Study of Medication Errors on a Community Hospital Oncology Ward

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Abstract

Purpose: Medication errors (MEs) have been a significant problem resulting in excessive patient morbidity and cost, especially for cancer chemotherapeutic agents. Although some progress has been made, ME measurement methods and prevention strategies remain important areas of research.

Methods: During a 2-year period (2003-2004), we conducted a prospective study on the oncology ward of a large community hospital, with the goals of (1) complete nurse reporting of observed medication administration errors (MAEs), (2) classifying observed MAEs, and (3) formulating improvement strategies. We also conducted a retrospective review of a randomly chosen sample of 200 chemotherapy orders to assess the appropriateness of ordering, dispensing, and administration.

Results: Our nurses reported 141 MAEs during the study period, for a reported rate of 0.04% of medication administrations. Twenty-one percent of these were order writing and transcribing errors, 38% were nurse or pharmacy dispensing errors, and 41% were nurse administration errors. Only three MAEs resulted in adverse drug events. Nurses were less likely to report MAEs that they felt were innocuous, especially late-arriving medications from the pharmacy. A retrospective review of 200 chemotherapy administrations found only one clear MAE, a miscalculated dose that should have been intercepted.

Conclusion: Significant reported MAE rates on our ward (0.04% of drug administrations and 0.03 MAEs/patient admission) appear to be relatively low due to application of current safety guidelines. An emphasis on studying MAEs at individual institutions is likely to result in meaningful process changes, improved efficiency of MAE reporting, and other benefits.

Introduction

Case History

A patient with a primitive neuroectodermal tumor was admitted to LDS Hospital to receive a regimen of ifosfamide and etoposide phosphate. A correct order was written by the physician and appropriately sent to the pharmacy. A pharmacist erroneously entered twice the written dose of ifosfamide into the computerized medication administration record (MAR). A second pharmacist, who was charged with independently comparing the MAR, initialed the prepared medication as correct. The incorrect dose was sent to the floor. The administering nurse appropriately checked for the two pharmacists' signatures, but was also charged, along with a second nurse, with independently comparing the dose on the medication to the written physician order. Both nurses initialed the medication as correct, and the drug administration was initiated. Before all of the medication had infused, there was a change in nursing shift. The next nurse, following standard procedure, compared the dose on the medication bag to the written order, discovered the error, called the attending physician, and stopped the ifosfamide averting an adverse drug event (ADE). Prior to the present study, the case would have been referred to risk management. The authors of this study were concerned that we had no accumulated data regarding not only how frequently such events occurred but also regarding the types of process failures that resulted in this medication error (ME), and thus, no systematic basis for quality improvement.

The authors of a well-publicized 1999 report by the Institute of Medicine¹ concluded that medical errors are a significant prob-

lem in the United States, resulting in excess mortality, morbidity, and cost. Although significant improvements have occurred since the initial Institute of Medicine report, medical errors remain problematic in the high-workload environment of current medical care. Past studies have suggested that MEs account for a significant percentage, if not a majority, of both total medical errors and medical misadventures resulting in mortality.²⁻⁴ Thus, MEs are an important subgroup of medical errors due to their frequency, possibility of significant patient harm, and potential for prevention.⁵

MEs involving cancer chemotherapeutic agents may be particularly harmful as these drugs have a narrow therapeutic index for which incorrect dosing or administration may result in increased toxicity and/or decreased tumor response.⁶ In addition, antineoplastic agents are often administered to older patients with comorbidities and may be part of novel and complex treatment protocols less familiar to nurses and pharmacists. As a result, antineoplastic agents are among the most common causes of ME-related deaths.⁷ These concerns have led to national guidelines, including recommendations for a systems approach consisting of multidisciplinary monitoring of medication use, prescribing guidelines, preparation and dispensing methods, and medication administration.⁸

Several prior studies from our hospital have examined the incidence of ADE, and we have pioneered the use of computer monitoring, prophylactic computer alerts, physician feedback, etc, to reduce ADEs.⁹⁻¹¹ However, we felt that MEs are a more optimal end point because: (1) minimization of MEs should be an important quality initiative for all hospitals; (2) only a small

percentage of MEs result in an ADE; (3) many MEs that do not result in ADE have the potential to do so; and (4) many ADEs are not caused by an ME, and may not be readily preventable.^{5,12} An additional issue involves definitions, as some studies have confined ME to medication administration errors (MAEs) that reach the patient,^{4,5,13} and others, to both administration and intercepted errors.¹² There are still other studies that do not clearly differentiate.¹⁴ We believe that MAEs are the most practical initial end point for most hospitals interested in establishing an ongoing program in ME quality improvement because (1) intercepted errors are of less practical interest, as they represent instances where one's ME prevention system is already effective, and (2) identifying intercepted errors adds significant labor intensity and expense.

Improvement in ME prevention systems requires accurate reporting, regular analysis, and protection of reporters.¹⁴ An optimal detection system would be accurate, inexpensive, and involving technology and practices readily available to the majority of hospitals. Like most hospitals, MAEs have been detected and reported at our institution primarily by the administering nurse. Also like most hospitals,¹⁵ we have ME prevention strategies that include a system of medication order writing, dispensing, and administration, each with independent checks by pharmacists and nurses.¹⁶ Our checks become progressively more intensive for nonchemotherapy medications, cancer chemotherapeutic agents administered to non–bone marrow transplantation (BMT) patients, and chemotherapy administered to BMT recipients. To evaluate the accuracy of our nurse MAE reporting, determine the types of our current nurse-reported MAEs, and formulate improvement strategies, we conducted a 2-year prospective study of all MAEs as identified by nurse reporting, and a retrospective study of cancer chemotherapy ordering, dispensing, and administration.

Methods

General

LDS Hospital is a 520-bed teaching and regional referral community hospital in Salt Lake City, Utah. The oncology ward has 43 beds and cares for BMT recipients; medical, surgical, and gynecologic oncology patients; and, when unoccupied beds are available, general medicine patients. During 2003 to 2004, we prospectively asked our nurses to focus on complete reporting of MAEs, with an intended focus on systems improvement. The reports were collected by the authors who evaluated each instance as to type of MAE and resulting ADE. During the years under study, computerized physician order entry (CPOE) was not available. Templated orders were used routinely for BMT patients, but not others.

Definition of an MAE

An MAE was defined as a preventable mistake in drug administration due to errors originating in ordering, dispensing, or administering,⁴ including administration of (1) the wrong medication, (2) the wrong dose, (3) the wrong route, (4) the

wrong time defined as administration outside of 30 minutes of the prescribed timing, (5) a medication to which the patient has a known allergy, and/or (6) a medication with a known significant interaction with another medication the patient is receiving.

Definition of an ADE

An ADE was defined as significant patient injury or discomfort resulting from the MAE. Such errors usually resulted in a change in patient care.

Poststudy Nursing Evaluation

Following completion of the study, we met with our nurses to collect the results and obtain their opinions and feedback regarding completeness and accuracy of reporting, as well as their suggestions for ME prevention process improvement.

Retrospective Study of the Effectiveness of Hospital Processes

From a complete list of cancer chemotherapy regimens, we randomly selected 200 for review. Each original written order was evaluated by a medical oncologist for appropriateness and defined as a dose ($\pm 10\%$), regimen, and schedule of agents in accord with the peer-review literature or an institutional review board–approved clinical trial. In addition, a pharmacist compared the written order with the MAR—the final record of the dispensed medication. Lastly, a chemotherapy-certified nurse compared the written order with the nursing administration records.

Statistical Analysis

Groups were compared by χ^2 analysis (2×2 contingency table and test on proportions) using SPSS software (SPSS Inc, Chicago, Illinois) and a *P* value significant at $< .05$.

Results

Frequency of Reported MAEs

During our nurse surveys, our nurses noted that our most frequent MAEs were late administration due to untimely arrival from the pharmacy. When quizzed regarding the reasons for only six of these having been reported, the nurses suggested that (1) because the medication had been ultimately administered not very much outside of our time guidelines, and the nurse's impression was that the late administration MAE had not resulted in an ADE, our nurses did not feel that these instances were clinically significant enough to warrant reporting; and (2) the occurrence of late-arriving medications was so frequent that comprehensive reporting was impractical. Thus, our nurse reporting focused on non–late administration types of MAEs.

During the 2-year study period, 135 MAEs that were not due to late dispensing were reported. Within this time, our nurses administered an average of 15,263 nonchemotherapy, and 195 chemotherapy regimens per month, and there were 4,752 patient admissions. These calculated to a total reported non–late

Table 1. Types of Nurse Reported Medication Errors

Type of Error	No. of Errors
Type 1: Errors in medication ordering and transcription	33
Type 1a. Physician order writing errors	8
Order illegible	1
Order written on wrong chart	1
Wrong dose	1
Fails to place chart in orders slot for ward clerk	4
Fails to complete order	1
Type 1b. Ward clerk errors	1
Fails to send copy of order to pharmacy	1
Type 1c. Nursing errors	1
Enters wrong order into MAR	1
Type 1d. Pharmacy errors	20
Miscopies written order into computer	10
Places order into computer without a written order	5
Fails to put order into computer	3
Fails to discontinue medication from computer when ordered	2
Type 1e. Type 1 errors not otherwise classifiable	3
Type 2: Errors in medication dispensing	50
Type 2a. Nursing dispensing errors	36
Dispenses wrong medication	16
Dispenses incorrect dose	20
Type 2b. Pharmacy dispensing errors	12
Failure to send medication to the ward at appropriate time	7
Dispenses wrong medication	1
Dispenses an incompatible medication	1
Dispenses incorrect dose	3
Type 3: Nursing errors in medication administration	58
Medication not given	18
Wrong medication given	1
Wrong time	10
Wrong dose	17
Wrong patient	6
Administered after discontinue order	1
Wrong route	1
Failure to chart medication given resulting in repeat dose	3
Administers incompatible medication	1

Abbreviation: MAR, medication administration record.

administration MAE rate of 0.04% of drug administrations and 0.03 MAEs per patient admission. It was estimated that MAE rates including late doses would be approximately two to three times higher. Reported MAE rates by quarter year did not sig-

nificantly differ during the entire study period ($P = .13$), and there was no difference in the frequency of reported chemotherapy and nonchemotherapy MAEs ($P = .27$). However, in BMT patients, with an extra emphasis on templated orders, additional independent checks, and BMT nurse certification, no chemotherapy errors in either nurse reporting or the retrospective chart review were seen. Thus, given the limitations of our measurements, it appeared that the added procedures in BMT recipients seemed to further decrease MAEs.

Types of Medical Administration Errors

We found it most convenient to distinguish between three types of MAE. Type 1 errors resulted in incorrect orders being recorded in the physician written order, the nurse kardex, and/or the MAR. Type 2 errors resulted in incorrect pharmacy or nurse dispensing of a correctly ordered medication. Type 3 errors resulted in incorrect administration of a medication that had been correctly ordered and dispensed. We noted that most written order/transcription, dispensing, and administration errors should be intercepted by our independent checks, and thus, multiple errors (type 1, 2, or 3 plus failure of interception[s]) would generally be required for an MAE to occur (termed in our hospital, "the Swiss-cheese effect"). Using our case reported here for example, the MAE occurred because of a type 1 error combined with a failure of both pharmacy and nursing independent checks.

Our nurse-reported MAEs are presented in detail in Table 1. Twenty-one percent of our reported MAEs originated from a type 1 error (primarily pharmacy entry), 38% from a type 2 error (primarily nurse dispensing), and 41% from a type 3 error. Only three (2%) of the reported MAEs were judged to result in an ADE.

Because we felt that some MAEs, especially type 1a errors escaping pharmacy review and errors in which a nurse was deficient in performing independent checks, were more likely to have gone unreported by our nurses, we conducted a retrospective review of 200 randomly chosen cancer chemotherapy administrations. There was clear evidence of one written error with a dose miscalculation that was not intercepted by pharmacy or nursing, and was not reported. Seven patients had lower than standard literature doses, and these seemed to be intentional due to patient age, performance status, and other factors. When written orders were compared to the MAR, a single case (Table 1) was discovered and reported. In two instances, an ordered medication was not noted in the record as being administered, and in another, the charted administration and written order did not match. An independent nurse reviewer felt that each almost certainly represented charting errors rather than MAEs, as each medication had been dispensed from the pharmacy correctly and in a timely fashion. Thus, two MAEs were discovered (one of which had been reported), and several areas for improvement were found.

Some Poststudy Nursing Observations

Anonymous nurse surveys following the study suggested that our nurses felt reasonably comfortable in reporting MAEs, had reported all observed non-late administration MAEs, and experienced reduced (but not eliminated) fear of retribution. It was also noted by our ward nurse manager that during the study, our ward had the highest rate of reported MAEs in our hospital.

Discussion

There are no entirely adequate methods for measuring ME rates, and a variety of self-reporting and non-self-reporting approaches have been used. The frequency of reported MEs will depend on the thoroughness with which MEs are sought, the methodology used, the patient population, and the definition of errors.¹⁷ We have chosen to study nurse self-reporting for several reasons. First, the administering nurse is the optimal single individual to discover an ME. By routinely evaluating the appropriateness of the medication and comparing the dispensed medication to the physician written order, the nurse is charged with evaluating the entire process between order writing and dispensing and then personally observing the administration procedure. Second, nurse reporting of ME is the predominant methodology in many, if not most, hospitals rendering studies aimed at understanding and improving the nurse reporting process of more generalized application. Third, although everyone clearly needs to be actively involved in reducing ME, ME prevention is a fundamental aspect of quality nursing. As O'Shea has noted, nurses are responsible and accountable for the drugs they administer,¹³ and ME prevention is currently a national nursing imperative.^{18,19} In addition, the rather constant rate of reported MEs during the course of our study suggests that effective nurse reporting, when its limitations are clearly understood, can be used to identify areas of focus for process improvement and to evaluate the effectiveness of ME improvement strategies.

A principle problem with any self-reporting system of ME is underreporting, which may be intentional or unintentional. Indeed, recent surveys in large American hospitals have suggested that on average, half or less MEs are reported.^{20,21} A nurse may fail to recognize, forget to report, or be reluctant to report an ME. Less experienced nurses or those who are very busy due to low nurse-patient staffing ratios are probably less likely to recognize an incorrectly written order, as occurred in our retrospective chart review case. And, as in our case, at the beginning of this study, an administering nurse would fail to recognize an error in which established nursing independent checking procedures had not been followed. Similar to the findings of others,^{20,22,23} our experience demonstrates that nurses are more likely to intentionally under-report MAEs that are frequent and considered unlikely to produce an ADE. The most prominent example of this on our ward involves late-administered medications, which, similar to the experience of Bates

et al,¹² is probably our most frequent MAE. In addition, prior studies have suggested that nurses may intentionally under-report MAEs due to fear of retribution or loss of prestige.^{6,21,23,24} Partially in response to this problem, many have advocated a focus on systems analysis that would use incidence reports for identification and improvement of processes rather than individual reprisals.^{25,26} In addition, the observation that our ward consistently had the highest rate of reported MAEs during the study suggests that our emphasis on MEs may have resulted in an increased accuracy of reporting, a phenomenon observed previously.²⁷

Although we feel that our administering nurse is in the best overall position to report an MAE, it is clearly important to involve all disciplines in the process of ME interception and in ME detection if intercepted MEs are included. The importance of the pharmacy in these areas has been highlighted in several studies.²⁸⁻³⁰ The pharmacist is in a position to intercept an ME by evaluating the appropriateness of the written order and comparing this to the dispensed medication. The pharmacy may also receive unused medications. Some analyses have suggested that the ME rates reported by nurses and pharmacists are comparable.^{12,29} Since the roles of pharmacists and nurses in MAE reporting overlap, the value of adding the pharmacy, at any institution, would be inversely proportional to the effectiveness of nurse reporting.

Taking into account our reduced rate of reporting late administrations, our MAE rates are probably similar to those reported from other programs with effective interception systems in place. Table 2 summarizes several selected prior studies. In sum, these suggest current benchmarks for error rates of about 5% for administration plus intercepted MEs, and approximately 0.1% to 0.2% for MAEs. These numbers seem to be relatively independent of patient age and chemotherapy versus nonchemotherapy medications. For administration plus intercepted MEs, type 1 errors have been most common. There are few data about types of errors resulting in MAEs. Our study indicates that the MAE types distribution may significantly shift toward nurse dispensing and administration. Nurse surveys have suggested a similar conclusion.^{6,31}

Our results suggest that in order to be most effective in formulating MAE prevention strategies, each hospital must first determine where in the drug ordering, dispensing, and administering process the predominant number of MAEs originates. In the previous decade, studies of MEs identified problems with physician ordering as the most frequent cause.^{32,33} Bates et al¹² estimated that the great majority of "non-missing dose" MEs could be prevented with CPOE. Conversely, the rate and distribution of our MAEs indicate that a system of effective independent checks can minimize type 1a MAEs. This suggests that a focus on (1) pharmacy computer entry and (2) nurse education, experience, work conditions, and medication dispensing and administration policies and procedures, is likely to be more rewarding.¹³

Table 2. Selected Reported Series of Medication Errors

Report	Year of Study	Patient Population	ME	ME Detection	ME Error Rate (%)	Types of Medications	Most Frequent ME	Systems for Interception	ADE/ME (%)
Bates et al ¹²	1995	Adult	A + I	CR, IR (P)	5.3	All	O/T	NS	0.9
Marino et al ³⁴	1995	Adult/Peds	A + I	CR, IR	6.5	All	O/T	Yes	
Kaushal et al ³⁵	1999	Adult/Peds	A + I	CR, IR (N, P, C)	5.7	All	O/T	Yes	0.24
Gandhi et al ³⁶	2000	Adult	A + I	CR, IR (C)	3.0	All	O/T	Yes	
Gandhi et al ³⁶	2000	Adult	A + I	CR, IR (C)	4	Chemo	O/T	Yes	
Marino et al ³⁴	1995	Adult/Peds	A	CR, IR	0.15	All	NS	Yes	
Womer et al ²⁵	2000	Peds	A	IR (P), IR	0.1	Chemo	NS	Yes	

Abbreviations: ME, medication error; ADE, adverse drug event; A, medication administration error; I, intercepted ME; Peds, pediatric; CR, chart review; IR, incidence reports; N, nurses; P, pharmacists; C, clinicians; Chemo, chemotherapy; O/T, ordering/transcribing; NS: not stated.

Our experience has shown that active MAE assessment studies are likely to result in institutional process changes. For example, in one interesting MAE, a nurse discovered a discrepancy between the kardex and MAR and changed the MAR without referring to the written order, thus circumventing our independent checks system. This has led to an alteration in the hospital computer entry process so that nurses are no longer able to change the MAR. On our ward, meetings with the nurses, including discussions of discovered MAEs, have been held to emphasize the need to follow procedures. Using our accumulated MAE data, discussions among our nursing staff on causes and ways to reduce nurse dispensing and administration MAEs are ongoing. We also discovered that, unbeknownst to pharmacy or nursing, our printed forms with pharmacy and nursing signatures documenting independent checks for chemotherapeutic agents were being discarded by our medical records department, making it impossible for us to validate our system of independent checks. This policy has since been changed. As a result of our study, our pharmacy has re-reviewed the importance of following established procedures. Our pharmacists have also instituted several programs to address the late-arriving medication problem. And for chemotherapy orders, especially those not representing frequently used and established regimens (such as those from clinical trials), our pharmacy now requires the clinician prescriber to furnish a copy of the protocol to facilitate the independent check of dose calculations.

We conclude that using MAEs as an end point, nurse reporting of MAEs as a methodology, and consistent analysis of reported MAEs within an atmosphere aimed at systems improvement, can form an effective program for monitoring error rates and discovering areas for quality improvement. Such methodology should be readily available to virtually all hospitals.

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Authors' Disclosures of Potential Conflicts of Interest

Although all authors completed the disclosure declaration, the following authors or their immediate family members indicated a financial interest. No conflict existed for drugs or devices used in a study if they are not being evaluated as part of the investigation.

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