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A Framework for the Evaluation of Medication Errors in the Inpatient Setting

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A Framework for the Evaluation of Medication Errors in the Inpatient Setting

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Background

Medication Errors

Over fifteen years ago, The Institute of Medicine's "To Err is Human" shed light on medication-related errors and their adverse effect on patient safety and quality.[1] Medication use is ubiquitous in the United States. It is estimated that more than four out of five adults in the United States take at least one prescription or over-the-counter medication, and nearly one third of adults use at least five medications.[2] Given these staggering medication use rates, it is not surprising that medication errors are some of the most prevalent types of errors seen across the healthcare continuum.[3] These statistics can be applied to the hospital population demographic as well. Although the incidence based on prior literature is controversial, medication errors occurring in the inpatient hospital setting are estimated to range between 1.5% and 35%.[4]

Medication errors are costly; both with regards to increased healthcare expenditure as well as the adverse effects on society.[5] A study looking at the cost of medication injuries reported in the states of Utah and Colorado concluded that adverse drug events comprised 32% of all reported events, and were the second most costly type, generating expenses of about $213,750,000/year.[5] This was extrapolated to amount to nationwide costs approaching $5.2 billion/year.[5] Errors not only result in increased hospital expenditure, but also lead to adverse societal costs ranging from disability and lost income to decreased worker productivity and reduced school attendance.[5] Factoring in the cost of outpatient healthcare, lost wages, and lost household production to the prior figure, Thomas et al. estimated the national cost of adverse drug events to be $12.2 billion/year.[5] Medication errors also result in dissatisfaction with respect to both the patient and the healthcare professional, and can lead to an overall loss of trust in the healthcare system.[1]

Data has shown that transitions of care are particularly high-risk times for medication errors as patients transition between inpatient and outpatient settings.[6]

> "Interfaces of care" [are] points of contact with patient care in which a caregiver is transferring, admitting, or discharging a patient to another floor in the hospital or to another health care organization. At the point of this transition, vulnerability has been created within the health care system. This occurs because essential data must accompany each patient and be assimilated by the new environment to ensure that care is not compromised.[6]

According to Bates et al., nearly half of preventable adverse drug events in hospitalized patients occur at the ordering stage.[4] Upon admission to the hospital, it is good practice to have providers obtain an accurate list of medications a patient is taking at home to provide uninterrupted and appropriate treatment while the patient is hospitalized.[7] An inaccurate list of outpatient medications may hinder the provider's ability to detect drug-related problems that can potentially cause admissions such as interactions, adverse drug events, or medication noncompliance.[7-9] A preadmission medication list can be obtained from a variety of sources including patients themselves, family members or caregivers, pharmacy refill information, outpatient medical records, and previous admission records.[10] There exists no all-inclusive electronic medical record; therefore all of these sources can contain inconsistencies.[10] Medication errors from the medication list at admission can then carry through to the patient's new medication regimen at discharge, resulting in omission of drugs, drug duplication, incorrect dosages, and drug interactions.[11,12]

Patients undergoing the transition of care process face a variety of obstacles. Changes in a person's health status frequently cause them to be under the care of several prescribing providers, all of which are simultaneously adjusting the patient's medication list.[6,13] It is important to consider the fact that hospitalized patients rely on clinical staff to administer medications at appropriate dosages and times, which can cause complacency during their inpatient stay.[13] Upon discharge, patients and their families are suddenly expected to self-manage their medications in tandem with their recovery process.[13] Undesirable side effects and the high cost of some medications are significant barriers that can also affect compliance.[6] All of these factors can in some way result in variations between the medications a patient is prescribed, the medications a patient is actually taking, and the written list of medications found in the patient's medical record.[14,15]

Discrepancies between home medications and inpatient medications place patients at high risk for adverse drug events and may lead to increased emergency department visits, hospital readmissions, and increased utilization of other resources.[15] A prospective cohort study focusing on adverse events found that 19% of patients experienced an adverse event following discharge, the most common of which was an adverse drug event (66%).[16] A similar study found 11% of patients experienced an adverse drug event following discharge.[17] Of these patients, 42% required additional healthcare because of the event and of those patients, the largest percentage were eventually readmitted to the hospital (16%); 11% visited a physician's office and 11% attended an emergency department.[17]

It has been reported that approximately 20% of Medicare patients discharged from the hospital are readmitted within 30 days.[18-20] Readmissions ultimately cost Medicare nearly $17.4 billion dollars a year and are now being viewed as a marker of healthcare quality.[20] Section 3025 of the Affordable Care Act established the *Hospital Readmissions Reduction Program (HRRP)* under the Centers for Medicare and Medicaid Services (CMS) to reduce healthcare expenditures, increase patient safety, and impose sanctions on hospitals reporting excessive readmissions.[21] Medication errors and adverse drug events have become an area of increased focus as hospitals are now commonly identifying patients at the highest risk of being readmitted with the end goal of targeting specific populations to prevent readmissions.[20]

Medication Reconciliation

Medication reconciliation is an approach designed to decrease medication discrepancies, and ultimately reduce the negative outcomes associated with discrepancies. It is defined as:

> A process of comparing the medications an individual is taking (and should be taking) with newly ordered medications. The comparison addresses duplications, omissions, and interactions, and the need to continue current medications. The types of information that clinicians use to reconcile medications include (among others) medication name, dose, frequency, route, and purpose.[22]

Medication reconciliation has been recognized by The Joint Commission as a National Patient Safety Goal (NPSG) and as of 2011, was incorporated into NPSG #3 for "Improving the Safety of Using Medications."[22] Elements of this safety goal include: obtaining and/or updating medications a patient is currently taking; defining the types of medication information; comparing the medication being taken with the medication ordered and resolving discrepancies; providing written information to the patient regarding medications; and explaining the importance of managing medications to the patient.[22]

Medication reconciliation has been statistically shown to reduce medication variances across the healthcare continuum.[15] A meta analysis of 26 medication reconciliation studies showed that reconciliation resulted in a reduction in medication discrepancies in 17 of 17 studies, potential adverse drug events in five of six studies, and adverse drug events in two of two studies.[15] At one hospital, pharmacy technicians performing medication reconciliation reduced errors by 80% in patients preparing for surgery.[23] The analysis by Mueller et al. did not find a reduction in post-discharge healthcare utilization however, as there was only an improvement in two of eight studies.[15] More research is needed to determine if medication reconciliation translates into a reduction in healthcare utilization after discharge.

The ability to conduct accurate medication reconciliation is hampered by many issues. The amount of available time to conduct the interview and complete the entire process may affect the quality of the information.[10,12,24] Language barriers and poor health literacy may also play a role, especially in hospitals with a large proportion of underserved patients.[10] Other issues include patient-associated factors namely illness severity, cognitive status, or the patient's familiarity with his or her medication regimen.[8,12] Lastly, many disconnects are caused by hospital formulary substitutions, multiple prescribing physicians, and the use of different pharmacies, which make it difficult to verify prescribed medications as well as a patient's compliance with medications.[10] All of these issues result in errors in medication reconciliation when patients are admitted and discharged from the hospital.

According to a 2005 meta-analysis by Tam et al. examining 22 articles totaling 3,755 patients, up to 83% of patients have medication reconciliation errors upon admission to the hospital.[9] The authors noted much variation in outcomes measures, specifically what defined a medication error.[9] Most studies defined error as a discrepancy between the verbal list of home medications obtained from the patient and either the written medication list in the medical record or the medication orders while the patient is hospitalized.[9] Types of errors included omission and commission as well as dosage and frequency errors.[9] Errors of omission are drugs being used by the patient that are not recorded in the medical history, while errors of commission are drugs listed in the medical record that are not being taken by the patient.[9]

Notable studies addressed in the meta analysis include Beers et al.[24] and Lau et al.[7] Both of these studies defined error as a discrepancy between the written medication list in the medical record and the verbal medication lists obtained from the patient. Beers et al. conducted a study comparing medication histories recorded in hospital medical records of patients greater than 65 years old to a structured history obtained from the patient by a trained research assistant. The study was conducted in Los Angeles at two hospitals, one of which was a university hospital. The sample included 122 patients with an average age of 76.6 years and average number of drugs per patient of 5.1. The study found that when including all drugs, including non-prescription drugs, 83% of patients had at least one error and 46% of patients had three or more errors. When excluding non-prescription drugs, topical medications, and cold remedies, they found 60% of patients had at least one error and 18% had three or more errors. Errors of omission accounted for the majority of errors. Based on a linear regression analysis, the authors determined that the risk of having an error increased with total number of medications, although age, sex, and hospital site were not predictors.

In a prospective study, Lau et al. studied the completeness of medication histories for patients greater than 40 years old admitted to the general medicine floor of two acute care hospitals in the Netherlands who had hospital stays greater than two days.[7] The researchers interviewed patients and obtained a verbal list of medications taken by the patient and then verified this list of medications with pharmacy records. They then compared this verified list to the medication history in the medical record. The authors excluded over-the-counter drugs. The sample included 304 patients with an average age of 71.5 years. The average number of drugs per patient according to the hospital medical records was 4.1. The study determined that 67% of patients had at least one error; specifically 29% had one error, 20% had two errors, and 18% had three or more errors. They also found that omission errors accounted for the majority of errors compared to a commission error. Of note, both Lau et al. and Beers et al. did not take into account errors in dosage or regimen.

Another notable study from the meta analysis was Cornish et al., who conducted a prospective study of patients admitted to the general medicine floors at a 1000-bed tertiary care teaching hospital affiliated with the University of Toronto during a three-month period.[8] The authors' primary outcome was unintended medication discrepancies between a medication history obtained by a pharmacist, pharmacy student, or medical student and the admission medication orders. Patients were only included who took at least four drugs prior to admission. Of 151 patients, the mean age of patients was 77 years old. This study found that in 151 patients, 81 (53.6%) had at least one discrepancy between home medications and admission orders. The most common error was an omission of a regularly used medication. The study also noted that 39% of these errors had the potential to cause moderate to severe harm. This study did not find a relationship between the number of medications that the patient was taking before admission and the risk for unintended discrepancies.

Lessard et al. conducted a small prospective study at a 1000-bed community teaching hospital to study medication discrepancies for senior patients at least 55 years old admitted to the medical intermediate care unit.[25] Medication histories were gathered by pharmacists or pharmacy students and compared with admission orders. The study sample was 63 patients; there was a mean age of 74 years and mean number of medications of 7.2. Of the 63 patients, 41 patients (65%) had a medication discrepancy. Of note, for patients taking 1-9 preadmission medications, there was a median discrepancy rate of one per patient whereas for patients taking 10-19 medications, there was a median discrepancy rate of two per patient.

In a similar study to Lessard et al., Gleason et al. conducted a study to determine risk factors of medication errors at admission by comparing pharmacist and hospital-based physician medication histories to medication orders at Northwestern Memorial Hospital in Chicago.[10] The authors considered medication errors to be discrepancies that resulted in hospital orders. Of the 651 patients, 234 patients (35.9%) were found to have errors and of these, 85% had medication errors that originated based on their medication histories and carried through to their inpatient medication orders. The most common type of an error was an omission (48.9%), followed by a different dosage (30.4%) and frequency (11%). Patient factors associated with increased errors included age over 65 and a larger number of prescriptions on admission.

Problems with medication reconciliation also occur at discharge. A study showed that 14% of the 375 study patients aged 65 years and older experienced one or more medication discrepancies during the transition from hospital to home, with a mean of 1.6 discrepancies.[14] Incomplete, inaccurate, or illegible discharge instructions were found to be the most common system-associated discrepancy. Patients with a noted medication discrepancy were prescribed more medications on average than patients without a discrepancy. Data also showed that the readmission rate for patients with medication discrepancies is higher than patients without medication discrepancies, 14.3% and 6.1% respectively. Another study focusing on discontinuity of care found that 42% of the 86 patients in the study sample had at least one medication error in transitioning from the inpatient to outpatient setting.[26]

Not all medication errors are clinically significant and have the potential to cause harm. A 2013 meta analysis focusing on clinically significant medication discrepancies by Kwan et al.

found the median proportion of patients with at least one clinically significant discrepancy to be 45%.[27] Pippins et al. conducted a small prospective observational study at two large academic hospitals in Boston, Massachusetts comparing preadmission medication histories taken by pharmacists versus a medical team's admission notes.[28] Data was subsequently compared with all admission and discharge medication orders. The primary outcome was the number of potentially harmful unintentional medication discrepancies per patient, also known as potential adverse drug events (PADEs). The study showed that of the 180 study patients, 54% of patients had at least one PADE, 37% had two or more PADEs, and 9% had five or more. The majority of errors (72%) were found to occur while taking the preadmission medication history. Similar to other studies, 60% were due to omissions. In their multivariable model, the factors that independently predicted a higher number of PADEs were as follows: four or more "high-risk" medications (those with indications for gout, respiratory conditions, depression, hyperlipidemia, or muscle relaxants) prescribed at admission, six or more medication changes during the hospitalization, low or medium patient understanding of preadmission medications, medication history supplied by a family member or caregiver, 13 or more outpatient visits during the previous year, and admission history taken by an intern.

Study Purpose and Specific Aims

The purpose of this study is to examine continuity of medication history collection as patients are admitted to the hospital from the outpatient setting. Home medication lists collected by pharmacy students were compared with medication lists compiled by admitting medical teams at time of admission as well as compared to inpatient medication orders to determine the prevalence of errors and potential predictors for errors in medication ordering. The end goal is to create a model to predict the likelihood of medication errors. Specific aims include: analysis of patients' demographic data; identifying the prevalence of medication list errors (*defined as discrepancies between verbal histories obtained from the patient and the medication list in the electronic medical record collected at the time of admission*); identifying the prevalence of inpatient medication order errors *(defined as discrepancies between verbal histories obtained from the patient and the medication orders while the patient is admitted)*; conducting bivariate logistic regression to determine odds ratios for variables of gender, race, language, time period, and number of medications; conducting multivariate logistic regression to determine odds ratio for all above variables together; and proposing a model framework for predicting errors in medication ordering.

Hypothesis

Based on examining prior literature which compared verbal medication histories obtained from the patient to written medication records and seeing errors rates of 83% when including over-the-counter drugs,[24] I hypothesize medication list errors to occur in over 80% of patients as this dataset includes non-prescription drugs. Because prior studies defined an error in very limited terms, this likely underestimated the total number of errors. Given my expanded definition of an error, I predict more errors will be uncovered in this patient sample. Lessard et al. conducted a study at a community teaching hospital with a similar patient population and found medication discrepancies in 65% of patients while comparing pharmacist-obtained medication histories to inpatient medication orders.[25] I therefore suspect a similar percentage of patients with medication order errors. I hypothesize a higher percentage of errors in the written medical record than medication orders because not all preadmission home medications are ordered when the patient is hospitalized.

I will also propose a model to determine predictors for medication order errors and directionality for the likelihood of medication errors. I do not hypothesize statistical significance based on the small sample size and do not hypothesize the ability to predict risk. Based on prior literature, I suspect a direct relationship between number of home medications and error[10,24,25] as well as age.[10] I also expect errors to decrease from July 2014 to January 2015 as there were multiple education sessions presented to the attending and resident physicians during this time frame. I do not expect to find an association between gender, language, or race and error.

Methods

Study Setting

The study was conducted at John Dempsey Hospital (JDH) located in Farmington, Connecticut. JDH is a university hospital affiliated with the University of Connecticut. A 174-bed teaching hospital, the hospital admitted 8,558 patients between October 1, 2013 and September 30, 2014.[29] The majority of patients receiving care at JDH are white (76%) followed by Hispanic/Latino (10.6%) and African-American (9.6%). The overwhelming majority of patients speak English (95.5%). The study was not determined to be Human Subjects Research by the IRB at UConn Health and thus was IRB exempt.

Sample Patients

The data used for this thesis was originally collected for a quality improvement project by medication safety pharmacist Ruth LaCasse Kalish and several University of Connecticut pharmacy students while on their clinical rotations. In July 2014 and January 2015, patients were identified via daily emails sent to the Health Quality Department of admitted patients. Inclusion criteria included patients greater than 18 years old with a primary diagnosis or history of heart failure, a primary diagnosis or history of chronic obstructive pulmonary disease (COPD), and a primary diagnosis of myocardial infarction. Exclusion criteria included patients admitted from another facility, specifically a skilled nursing facility, patients admitted to the ICU for the first 24-48 hours of their hospital admission, patients admitted to the hospice service, and lastly, patients unavailable or unable to be interviewed prior to their discharge.

In preparation for each patient interview, pharmacy students extensively reviewed the patient's medical record for home medication lists, outpatient prescription information history, and any other pertinent parts of the clinical record such as prior discharge summaries or notes from the emergency department and/or ambulatory care clinics. If medication lists were not available in the clinical record, pharmacy students called the patient's pharmacy to obtain the most recent prescription fill history. Demographic information was also collected. After the background information was gathered, an interview was performed with either the patient or family members/caregiver to obtain a medication regimen, which included both prescription and over-the-counter medications. Lists collected by pharmacy students were then compared with the lists collected by medical house staff and subsequently cross-referenced with the actual medications ordered while the patient was hospitalized at JDH.

Between July 2014 and January 2015, there was a Grand Rounds devoted to medication reconciliation errors, during which the July 2014 medication error data was presented. There were also two teaching sessions given by a pharmacist to the medical residents in November and December regarding medication reconciliation errors.

Measures and Data Collection

Patient demographic data included age, gender, primary language, race, insurance type, and marital status. Information regarding heart failure, COPD, and myocardial infarction diagnoses was also collected. For the purpose of this study, medication list errors are defined as discrepancies between the verbal list of medications obtained from the patient by the pharmacy students and the medication list in the medical record, whereas medication order errors are discrepancies between the verbal list of medications obtained from the patient by the pharmacy students and actual medication orders while the patient was admitted to the hospital.

Statistical Analysis

Study patients were separated into two groups based on the number of home medications taken prior to admission. Of note, two patients were removed from the analyses because these patients did not take any home medications, resulting in 98 patients available for analyses. A t test calculator was used to determine the significance of independent means and z test calculator was used to determine the significance of population proportions. Binary logistic regression analyses were then conducted to determine the significance of age, race, language, time period, and number of home medications on the likelihood of having a medication order error. Analyses were conducted with Excel 2010 (Microsoft, Redmond, WA) and SPSS software version 22 (SPSS Inc., Chicago, IL). A p value of ≤ 0.05 was considered statistically significant.

Results

Table 1. Demographic Data*

	1-11 Preadmission Medications (n = 52)	**> 11 Preadmission Medications (n = 46)**	**P-value**
Number of medications, mean	7.73	16.5	
Age, mean (years)	71.8	74.8	0.29
Gender (female)	25 (48%)	23 (50%)	0.85
Race (white)	46 (88.5%)	38 (82.6%)	0.41
Language (English)	46 (88.5%)	44 (95.7%)	0.19

***** Data are given as number (percentage) unless otherwise indicated
** Significant at $P \leq 0.05$

Table 2. Medication Errors*

	1-11 Preadmission Medications (n = 52)	**> 11 Preadmission Medications (n = 46)**	**P-value**
Medication list errors	48 (92.3%)	45 (97.8%)	0.21
Total number of medication list errors	179	311	
Medication list errors per patient, mean	3.73	6.91	
Medication order errors	27 (54%)	35 (76%)	0.01**
Total number of medication order errors	39	90	
Medication order errors per patient, mean	1.44	2.57	

* Data are given as number (percentage) unless otherwise indicated
** Significant at $P \leq 0.05$

Table 3. Bivariate Analysis Odds Ratios

	Total patients (n = 98)	**July 2014 (n = 50)**	**January 2015 (n = 48)**
Male vs. female	1.33	0.50	2.29
White vs. nonwhite	2.37	*	1.15
English vs. non-English	0.96	1.18	0.83
July 2014 vs. January 2015	0.46	--	--
1-11 preadmission medications vs. >11 preadmission medications	2.95**	4.10	2.80

* Cannot be analyzed due to no non-white patients without medication order errors
** Significant at $P \leq 0.05$

Table 4. Multivariate Analysis Odds Ratios

	Total patients (n = 98)
Age	1.02
Male vs. female	0.93
White vs. nonwhite	3.21
English vs. non-English	0.72
July 2014 vs. January 2015	0.40
Number of medications	1.14**

** Significant at $P \leq 0.05$

Of the 98 study patients, the mean number of medications per patient was 11.84. Demographic data for the patients can be found in Table 1. Patients taking 1-11 preadmission medications compared to patients taking more than 11 preadmission medications did not significantly differ in age (p = 0.29), gender (p = 0.85), race (p = 0.41), or language (p = 0.91).

Table 2 shows medication error data. Of the 52 patients taking 1-11 preadmission medications, 48 patients (92.3%) had medication list errors. There were a total of 173 errors in this group with 3.73 errors per patient on average. Of the 46 patients with greater than 11 preadmission medications, 45 patients (97.8%) had medication list errors with a total of 311 errors, averaging 6.91 errors per patient. There was no statistical different between the number of patients with medication list errors between these two groups of patients ($p = 0.21$). With regards to medication order errors, there was a statistically significant difference in the number of patients with medication order errors based on the number of home medications. For patients with 1-11 preadmission medications, 27 patients (54%) had medication order errors compared to 35 patients (76%) of those taking more than 11 preadmission medications ($p = 0.01$).

Odds ratios were calculated for each categorical variable to determine the how the likelihood of a medication order error changes for each individual potential predictor (Table 3). The data was analyzed using all sample patients as well as compared patients in the two time periods of July 2014 and January 2015. Due to the high percentage of sample patients with medication list errors and therefore the few numbers of patients without medication list errors available for comparison, only medication order errors were analyzed by regression analysis. The dependent variable was a dichotomous variable, namely the presence versus absence of a medication order error.

For all patients, the likelihood of a medication order error increased for male to female gender, white race to other race, and 1-11 preadmission medications to more than 11 preadmission medications. The time variable, from July 2014 to January 2015, decreased the likelihood of error. English language versus other language had an odds ratio of nearly 1, indicating virtually no directionality for predicting errors. Number of medications was statistically significant ($p = 0.015$) whereas time period was nearly significant ($p = 0.069$). Also included in Table 3 are the odds ratios based on the time of admission to assess any change in predictors over time.

The odds ratios of multivariate analysis can be found in Table 4. Based on this analysis, the following equation was generated for predicted medication order errors: P(Error) = 0.18 +

1.02(age) + 0.93(male) + 3.21(white) + 0.72(English) + 0.40(July 2014) + 1.14(number of medications). Number of medications was statistically significant ($p = 0.006$).

Discussion

The goal of this thesis was to determine the prevalence of medication list errors and medication order errors compared to verbal histories obtained by student pharmacists, as well as generate a model for predicting medication errors. Given the small sample size and homogenous patient population, the goal was not to predict risk, but rather determine if a model could indeed be produced for potential usage with a larger patient population.

The number of patients with errors in the medication list as reported in the electronic record was higher than expected based on prior literature. Beers et al. found discrepancies in 83% of patients.[24] Of note, these authors utilized a conservative definition of error, only accounting for errors of omission and commission and not errors in dosage or regimen. Therefore, taking into account more types of errors likely contributed to a higher error rate. Another factor contributing to more errors may be related to the higher number of medications per patient at JDH. The sample patients in the aforementioned study took fewer home medications (5.1) compared to the patients in this study, where the average number of medications per patient was 11.84. Other factors may include the limited time available for interviews, the acuteness of the patient's illness as sample patients were limited to a history or diagnosis of chronic heart failure, chronic obstructive lung disease, or myocardial infarction, as well as unfamiliarity of the electronic medical record by the residents. Medical residents at JDH spend the majority of their clinical training at other hospitals, and therefore may be unfamiliar with the process of medical reconciliation at JDH.

The percentage of patients with medication order errors was found to be 54% for patients taking 1-11 preadmission medications and 76% for patients taking greater than 11 preadmission medications. These error rates are comparable to other studies.[8,25] Lessard et al. also noted a different error rate for patients taking fewer home medications compared to more home medications, also noted in this study.[25]

With regards to individual predictors, the likelihood of having an error increased based on advancing age, male versus female gender, white versus other race, and 1-11 preadmission medications versus more than 11 preadmission medications. The greatest predictors were found to be race and number of medications, although number of home medications was the only significant variable. When stratified by time period, a suppressor effect can be observed with race as the initial odds ratio of 2.37 decreased to 1.15 for the January 2015 cohort of patients.

The likelihood of error decreased over time from July 2014 to January 2015. There were multiple educational sessions with a medication reconciliation focus between July 2014 and January 2015 including a Medical Grand Rounds and two pharmacist-led teaching sessions for medical residents in November and December 2014. These sessions, combined with an overall awareness of the quality improvement project by the attending and resident physicians, likely resulted in decreased medication order errors during the later portion of the period being studied. Factoring in the time period demonstrates how errors can be analyzed chronologically to measure the success of an intervention and finally how this can be incorporated into a model to predict errors.

Using the multivariate analyses for collective variables, an equation was generated to predict error: P(Error) = 0.18 + 1.02(age) + 0.93(male) + 3.21(white) + 0.72(English) + 0.40(July 2014) + 1.14(number of medications). For example, for each additional home medication taken by a patient, the likelihood of a medication order error increases by 14%. To the degree the predictors were correlated, there was no significance found among them such that the individual versus collective predictors changed the predictions of error.

This model can potentially be used twofold: for predicting medication errors on a population level at JDH or other institutions, and as a tool for identifying patients with a high likelihood of having a medication error. Targeted efforts can then be made to prevent errors for these high-risk patients. Prior literature illustrates that medication reconciliation has been shown to decrease discrepancies.[15] Specifically, medication reconciliation completed by pharmacists and pharmacy technicians was found to be more accurate when compared to other disciplines.[30] Patients with a high number of home medications should receive a more thorough interview from a pharmacist or pharmacy student regarding their medication history. More research is necessary to determine if such a model proves useful for predicting errors, decreasing adverse drug events, and thus increasing overall quality of care received while patients are admitted to the hospital.

Limitations

This study was limited with regards to the population demographics. The patients were sampled from one suburban teaching hospital in Connecticut, which services a homogenous population of patients with regards to their demographics and medical care. The vast majority of study patients were white and English-speaking with a primary diagnosis or history of heart failure, chronic obstructive pulmonary disease, or myocardial infarction. Given this information, the study may have limited generalizability to other patient populations in other settings. Another limitation was the small sample size, which limited findings due to low power. Due to the fact that the data was not collected by the primary author, the data was also limited by the types of classifications and format of the initial data received by the author.

Conclusion

Medication errors have continually been reported as one the most common types of healthcare errors.[3] Medication list errors and medication order errors during hospitalization may adversely affect the care the patient receives while in the hospital[7-9] as well as puts patients at risk post-discharge for a wide variety of medication-related issues.[11,12] The data presented here shows medication list errors and medication order orders are prevalent at JDH, which is consistent with data from a multitude of different studies from sites around the world. Lastly, using this data, a model for predicting medication order errors was generated that could potentially identify and target those patients with the highest risk for a medication error occurrence. This and similar research could potentially have profound outcomes with regard to error prevention during a hospitalized patient’s transition of care.

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