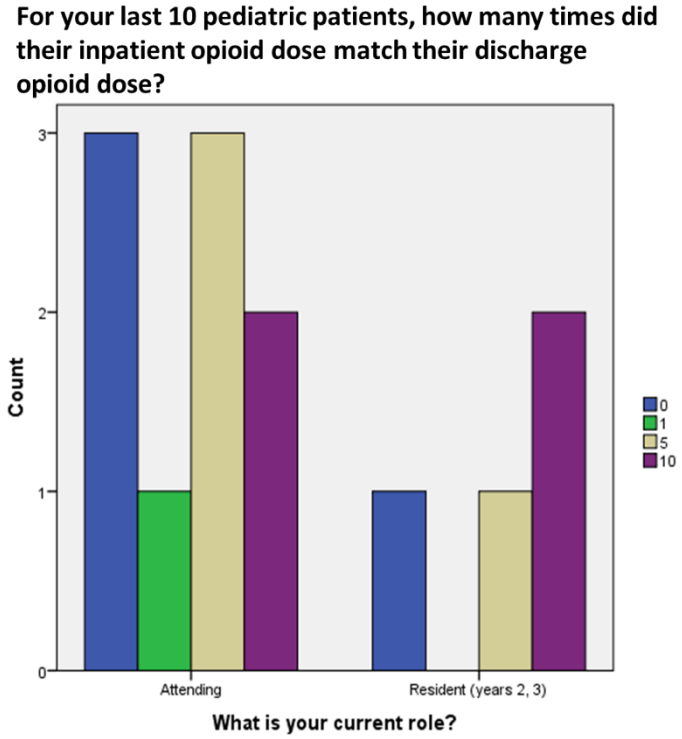
A total of 28 individuals responded to the pre-survey. This value included eight attending physicians, four residents, nine pharmacists and seven pharmacy technicians. A chi-squared test was conducted on pre-data to determine if there was a specific association between variables. When evaluating the level of satisfaction with the system with respondent's current role (attending, resident, pharmacist, pharmacy technicians), it was determined that the chi-squared statistic was 10.894 (p value 0.283). Since the p-value was greater than our level of significance (alpha = 0.05), the null hypothesis was not rejected. Therefore, there was not enough evidence to suggest that there was an association between respondent's role and degree of satisfaction with the system.

Satisfaction level was analyzed in regard to respondent's age range (18-24 years, 25-34 years, 35-44 years, 45-54 years). The chi-squared statistic was 6.853 with p value of 0.867. Since this p-value was also greater than our level of significance (alpha =0.05), the null hypothesis was again rejected. Therefore, it was concluded that there was not

enough evidence to suggest an association between respondent's age and degree of satisfaction with the system.

On average, most individuals rated their level of satisfaction with the electronic health record on the Likert scale of 2.66 with a standard deviation of 0.897. Overall, this suggests that hospital staff were satisfied with the system. When evaluating satisfaction and ease of ordering, most residents and physicians found it easier to order antibiotics with a Likert scale mean of 3.46 (standard deviation 0.519) vs. opioids with a Likert scale mean of 3.23 (s.d. 0.725). When reflecting on their last 10 patients, most providers found that the inpatient and home dose matched for more of their patients who were on antibiotics with a Likert mean of 8.69(s.d. 2.933) as compared to those who were on opioids 4.69 (s.d. 4.231). Pharmacists and pharmacy technicians were asked to rate how challenging it is to draw up various antibiotics vs. opioids. Respondents reported that overall it was more challenging to draw up opioids with a Likert mean of 2.69 (s.d. 1.078) vs. antibiotics 2.44 (s.d. 1.209).

Figure 4: Pre-intervention Opioid Inpatient vs. Home Dose As Reported By Participants



When looking at preliminary data, the evidence shows that most staff are satisfied with the medication ordering system. In fact, results show that every staff category: physicians, residents, pharmacist were satisfied with the current electronic health record while pharmacy technicians were indifferent about the electronic health record as shown in the Figure 4 above. Additionally, when looking at age, it appears that most groups are satisfied; however, a larger percentage of participants were satisfied if their age was between the ages of 25 to 34 as shown in Figure 5.

Figure 5: Pre-Intervention Role vs. Level of Satisfaction with Dose Ordering System

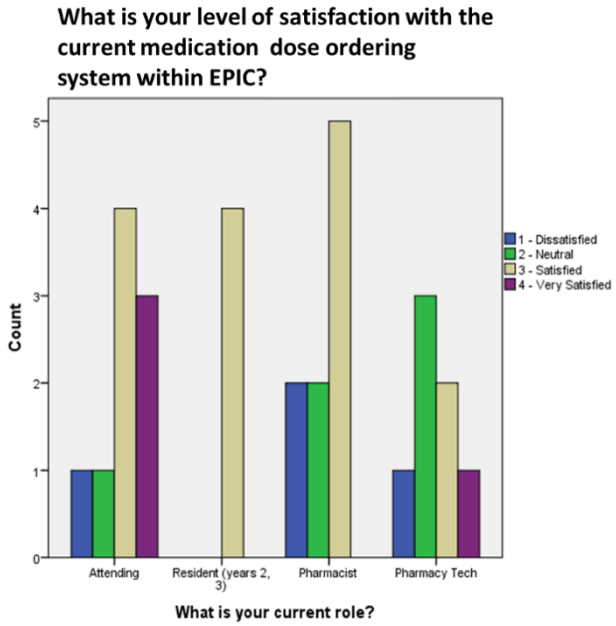
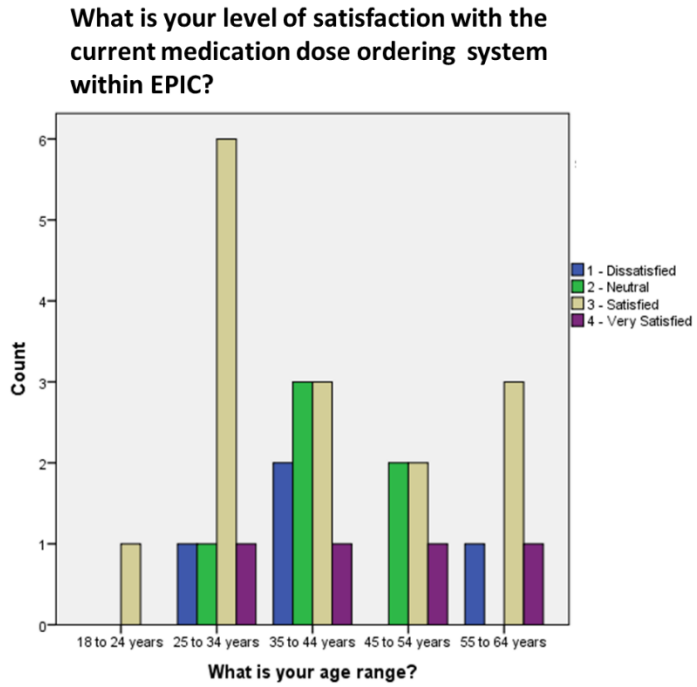


Figure 6: Pre-Intervention Age vs. Level of Satisfaction with Dose Ordering System

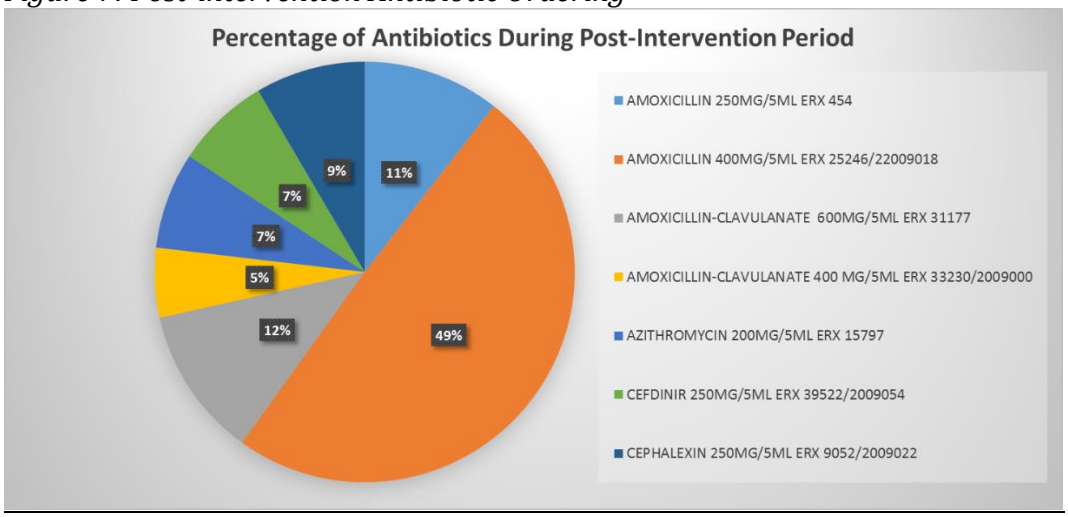


7.5 Post-Data: Antibiotics

A total of 598 antibiotics of interest were recorded during the six-week inpatient post-intervention period from March to April 2017. The most commonly ordered antibiotics were amoxicillin 400mg/5ml (49%), and amoxicillin-clavulanic acid 600mg/5ml (12%).

Of the 598 antibiotics orders, 64% were rounded from the physician's initial ordered dose, and 47% were consistent with the dose standardization tables. Figure 7 below shows the percentage of each antibiotic ordered within this six-week time period.

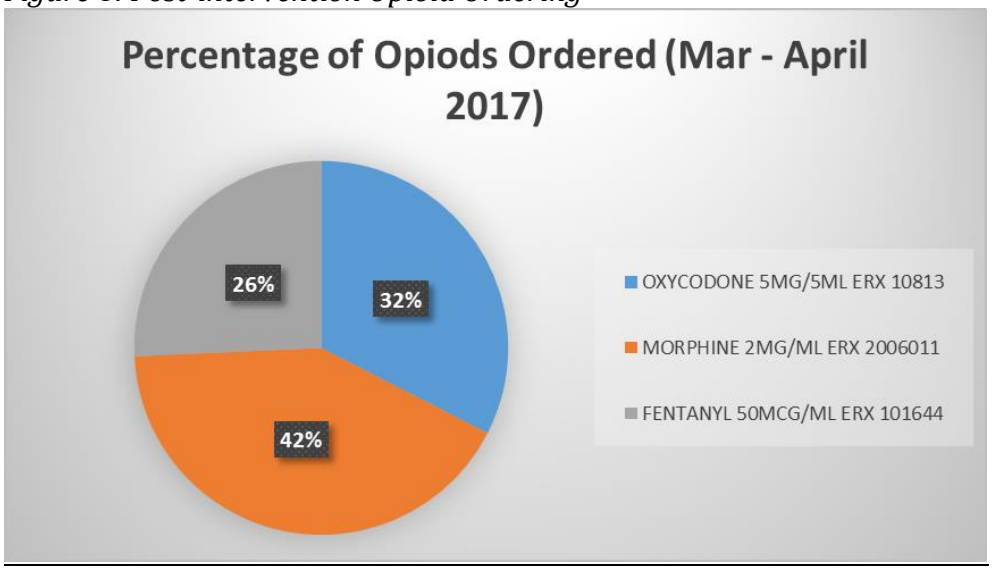
Figure 7: Post-intervention Antibiotic Ordering



7.6 Post-Data: Opioids

A total of 1,613 opioids of interest were ordered during the six-week inpatient post-intervention period from March to April 2017. The most commonly ordered opioid was morphine 2mg (42%). Of the 1613 opioids ordered, 55% were rounded from the physician's initial ordered dose. Seventy-two percent of the low doses were consistent with the dose standardization tables while 17% of the high doses were consistent with the dose standardization tables. Figure 8 below shows the percentage of each opioid ordered within this six-week time period.

Figure 8: Post-intervention Opioid Ordering



Post-Data: Survey

A total of 11 individuals responded to the post-survey. This value included three attending physicians, two residents, three pharmacists and three pharmacy technicians. A Chi-squared test was conducted on post-data to determine if there was a specific association between variables. When evaluating the various roles of the respondents (attending, resident, pharmacist, pharmacy test) with the level of satisfaction with the system, it was determined that the chi-squared analysis was 43.004 (p value 0.114). Since the p-value is greater than the 0.05 level of significance, the null hypothesis was not rejected. Therefore, there was not enough evidence to suggest that there was an association between respondent's role and degree of satisfaction with the system.

Participants' age range (18-24 years, 25-34 years, 35-44 years, 45-54 years) was also analyzed in regards to satisfaction level. The chi-squared analysis was 31.723 with p value of 0.531. Since this p-value was also greater than the 0.05 level of significance, the null hypothesis was again rejected. Therefore, it was concluded that there was not

enough evidence to suggest an association between respondent's age and degree of satisfaction with the system.

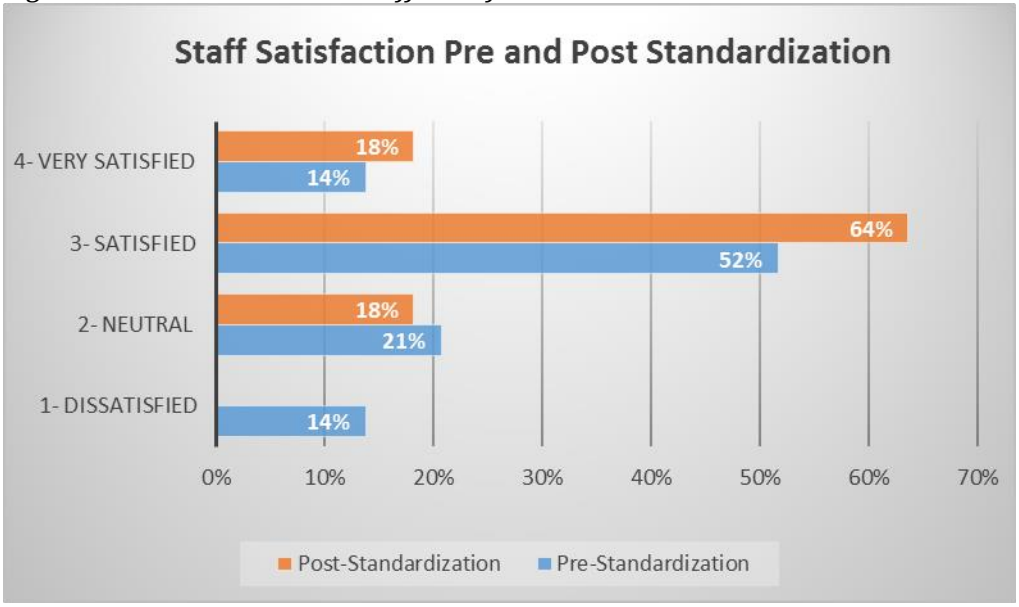
Overall, most individuals rated their satisfaction with the electronic health record's medication ordering as 3.0 +/- 0.60. This suggests that most respondents were satisfied with the system. When evaluating satisfaction and ease of ordering, most residents and physicians found it easier to order antibiotics (3.6 +/- 0.49) vs. opioids (3.4 +/- 0.49). When reflecting on their last 10 patients, providers found that the inpatient and home dose matched on average 8.2+/- 1.32. Pharmacists and pharmacy technicians were asked to rate how challenging it is to draw up various antibiotics vs. opioids. Respondents reported that overall it is more challenging to draw up opioids (2.0 +/- 1) vs. antibiotics (2.16 + 1.06).

7.7 Comparison of Pre- and Post-Data

Hypothesis 1: *Standardization will lead to an increase in staff satisfaction*

Staff satisfaction measured as a function of age and job description during the pre-implementation and post-implementation phase was determined to be non-significant as measured by the Chi-squared statistic. Overall, the distribution of satisfaction pre and post implementation did not change as shown by the histogram in Figure 9 below.

Figure 9: Pre-intervention Staff Satisfaction Distribution



When the data were matched for hospital staff that completed the pre and post survey, the trend was positive. The satisfaction level for the 11 individuals who completed the pre-intervention mean Likert scale was 2.5 (s.d. 0.90) while the mean Likert satisfaction post-intervention was 3 (s.d. 0.60). Additionally, when pharmacists were matched, their ease of drawing up opioids and antibiotics increased from a mean Likert scale of 1.8 (s.d. 0.75), 1.67 (s.d. 0.8) pre-intervention to 2 (s.d. 1), 2.16 (s.d. 1.06) post-intervention. The matched physicians seemed to be less satisfied post-standardization. When comparing their ease of ordering opioids the physicians the mean Likert scale score of 3.66 (s.d. 0.47) pre-intervention dropped to 3.4 (s.d. 0.49) post-intervention. Similarly, when comparing their ease of ordering antibiotics, their mean average Likert scale of 4.0 pre-intervention dropped to 2.16 (s.d. 1.06) post intervention.

Hypothesis 2: *Standardization will lead to an increase in physician acceptance of the proposed doses*

A Fisher's Exact Test was used to analyze pre and post data to determine if there was a significant change in acceptance of standardized doses pre and post intervention. Fisher's

exact was chosen as several of the medications had less than five medications ordered or accepted in the pre and post standardization periods. The following medications had a significant change in acceptance rate from pre-intervention to post-intervention: amoxicillin 600mg/5ml (Chi-squared 4.727, p=0.038) , amoxicillin-clavulanic acid 400mg/5ml (chi-squared 4.387, p=0.047), azithromycin 200mg/5ml (chi-squared 12.161, p=0.001), cefdinir 250mg/5ml (chi-squared 5.197, p=0.029), cephalexin 250mg/5ml (chi-squared 9.596, p= 0.002) , oxycodone 5mg/5ml (chi-squared 79.073, p=0.0001), morphine 2mg/ml (chi-squared 36.023, p=0.0001), fentanyl 50mcg/ml (chi-squared 142.99, p=0.0001). Interestingly, all the opioids had a significant change in their acceptance rates as evident by the p value of less than 0.05. Figure 10 below shows the output of the Fisher's Exact Test for the three opioids. The Chi-squared output for the remainder of the medications is located in Appendix F.

Figure 10: Fishers Exact Test- Pre- and Post-Medication Standardization Acceptance Rate

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	79.073[a]	1	.000		
Continuity Correction[b]	78.285	1	.000		
Likelihood Ratio	79.486	1	.000		
Fisher's Exact Test				.000	.000
N of Valid Cases	2133				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 398.94.

b. Computed only for a 2x2 table

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	36.023[a]	1	.000		
Continuity Correction[b]	35.566	1	.000		
Likelihood Ratio	35.866	1	.000		
Fisher's Exact Test				.000	.000
N of Valid Cases	3023				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 463.41.

b. Computed only for a 2x2 table

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	142.999[a]	1	.000		
Continuity Correction[b]	142.241	1	.000		
Likelihood Ratio	146.711	1	.000		
Fisher's Exact Test				.000	.000
N of Valid Cases	4569				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 629.37.

b. Computed only for a 2x2 table

Table 2: Fishers Exact Test coming Pre- and Post-Medication Standardization Acceptance Rate

ANTIBIOTIC	Chi-squared	p-value
AMOXICILLIN 250mg/5ml ERX# 454	0.175	0.764
AMOXICILLIN 400mg/5ml THP ERX# 22009018	0.914	1
AMOXICILLIN 400mg/5ml ERX# 25246	0.001	1
AUGMENTIN 600mg/5ml ERX# 31177	4.727	0.038
AUGMENTIN 400mg/5ml ERX# 33230	4.387	0.047
AZITHROMYCIN 200mg/5ml ERX# 15797	12.161	0.001
CEFDINIR 250mg/5ml ERX# 39522	5.197	0.029
CEFDINIR 250mg/5ml THP ERX# 2009054	1.659	0.301
CEPHALEXIN 250mg/5ml ERX# 9052	9.596	0.002
CEPHALEXIN 250mg/5ml THP ERX# 2009022	0.694	0.442
OPIOIDS		
OXYCODONE 5mg/ml ERX# 10813	79.073	0.0000
MORPHINE 2mg/ml ERX# 2006011	36.023	0.0000
FENTANYL 50mcg/ml ERX# 101644	142.999	0.0000

The percentage of standardized doses consistent with the standardized table was also compared pre- and post-standardization. Table 2 shows the percentages as well as the percent change of each medication from the pre and post-period. The majority of orders were more consistent with the post implementation standardized doses. While

amoxicillin-clavulanic acid 400mg/5ml THP showed a negative change, this was because this medication was not ordered during the 6-week post implementation period.

Table 3: Pre-and Post- Intervention Antibiotic Percentages and Rates of Change

	Percent Consistent with Standardization Table		
Antibiotic	**Pre-**	**Post-**	**Change**
AMOXICILLIN 250 ERX# 454	0.780487805	0.885245902	0.10
AMOXICILLIN 400 THP ERX# 22009018	0	0.619047619	0.62
AMOXICILLIN 400 ERX# 25246	0.011857708	0.011494253	0.00
AUGMENTIN 250 ERX# 98229	0	0	0.00
AUGMENTIN 400 THP ERX# 2009000	0.5	0	-0.50
AUGMENTIN 600 ERX# 31177	0.125	0.940298507	0.82
AUGMENTIN 400 ERX# 33230	0.310344828	0.759259259	0.45
AUGMENTIN 600 THP ERX# 2009035	0	0	0.00
AZITHROMYCIN 200 ERX# 15797	0.289855072	0.926829268	0.64
CEFDINIR 250 ERX# 39522	0.366666667	0.947368421	0.58
CEFDINIR 250 THP ERX# 2009054	0.2	1	0.80
CEPHALEXIN 250 ERX# 9052	0.443037975	0.977272727	0.53
CEPHALEXIN 250 THP ERX# 2009022	0.5	1	0.50

Table 4 below shows the percentage of opioid doses that were consistent with the standardization table at pre-and post-intervention. The findings show-that the majority of the opioids were more consistent with the standardization tables post-intervention.

Table 4: Pre-and Post- Intervention Opioid Percentages and Rates of Change

	Percent Consistent with Standardization Table		
Opioids	**Pre-**	**Post-**	**Change**
OXYCODONE 5MG ERX# 10813	0.427284427	0.95047619	0.52
MORPHINE 2MG ERX# 2006011	0.510442774	0.805349183	0.29
FENTANYL 50MCG ERX# 101644	0.325701625	0.289156627	-0.04

7.8 Subject Responses

During the post-survey, hospital staff was asked to comment on the medication standardization system. The staff responses to the medication standardization process are located in Appendix E. The following themes about the standardization system were identified by staff at post-intervention: patient safety, easy, efficient, and better. In summary, staff identified positive benefits of the standardization system. The staff

expressed concern regarding ‘clear notifications of rounding’ and ‘large rounding intervals.' There also seemed to be a difference in perspective on the standardization method between pharmacists and physicians. While pharmacists commented that they would like to see more medications standardized, physicians noted that they wished to have more flexibility.

8 Discussion

8.1 Summary of Findings

Overall, most staff members were satisfied with the medication ordering process both pre-implementation and post-implementation. This suggests that the medication standardization process is not a detriment to staff satisfaction. Given that multiple medications were standardized at one time, it suggests that large changes in standardization do not have adverse effects on user’s satisfaction. Given the small sample size, it is difficult to assess whether standardization led to an overall increase in staff satisfaction. However, when comparing overall trends, it appears that pharmacists found it easier to draw up opioids and antibiotics after standardization while physicians found it more challenging to order opioids and antibiotics based on comparison of matched pre- and post-standardization Likert scores.

After implementation of the medication standardization system, there was an increase in acceptance of the proposed dose. This suggests that many physicians did not have numerous encounters where they needed to change the dose to something different than what was outlined in the standardization table. The qualitative responses helped to identify a few concerns with the standardization system which may have lowered acceptance of the system. One of these concerns was the ordering range percentages

chosen. The dosing ranges (+/- 15%) were approved by pharmacy and were slightly outside the range of what the pharmacist could change without notifying a physician (+/- 10% range). The goal was to keep the ranges as close to 10% as possible; however, with some medications slightly larger ranges were used to better assist with creating user-friendly doses. Some staff commented that they found the ranges to be too high for some medications. Therefore, for future iterations of the system, it might be beneficial to consider adding more standard doses for each medication to lower ordering ranges.

Another finding from the study was that staff was challenged when trying to determine whether a medication was standardized. The electronic health record displayed 'Changed to' anytime a medication standardization occurred. However, this language was slightly confusing and there was no way for this language to be changed to something more indicative that the dose was rounded such as 'rounded to.' Physicians and staff were emailed regarding the standardization display, and a medication standardization guide was inserted within each of the manipulated orders, however by not being able to change the user interface, it was difficult for new users and/or users who did not read the email to realize that medication standardization was occurring. Additionally, most of the physician comments focused on their desire for more freedom in regards to standardization while most of the comments by the pharmacists supported the change.

As previously noted, the number of survey respondents significantly dropped from the pre-survey to the post-study. There are likely several reasons for this high rate of attrition in the post-study. One likely reason for increasing pharmacy staff response rate is that

the pharmacy coordinator who helped support the pre-survey by encouraging her team to complete the survey was out of town during the follow-up period. Additionally, several residents completed the pre-study but is likely that due to the residency schedule, several of them were not available and/or on the rotation when the post-study was sent. There is also a chance that survey respondents lost interest in the project, hence the lower post-survey response rate.

8.2 Comparison to Previously Published Literature

Within the literature, one study evaluated physician compliance following implementation of an antibiotic standardization dosing table in a tertiary care hospital in Saudi Arabia. Within this study, it was determined that physician compliance following implementation of the antibiotic standardization table was 62% (Aseeri, 2003). In comparison, the physician compliance rate of antibiotics within this study was 47%. In comparing, methods between two studies some differences that may have contributed to higher compliance rates among physicians within Aseeri's study include their use of handy pocket-sized dosing tables given to physicians, implementation of departmental policies and procedures regarding the standardization tables as well as dosing policy reminders placed throughout the hospital. Additionally, more 'at the elbow' teaching was provided to physicians, pharmacists, and nurses. However, one challenge in comparing this study with Aseeri's study is that their ordering system did not involve CPOE.

Subject comments from the study highlight a well-known informatics debate regarding standardization vs. individualization. Standardization offers many benefits including ease of training and identification of errors. For example, a pharmacist abreast in medication standardization might quickly realize when a medication was under-dosed.

Hence, why pharmacists commenting on the study may have favored mass standardization efforts of medications. Standardization can also lead to lower healthcare costs if the standard doses were created in a way to minimize extra resources. For example, if patients were given a standard dose of 5ml instead of 5.6ml, it might lead to a reduction of medication and supplies utilized.

Individualization can also be beneficial since not every patient is the same. Individualization allows the practitioner to make adjustments based on each individual patient. For example, frequently in pediatrics opioid dosing is adjusted to account for tolerance of the dose. A sickle cell patient who has required opioids for past crisis might require a higher baseline dose for pain vs. a patient that is opioid naïve. This option seemed to be highly desirable among physicians partaking in the study. As demonstrated there are benefits of having a balance of standardization and individualization. In fact, a balance might be helpful in understanding doses tolerance. For example, if patients are initially given a 'standard' dose, subjective monitoring can be utilized to determine how the patient may differ from other patients receiving the standard dose to understand their pain level.

While not evaluated in this study, standardization has the potential to reduce calculation errors. By reducing the amount of concentrations available for physician ordering, the hospital can help lower calculation errors. In fact, Engels et al. (2016) in partnership with the state of Michigan have found success by choosing standard concentrations for over 120 medications available. The project was initiated after the Michigan Pharmacists Association discovered that more than half of compounded drugs had concentrations that

were different by up to 30 fold. While the initiative is not mandatory in the state of Michigan, it is being heavily advocated by pharmacists with a goal of eliminating errors state-wide.

Standardization likely decreases the cognitive load of physicians and pharmacists. Computation of medication doses can lead to delays in patient care and medication errors. By reducing the concentrations available for pharmacists and physicians, it is likely that medication errors and delivery time of medications would be reduced as the pharmacists can pre-fill medications. Moreira et al. (2015) found that color-coded prefilled medication syringes within their ED during stimulated resuscitations often led to decreased delivery time secondary to the decrease in cognitive load required during within the high-stress environment.

8.3 Limitations

This study had several limitations. One limitation of this study was that data were only collected from a single medical facility. The medication dose standardization was distributed hospital wide; however, this research study only evaluated pediatric hospital staff and pharmacists in the inpatient setting. It is unknown how these changes affected pediatric physicians and hospital staff in the outpatient setting or in the emergent setting.

Another limitation was the relatively short time period of the study. The post-intervention data collection began on the day that the intervention went live. It is unknown if the results would have been affected if the study were longer. Additionally,

as the study was conducted during different time periods and different seasons, it is unknown if seasonal variation may have played a role in the outcomes.

Lastly, the sample size was small. This resulted in reduced statistical power of the study. Low statistical power results in a less generalizable study as it may not be a representative sample of all the inpatient pediatricians, pharmacists, residents and pharmacy technicians within the hospital. Additionally, the return survey rate was higher for pharmacists and pharmacy technicians suggesting that they may have been more interested in the study. The higher pharmacist and pharmacy technician response rate may have also been a result of increased encouragement by the pharmacy lead to complete the surveys as compared to other departments.

8.4 Implications of Future Research and Clinical Practice

The results of this study have several implications for medication standardization. The increase in the percentage of accepted standardized medications suggests that physicians at the hospital might be willing to accept standardization methods. This could lead to further standardization of medications within the hospital in addition to the opioid and antibiotic drug classes. Additionally, the study shows that physicians were able to tolerate a large number of medications being standardized at one time. This suggests that a hospital could potentially standardize large groups of medications without it influencing physician workflow.

The finding from this study may benefit patients in the future by lowering the risk of errors. The findings may also help to reduce the need for pharmacy involvement which could decrease workload and cost for the institution. However, the study also suggests

that pharmacists and physicians might have different standardization needs so it is important to consider this balance when standardization parameters are made. Additionally, the similarities between various antibiotic bands suggest that it may be possible to generate a few dose banding standards for various classes of medications.

9 Conclusion

9.1 Summary

The goal of this quality improvement based research study was to examine the relationship between medication standardization and hospital staff satisfaction, and acceptance of doses. This study did not find statistically significant differences in satisfaction pre-and post-standardization. However, the study showed that there was a greater percentage of accepted doses following standardization. Significant increases in percentage of physician accepted were noted for the following medication: amoxicillin 600mg/5ml, amoxicillin-clavulanic acid 400mg/5ml, azithromycin 200mg/5ml, cefdinir 250mg/5ml, cephalexin 250mg/5ml, oxycodone 5mg/5ml, morphine 2mg/ml, and fentanyl 50mcg/ml.

These findings indicate that some modifications are needed to the research study. For example, the timeline of the intervention should be lengthened to allow for adequate data collection. In addition, the post-data should be collected after the intervention has been active for a significant period of time to allow for efficient assessment of the intervention. Furthermore, the failure of the intervention to demonstrate statistically significant changes in the post study group is likely due to the small sample size and low power of this study. A longer, more robust study is needed to determine the short and long term effects of dose standardization. Performing assessments at different time points may help to identify long-term effects of the intervention such as a time-series.

9.2 Recommendations for Further Study

There are several recommendations which could improve the study and outcomes in the future. The first recommendation is to perform the study with larger sample size and more diverse physician specialties to examine the consistency of these findings. A greater sample size would allow the study to achieve a higher statistical power. It is also recommended that additional studies be designed with more emphasis on quantitative analysis as a means to understand staff's experience with the new standardization system. One of the most interesting components of the current study was the perspective of the staff on standardization. It will be interesting to obtain more information about staff perspective. Additionally, it would be interesting to explore the relationship between medication standardization and cost, and medication standardization and its relation to discharge dosing. The effects of medication standardization and costs would be beneficial to the organization as it could potentially lead to substantial cost savings. Likewise, if a relationship is noted between medication standardization and discharge dosing, it could potentially improve physician workflow.

Medication standardization also needs to be examined in regards to its clinical implications. Since patients may receive more or less than the initially calculated dose, further research is needed to determine the long-term outcomes of these adjustments. For example, if a patient's antibiotic dose was rounded down, was their infection adequately treated? Likewise, further research is needed to determine how standardization may affect the ordering of various specialists. Lastly, this study was completed over a short time interval. It may be helpful to conduct the study as a time-series or as a Plan-Study-Do-Act cycle for continuous improvements of the system.

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11 Appendices

ACETAMINOPHEN

Acetaminophen Oral Suspension Orderable. ERX# 4020463

Standard Dose (mg)	Rounding Factor (mg)	Lower Bound	Upper Bound
	0.3		28.849
32		28.85	39.99
48		40	55
64		55.001	71
80		71.001	99.99
120		100	140
160		140.001	199.9
240		199.901	275
325		275.001	398.9
480		398.901	550
650		550.001	

Acetaminophen Rectal Suppository Orderable. ERX# 4020464

Standard Dose (mg)	Lower Bound	Upper Bound
20	18	26.99
30	27	35
40	36	53
60	54	71
80	72	107
120	108	146.1
162.5	146.2	215
240	216	292
325	293	584
650	595	

AMOXICILLIN

Amoxicillin 250mg/5ml Oral Suspension. ERX# 454

Standard Dose (mg)	Lower Bound	Upper Bound
25	22.5	27
30	27.01	32
35	32.01	37
40	37.01	44
50	44.01	56
65	56.01	69
75	69.01	86
100	86.01	110
125	110.01	135
150	135.01	170
200	170.01	225
250	225.01	270
300	270.01	345
400	345.01	450
500	450.01	550
600	550.01	650
750	650.01	855
1000	855.01	1150

Amoxicillin 400mg/5ml Oral Suspension. ERX# 25246

Standard Dose (mg)	Lower Bound	Upper Bound
40	36	44
48	44.01	52
56	52.01	58
60	58.01	62
64	62.01	71
80	71.01	87
96	87.01	107
120	107.01	136
160	136.01	180
200	180.01	216
240	216.01	274.99
320	275	351.99
400	352	440
480	440.01	539.99
600	540	680
800	680.01	900
1000	900.01	1150

Amoxicillin 400mg/5ml Oral Suspension THP. ERX# 2009018

Standard Dose (mg)	Lower Bound	Upper Bound
40	36	44
48	44.01	52
56	52.01	58
60	58.01	62
64	62.01	71
80	71.01	87
96	87.01	107
120	107.01	136
160	136.01	180
200	180.01	216
240	216.01	274.99
320	275	351.99
400	352	440
480	440.01	539.99
600	540	680
800	680.01	900
1000	900.01	1150

AMOXICILLIN/CLAVULANATE

Amoxicillin/Clavulanate 250-62.5 MG/5 ML Oral Suspension. ERX# 98229

Standard Dose (mg)	Lower Bound	Upper Bound
25	22.5	27
30	27.01	32
35	32.01	37
40	37.01	44
50	44.01	56
65	56.01	69
75	69.01	86
100	86.01	110
125	110.01	135
150	135.01	170
200	170.01	225
250	225.01	270
300	270.01	345
400	345.01	450
500	450.01	575

Amoxicillin/Clavulanate 400-57 MG/5 ML Oral Suspension. ERX# 33230

Standard Dose (mg)	Lower Bound	Upper Bound
40	36	44
48	44.01	52
56	52.01	58
60	58.01	62
64	62.01	71
80	71.01	87
96	87.01	107
120	107.01	136
160	136.01	180
200	180.01	216
240	216.01	274.99
320	275	351.99
400	352	440
480	440.01	539.99
600	540	680
800	680.01	849.99
880	850	975
1000	975.01	1150

Amoxicillin/Clavulanate ES-600 600-42.9 MG/5 ML Oral Suspension. ERX# 31177

Standard Dose (mg)	Lower Bound	Upper Bound
42	36	45
48	45.01	53
60	**53.01**	**65**
72	**65.01**	**78**
84	**78.01**	**91.99**
96	**92**	**105**
120	**105.01**	**130**
144	**130.01**	**156.99**
168	**157**	**178**
192	**178.01**	**212**
180	**160**	**207**
240	**212.01**	**270**
300	**270.01**	**330**
360	330.01	407.99
480	408	528
600	528.01	660
720	660.01	800
900	800	1035
1200	1035.01	1350
1560	1350.01	1800

Amoxicillin/Clavulanate ES-600 600-42.9 MG/5 ML Oral Suspension THP. ERX# 2009035

Standard Dose (mg)	Lower Bound	Upper Bound
42	36	45
48	45.01	53
60	53.01	65
72	65.01	78
84	78.01	919.9
96	92	105
120	105.01	130
144	130.01	156.99
168	157	178
192	178.01	212
240	212.01	270
300	270.01	330
360	330.01	407.99
480	408	528
600	528.01	660
720	660.01	800
900	800	1035
1200	1035.01	1350
1560	1350.01	1800

Amoxicillin/Clavulanate 400-57 MG/5 ML Oral Suspension THP. ERX# 2009000

Standard Dose (mg)	Lower Bound	Upper Bound
40	36	44
48	44.01	52
56	52.01	58
60	58.01	62
64	62.01	71
80	71.01	87
96	87.01	107
120	107.01	136
160	136.01	180
200	180.01	216
240	216.01	274.99
320	275	351.99
400	352	440
480	440.01	539.99
600	540	680
800	680.01	849.99

880	850	975

AZITHROMYCIN

Azithromycin 200mg/5ml Oral Solution. ERX# 15797

Standard Dose (mg)	Lower Bound	Upper Bound
32	29	35
40	35.01	43
48	43.01	53
60	53.01	68
80	68.01	90
100	90.01	110
120	110.01	136
160	136.01	176
200	176.01	218
240	218.01	264
300	264.01	340
400	340.01	450
500	450.01	575

CEFDINIR

Cefdinir 250mg/5ml Oral Solution. ERX# 39522

Standard Dose (mg)	Lower Bound	Upper Bound
25	22.5	27
30	27.01	32
35	32.01	37
40	37.01	44
50	44.01	56
65	56.01	69
75	69.01	86
100	86.01	110
125	110.01	135
150	135.01	170
200	170.01	225
250	225.01	270
300	270.01	345
400	345.01	450
500	450.01	550
600	550.01	650

Cefdinir 250mg/5ml Oral Solution THP. ERX# 2009054

Standard Dose (mg)	Lower Bound	Upper Bound
25	22.5	27
30	27.01	32
35	32.01	37
40	37.01	44
50	44.01	56
65	56.01	69
75	69.01	86
100	86.01	110
125	110.01	135
150	135.01	170
200	170.01	225
250	225.01	270
300	270.01	345
400	345.01	450
500	450.01	550
600	550.01	650

CEFTRIAXONE

CEFTRIAXONE IV ORDERABLE. ERX# 4020017

Standard Dose (mg)	Lower Bound	Upper Bound	Standard Dose (mg)	Lower Bound	Upper Bound
4	0	3.999	222	200.001	219.999
8	4.001	7.999	240	220.001	239.999
12	8.001	11.999	260	240.001	259.999
16	12.001	15.999	280	260.001	279.999
20	16.001	19.999	300	280.001	299.999
24	20.001	23.999	320	300.001	319.999
28	24.001	27.999	340	320.001	339.999
32	28.001	31.999	360	340.001	359.999
36	32.001	35.999	380	360.001	379.999
40	36.001	39.999	400	380.001	399.999
44	40.001	43.999	440	400.001	439.999
48	44.001	47.999	480	440.001	479.999
52	48.001	51.999	520	480.001	519.999
56	52.001	55.999	560	520.001	559.999
60	56.001	59.999	600	560.001	599.999
64	60.001	63.999	640	600.001	639.999
68	64.001	67.999	680	640.001	679.999

72	68.001	71.999	720	680.001	719.999
76	72.001	75.999	760	720.001	759.999
80	76.001	79.999	800	760.001	799.999
84	80.001	83.999	840	800.001	839.999
88	84.001	87.999	880	840.001	879.999
92	88.001	91.999	920	880.001	919.999
96	92.001	95.999	960	920.001	959.999
100	96.001	99.999	1000	960.001	999.999
110	100.001	109.999	1100	1000.001	1099.999
120	110.001	119.99	1200	1100.001	1199.999
130	120.001	129.99	1300	1200.001	1299.999
140	130.001	139.999	1400	1300.001	1399.999
150	140.001	149.999	1500	1400.001	1499.999
160	150.001	159.999	1600	1500.001	1599.999
170	160.001	169.999	1700	1600.001	1699.999
180	170.001	179.999	1800	1700.001	1799.999
190	180.001	189.999	1900	1800.001	1899.999
200	190.001	199.999	2000	1900.001	1999.999

CEPHALEXIN

Cephalexin 250mg/5ml Oral Suspension. ERX# 9502

Standard Dose (mg)	Lower Bound	Upper Bound
25	22.5	27
30	27.01	32
35	32.01	37
40	37.01	44
50	44.01	56
65	56.01	69
75	69.01	86
100	86.01	110
125	110.01	135
150	135.01	170
200	170.01	225
250	225.01	270
300	270.01	345
400	345.01	450
500	450.01	550
600	550.01	650
750	650.01	855
1000	855.01	1150

Cephalexin 250mg/5ml Oral Suspension THP. ERX# 2009022

Standard Dose (mg)	Lower Bound	Upper Bound
25	22.5	27
30	27.01	32
35	32.01	37
40	37.01	44
50	44.01	56
65	56.01	69
75	69.01	86
100	86.01	110
125	110.01	135
150	135.01	170
200	170.01	225
250	225.01	270
300	270.01	345
400	345.01	450
500	450.01	550
600	550.01	650
750	650.01	855
1000	855.01	1150

FAMOTIDINE

Famotidine IV Orderable. ERX# 4020455

Standard Dose	Rounded Factor (mg)	Lower Bound	Upper Bound
	1	10.001	
	0.2	2.001	9.999
	0.08	1.001	1.999
	.04		0.999

FENTANYL

Fentanyl Citrate (PF) 50 MCG/ML INJ Solution. ERX# 101644

Standard Dose (mg)	Lower Bound	Upper Bound
7	6.501	7.5
8	7.501	8.5
9	8.501	9.5
10	9.501	10.85
12	10.8501	13.3
15	13.301	16.4
18	16.401	19
20	19.01	22
25	22.01	27.5
30	27.501	32
35	32.01	37
40	37.01	44
50	44.01	55
60	55.01	67
75	67.01	90
100	90.01	

HYDROCODONE/ACETAMINOPHEN

Hydrocodone/Acetaminophen 7.5-325 MG/15 ML Oral Solution. ERX# 37848

Standard Dose (ml)	Rounded Factor (mg)	Lower Bound	Upper Bound
	0.01		0.99
	0.2	1	4.49
5		4.5	6.25
7.5	.	6.26	8.62
10		68.63	12.5
15		12.51	

IBUPROFEN

Ibuprofen 100 MG/5 ML Oral Suspension. ERX# 10246

Standard Dose (mg)	Rounded Factor (mg)	Lower Bound	Upper Bound
	0.2		19.999
	2	20	59.99
60		60	74.999
80		75	94.999
100		95	109.999
120		110	139.999
150		140	187.999
200		188	229.999
240		230	289.999
300		290	375.999
400		376	

MORPHINE

Morphine 2mg/ml Syringe. ERX# 2006011

Standard Dose (mg)	Lower Bound	Upper Bound
0.5	0.4801	0.55
0.6	0.5501	0.64
0.7	0.6401	0.74
0.8	0.7401	0.85
0.9	0.8501	0.95
1	0.9501	1.1
1.2	1.101	1.33
1.5	1.3301	1.62
1.8	1.6201	1.9
2	1.901	2.2
2.4	2.201	2.5
2.6	2.501	2.77
3	2.7701	3.2
3.2	3.211	3.55
3.4	3.5501	4.45
5	4.4501	5.4
6	5.401	6.2
6.4	6.201	6.49
7	6.4901	7.49
8	7.4901	8.8
10	8.801	

OXYCODONE

Oxycodone 5mg/5ml Oral Solution. ERX# 10813

Standard Dose (mg)	Lower Bound	Upper Bound
0.4	0.36	0.425
0.45	0.42501	0.475
0.5	0.47501	0.545
0.6	0.54501	0.64
0.7	0.6401	0.74
0.8	0.7401	0.85
0.9	0.8501	0.95
1	0.9501	1.1
1.2	1.101	1.3
1.4	1.301	1.5
1.6	1.501	1.7
1.8	1.701	1.9
2	1.901	2.1
2.2	2.101	2.38
2.6	2.3801	2.8
3	2.801	3.1
3.2	3.101	3.4
3.6	3.401	3.8
4	3.801	4.45
5	4.4501	5.4
6	5.401	6.65
7.5	6.6501	7.7
8	7.701	8.8
10	8.801	

Appendix B: Pre-Implementation Survey

Study Questionnaire

Please complete the survey below.

Today's Date (MM-DD-YYYY):

_____

What is your current role?

Attending

Resident (years 2, 3)

Intern (year 1)

Pharmacist

Pharmacy Tech

What is your age range?

18 to 24 years

25 to 34 years

35 to 44 years

45 to 54 years

55 to 64 years

Age 65 or older

What year did you graduate from medical school (YYYY)?

_____

What year did you graduate from pharmacy school (YYYY)?

_____

What year did you graduate from pharmacy technician school?

_____

When did you begin working at RCH?

_____

Years:

_____

Months:

_____

If you are a intern or resident, please indicate what month(s) within the past year you worked at RCH?

Jan

Feb

Mar

Apr

May
Jun
Jul
Aug
Sept
Oct
Nov
Dec
For your last 10 pediatric patients, please rate the ease at which you were able to:
-Order IV Fentanyl, IV Morphine and/or Oxycodone oral solution within EPIC.
0 - Very Difficult
1 - Somewhat Difficult
2 - Neutral
3 - Somewhat Easy
4 - Very Easy
-Order Cefdinir, Cephalexin, Amoxicillin, Amoxicillin-clavulanic acid,
and/or Azithromycin within EPIC
0 - Very Difficult
1 - Somewhat Difficult
2 - Neutral
3 - Somewhat Easy
4 - Very Easy
Calculate the oral dose of Cefdinir, Cephalexin,
Amoxicillin, Amoxicillin-clavulanic acid, and/or Azithromycin within EPIC at time of discharge
0 - Very Difficult
1 - Somewhat Difficult
2 - Neutral
3 - Somewhat Easy
4 - Very Easy
For your last 10 pediatric patients, how many times did their inpatient antibiotic dose match their discharge antibiotic
dose?
0
123456789
10
For your last 10 pediatric patients, how many times did their inpatient opioid dose match their discharge opioid dose?

0

123456789

10

What is your level of satisfaction with the current medication dose ordering system within EPIC?

0 - Very Dissatisfied

1 - Dissatisfied

2 - Neutral

3 - Satisfied

4 - Very Satisfied

How challenging is it to draw up pediatric volumes of IV Fentanyl, IV Morphine, oral Oxycodone at this time?

0 - Very Challenging

1 - Somewhat Challenging

2 - Neutral

3 - Somewhat Easy

4 - Very Easy

How challenging is it to draw up pediatric volumes of Cefdinir, Cephalexin, Amoxicillin, Amoxicillin-clavulanic acid, and/or

Azithromycin at this time?

0 - Very Challenging

1 - Somewhat Challenging

2 - Neutral

3 - Somewhat Easy

4 - Very Easy

Appendix C: Post-Implementation Survey

Study Questionnaire

Please complete the survey below.

Today's Date (MM-DD-YYYY):

_____

What is your current role?

Attending

Resident (years 2, 3)

Intern (year 1)

Pharmacist

Pharmacy Tech

What is your age range?

18 to 24 years

25 to 34 years

35 to 44 years

45 to 54 years

55 to 64 years

Age 65 or older

What year did you graduate from medical school (YYYY)?

_____

What year did you graduate from pharmacy school (YYYY)?

_____

What year did you graduate from pharmacy technician school?

_____

When did you begin working at RCH?

_____

Years:

_____

Months:

_____

If you are a intern or resident, please indicate what month(s) within the past year you worked at RCH?

Jan

Feb

Mar

Apr

May

Jun

Jul

Aug

Sept

Oct

Nov

Dec

For your last 10 pediatric patients, please rate the ease at which you were able to:

-Order IV Fentanyl, IV Morphine and/or Oxycodone oral solution within EPIC.

0 - Very Difficult

1 - Somewhat Difficult

2 - Neutral

3 - Somewhat Easy

4 - Very Easy

-Order Cefdinir, Cephalexin, Amoxicillin, Amoxicillin-clavulanic acid,

and/or Azithromycin within EPIC

0 - Very Difficult

1 - Somewhat Difficult

2 - Neutral

3 - Somewhat Easy

4 - Very Easy

Calculate the oral dose of Cefdinir, Cephalexin,

Amoxicillin, Amoxicillin-clavulanic acid, and/or Azithromycin within EPIC at time of discharge

0 - Very Difficult

1 - Somewhat Difficult

2 - Neutral

3 - Somewhat Easy

4 - Very Easy

For your last 10 pediatric patients, how many times did their inpatient antibiotic dose match their discharge antibiotic

dose?

0

123456789

10

For your last 10 pediatric patients, how many times did their inpatient opioid dose match their discharge opioid dose?

0

123456789

10

What is your level of satisfaction with the current medication dose ordering system within EPIC?

0 - Very Dissatisfied

1 - Dissatisfied

2 - Neutral

3 - Satisfied

4 - Very Satisfied

How challenging is it to draw up pediatric volumes of IV Fentanyl, IV Morphine, oral Oxycodone at this time?

0 - Very Challenging

1 - Somewhat Challenging

2 - Neutral

3 - Somewhat Easy

4 - Very Easy

How challenging is it to draw up pediatric volumes of Cefdinir, Cephalexin, Amoxicillin, Amoxicillin-clavulanic acid, and/or

Azithromycin at this time?

0 - Very Challenging

1 - Somewhat Challenging

2 - Neutral

3 - Somewhat

Medication standardization is a process of making medications conform to a particular dose if they fall within a certain dose banding range. For example, a patient that was prescribed 440mg of Amoxicillin 250mg/5ml would receive a standardized medication dose of 400mg as the system is set to round any dose between 345.01 to 450mg to 400mg. The following medications were standardized:

1. Keflex 250mg/5ml Oral Susp. Med # 9502
2. Keflex 250mg/5ml Oral Susp. THP. Med # 2009022
3. Amoxicillin 250mg/5ml Oral Susp. Med # 454
4. Amoxicillin 400mg/5ml Oral Susp. Med # 25246
5. Amoxicillin 400mg/5ml Oral Susp. THP. Med # 22009018
6. Augmentin 250mg/5ml Oral Susp. Med # 98229
7. Augmentin 400mg/5ml Oral Susp. Med # 33230
8. Augmentin 400mg/5ml Oral Susp. THP. Med # 2009000
9. Augmentin 600mg/5ml Oral Susp. Med # 31177
10. Augmentin 600mg/5ml Oral Susp. Med # 31177
11. Augmentin 600mg/5ml Oral Susp. THP. Med # 2009035
12. Azithromycin 200mg/5ml Oral Soln. Med # 15797
13. Cefdinir 250mg/5ml Oral Susp. Med # 39522
14. Cefdinir 250mg/5ml Oral Susp. THP. Med # 2009054
15. Fentanyl Citrate 50 mcg/ml Inj Soln. Med # 101644
16. Morphine 2mg/ml Syringe. Med # 200611
17. Oxycodone 5mg/5ml Oral Soln. Med # 10813

Please answer the following questions with these medications in mind.

What are three things you like most about the standardized medication orders?

What are three things you would like to change about the standardized medication options to make them better?

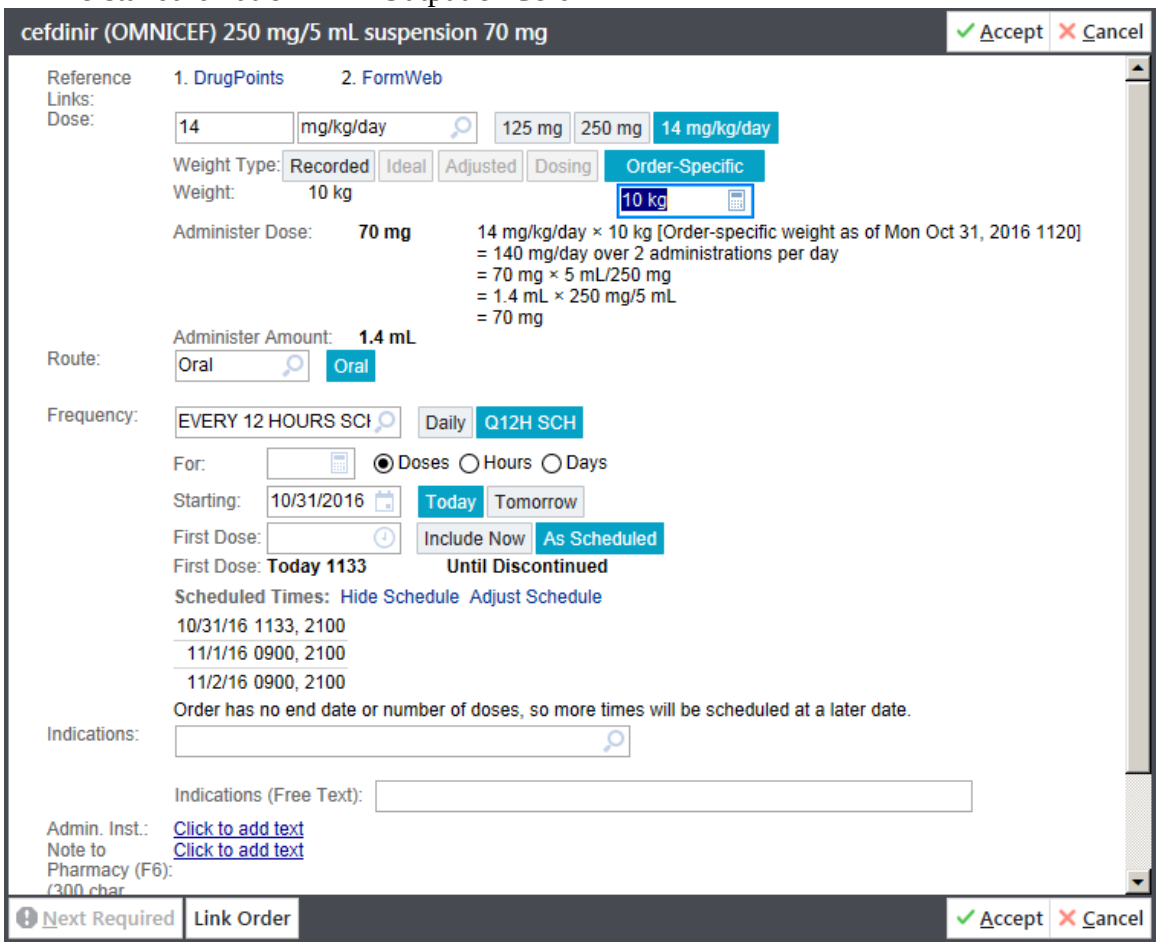
What is your overall reaction to the new medication reconciliation?

What is your overall reaction to medication standardization options?

Any additional comments on dose standardization:

Appendix D: Sample of Standardization Process

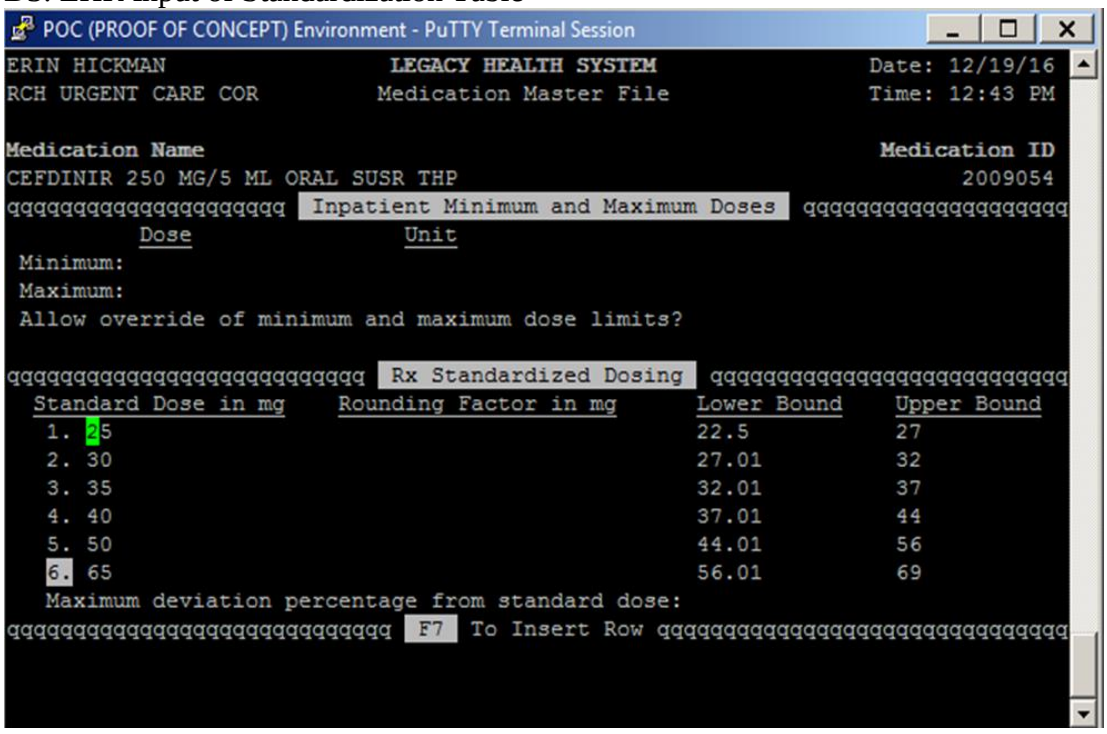
D1 Pre-standardization EHR Output of Cefdinir

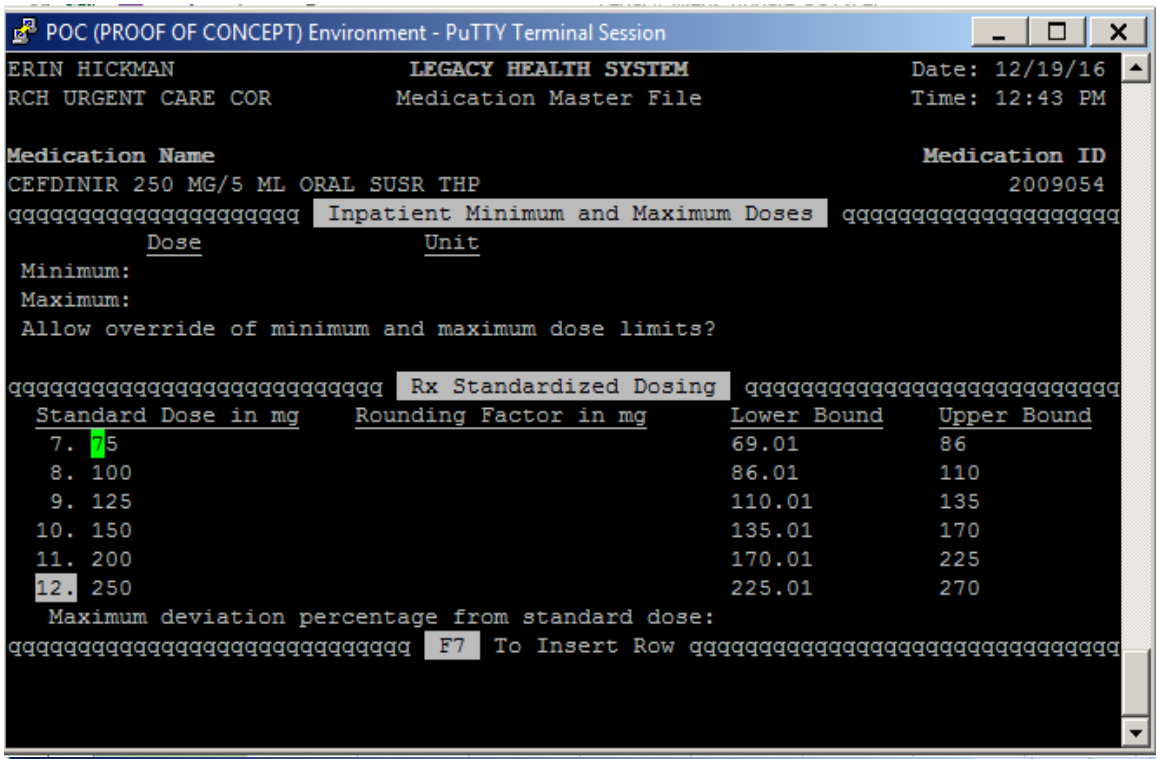


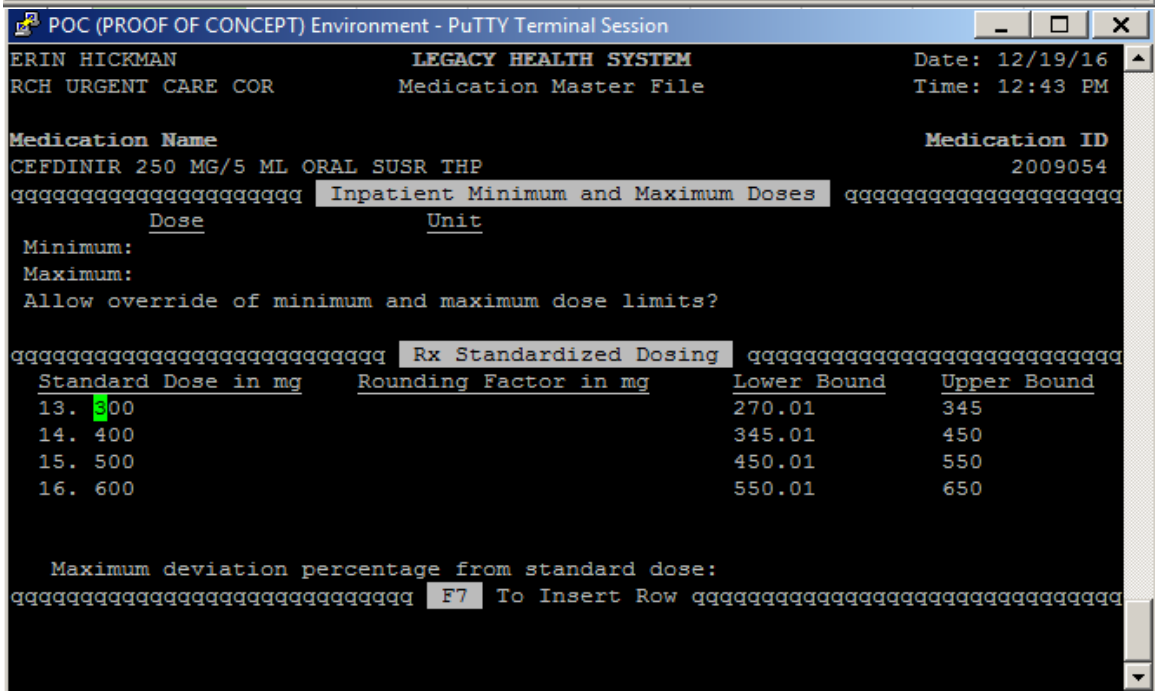
D2: Cefdinir Standardization Table

Cefdinir						
Concentration	Dose (mg)	Dose (ml)	LowBound	UpperBound	LowBound%	UpperBou
250mg/5ml	25	0.5	22.5	27	10%	8%
	30	0.6	27.01	32	10%	7%
	35	0.7	32.01	37	9%	6%
	40	0.8	37.01	44	7%	10%
	50	1	44.01	56	12%	12%
	65	1.3	56.01	69	14%	6%
	75	1.5	69.01	86	8%	15%
	100	2	86.01	110	14%	10%
	125	2.5	110.01	135	12%	8%
	150	3	135.01	170	10%	13%
	200	4	170.01	225	15%	13%
	250	5	225.01	270	10%	8%
	300	6	270.01	345	10%	15%
	400	8	345.01	450	14%	13%
	500	10	450.01	550	10%	10%

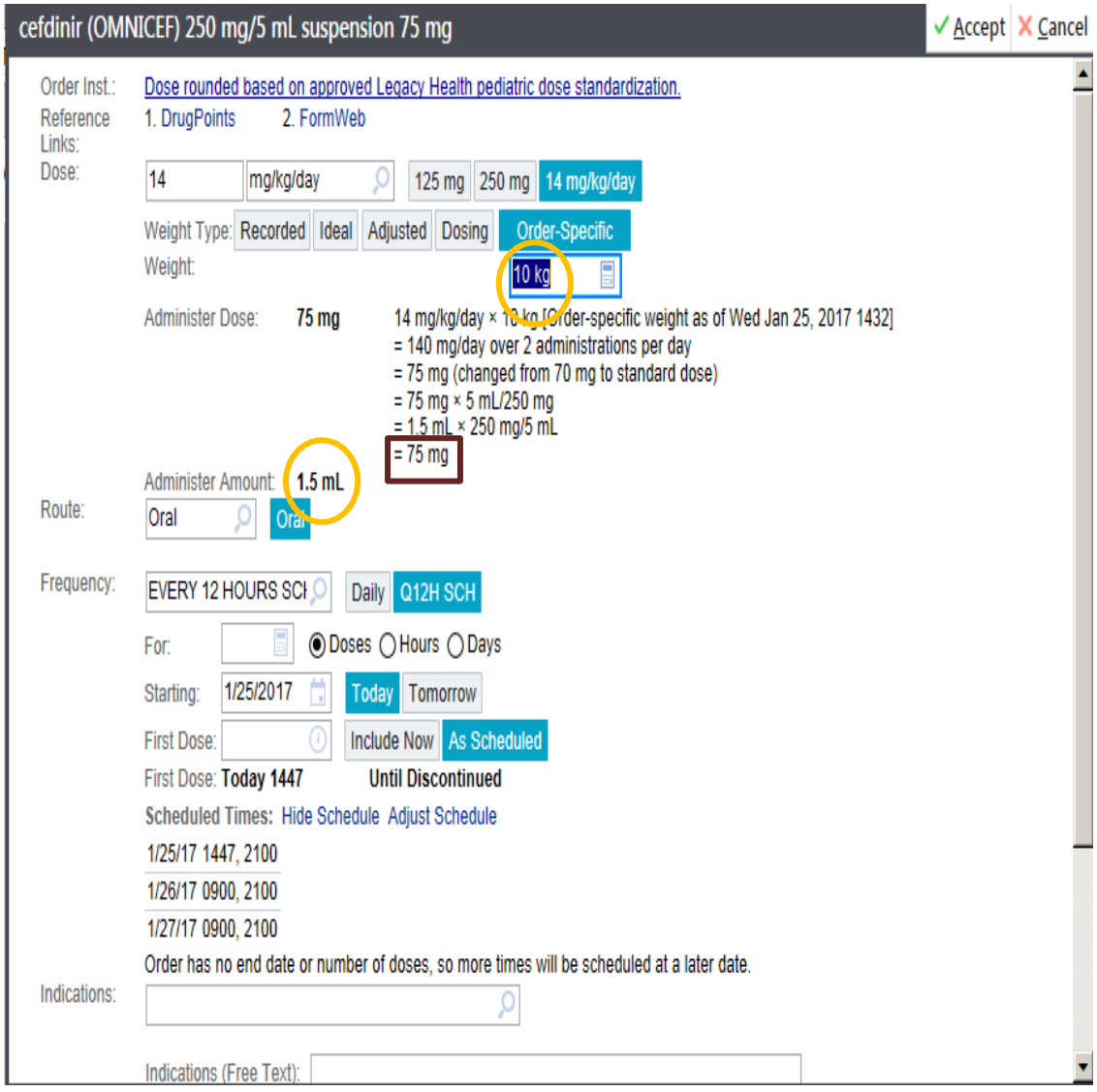
D3: EHR Input of Standardization Table




POC (PROOF OF CONCEPT) Environment - PuTTY Terminal Session
ERIN HICKMAN
LEGACY HEALTH SYSTEM
Date: 12/19/16
RCH URGENT CARE COR
Medication Master File
Time: 12:43 PM
Medication Name
Medication ID
CEFDINIR 250 MG/5 ML ORAL SUSR THP
2009054
Inpatient Minimum and Maximum Doses
Dose
Unit
Minimum:
Maximum:
Allow override of minimum and maximum dose limits?
Rx Standardized Dosing
Standard Dose in mg
Rounding Factor in mg
Lower Bound
Upper Bound
7. 75
69.01
86
8. 100
86.01
110
9. 125
110.01
135
10. 150
135.01
170
11. 200
170.01
225
12. 250
225.01
270
Maximum deviation percentage from standard dose:
F7
To Insert Row


POC (PROOF OF CONCEPT) Environment - PuTTY Terminal Session
ERIN HICKMAN
LEGACY HEALTH SYSTEM
Date: 12/19/16
RCH URGENT CARE COR
Medication Master File
Time: 12:43 PM
Medication Name
Medication ID
CEFDINIR 250 MG/5 ML ORAL SUSR THP
2009054
Inpatient Minimum and Maximum Doses
Dose
Unit
Minimum:
Maximum:
Allow override of minimum and maximum dose limits?
Rx Standardized Dosing
Standard Dose in mg
Rounding Factor in mg
Lower Bound
Upper Bound
13. 300
270.01
345
14. 400
345.01
450
15. 500
450.01
550
16. 600
550.01
650
Maximum deviation percentage from standard dose:
F7
To Insert Row

D4: Post-standardization EHR Output of Cefdinir



Appendix E: Staff Free-Reponses Regarding Medication Standardization

Love it!

It's working as intended, which is actually a fairly impressive commendation

Faster prep time, fewer dilutions to be made so less waste of drug at the end of the day, & better patient safety
To actually standardize it! Not let physicians continuously custom make everything. That creates nothing but possibilities for errors plus the amount of drug waste that is involved by constantly changing everything is astronomical
Wish we had it at Emanuel & Randall's for the sake of patient safety.
Would LOVE to see it happen for patient safety, to help reduced prep time, and to stop wasting so much drug!

1.Medication administration policies and procedures
2.Routes of medication administration
3.entering medication orders
Training in medication administration
MEDICATION ASSESSMENT PROTOCOL
Patient Tool: Universal Medication Form
Medication Reconciliation is definitely the right thing to do. We have certainly caught errors that could have caused harm to patients, which helps staff and physicians better understand the importance of MedRec."
Standard Medication Safety Safety and Quality Improvement Guide.

more practical for the patients and easier for them to dose
easy for us
safer
favorable

Helps with dosing and potentially prevents overdosing, efficient
I don't like rounding in antibiotics if the rounding interval is large
Happy when the rounding dose is close, annoyed when it is not

Efficiency, Safety, Information
Indications
Good

Alerts provider with percentage of over dosing, parent/patient friendly with easy to administer doses
Rounding down or up doses without clear notification, inability to order in mL with some medications
Neutral

Appendix F: Chi-Squared Pre-/Post-Standardization

Amoxicillin 250mg/5ml

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.175[a]	1	.675		
Continuity Correction[b]	.072	1	.788		
Likelihood Ratio	.175	1	.675		
Fisher's Exact Test				.764	.395
N of Valid Cases	188				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 33.39.

b. Computed only for a 2x2 table

Amoxicillin 400mg/5ml

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.001[a]	1	.970		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.001	1	.970		
Fisher's Exact Test				1.000	.643
N of Valid Cases	520				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.95.

b. Computed only for a 2x2 table

Amoxicillin 400mg/ml THP

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.917[a]	1	.338		
Continuity Correction[b]	.006	1	.936		
Likelihood Ratio	1.434	1	.231		
Fisher's Exact Test				1.000	.509
N of Valid Cases	11				

a. 3 cells (75.0%) have expected count less than 5. The minimum expected count is .55.

b. Computed only for a 2x2 table

Amoxicillin-clavulanic acid 600mg/5ml

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.727[a]	1	.030		
Continuity Correction[b]	3.343	1	.068		
Likelihood Ratio	5.449	1	.020		
Fisher's Exact Test				.038	.029
N of Valid Cases	139				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 4.14.

b. Computed only for a 2x2 table

Amoxicillin-clavulanic acid 400mg/5ml

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.387[a]	1	.036		
Continuity Correction[b]	3.597	1	.058		
Likelihood Ratio	4.586	1	.032		
Fisher's Exact Test				.047	.027
N of Valid Cases	133				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 14.29.

b. Computed only for a 2x2 table

Azithromycin 200mg/5ml

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	12.161[a]	1	.000		
Continuity Correction[b]	11.054	1	.001		
Likelihood Ratio	12.290	1	.000		
Fisher's Exact Test				.001	.000
N of Valid Cases	168				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 27.27.

b. Computed only for a 2x2 table

Cefdinir 250mg/5ml

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.197[a]	1	.023		
Continuity Correction[b]	4.334	1	.037		
Likelihood Ratio	5.348	1	.021		
Fisher's Exact Test				.029	.018
N of Valid Cases	115				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 16.76.

b. Computed only for a 2x2 table

Cefdinir 250mg/5ml THP

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.659[a]	1	.198		
Continuity Correction[b]	.525	1	.469		
Likelihood Ratio	1.752	1	.186		
Fisher's Exact Test				.301	.238
N of Valid Cases	14				

a. 3 cells (75.0%) have expected count less than 5. The minimum expected count is 2.14.

b. Computed only for a 2x2 table

Keflex 250mg/ml

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	9.596[a]	1	.002		
Continuity Correction[b]	8.800	1	.003		
Likelihood Ratio	9.383	1	.002		
Fisher's Exact Test				.002	.002
N of Valid Cases	315				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 31.21.

b. Computed only for a 2x2 table

Keflex 250mg/5ml THP

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.694[a]	1	.405		
Continuity Correction[b]	.174	1	.677		
Likelihood Ratio	.692	1	.405		
Fisher's Exact Test				.442	.337
N of Valid Cases	25				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 4.00.

b. Computed only for a 2x2 table

Oxycodone 5mg/5ml Oral Solution

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	79.073[a]	1	.000		
Continuity Correction[b]	78.285	1	.000		
Likelihood Ratio	79.486	1	.000		
Fisher's Exact Test				.000	.000
N of Valid Cases	2133				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 398.94.

b. Computed only for a 2x2 table

Morphine 2mg/mml Syringe

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	36.023[a]	1	.000		
Continuity Correction[b]	35.566	1	.000		
Likelihood Ratio	35.866	1	.000		
Fisher's Exact Test				.000	.000
N of Valid Cases	3023				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 463.41.

b. Computed only for a 2x2 table

Fentanyl Citrate 50mcg/ml Inj Soln

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	142.999[a]	1	.000		
Continuity Correction[b]	142.241	1	.000		
Likelihood Ratio	146.711	1	.000		
Fisher's Exact Test				.000	.000
N of Valid Cases	4569				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 629.37.

b. Computed only for a 2x2 table