Medication administration is a high-risk core function in a health care setting involving multiple disciplines. The processes involved in the delivery of medication to a patient require precision, communication, and meticulous attention to detail by hospital staff. The administration of medication has tremendous implications if done incorrectly.1

Medication errors are not uncommon in health care. By some estimates, at least 2 million people every year are harmed by errors, which cost the U.S. an extra $3.5 billion annually in extra hospital costs alone.2 According to the Institute of Medicine’s 1999 landmark report, *To Err is Human: Building a Safer Health System*, approximately 100,000 deaths occur annually due to medication problems.3 A more recent study, in the September 2013 *Journal of Patient Safety*, suggests that the number of fatalities caused by medical errors in hospitals may be as high as 210,000 to 440,000.4

The term "error" (which is used interchangeably with the terms "event" and “incident” in this article) encompasses cases in which the error did and did not reach the patient. The National Coordinating Council for Medication Error Reporting and Prevention defines an error this way:

A medication error is any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer. Such events may be related to professional practice, health care products, procedures, and systems, including prescribing; order communication; product labeling, packaging, and nomenclature; compounding; dispensing; distribution; administration; education; monitoring; and use.5

This article analyzes medication error data that pharmacists reported to an online database between April and September 2011 at an integrated health care system comprised of two main hospital sites and 10 satellite clinics. The two hospital sites have a total of 637 beds, and the outpatient pharmacies dispense approximately a quarter-million prescriptions annually. Most reported incidents consisted of errors in the prescribing and prescription-filling phases of medication delivery.

In this online database, a pharmacist (the reporter) marks off a series of boxes to describe the details of an event (Figure 1). To submit a medication error to the online database, a reporter must answer several questions, including medication name, type of error, and location of event. Sixteen types of errors are listed by category (Figure 2). An optional, free-text space is available to describe additional details of an event that does not fit into any of the 16 provided error types. The date of the event is automatically recorded on the day the reporter submits an entry.

The information gathered from the database was used to identify patterns through a systematic evaluation of recorded errors. Discernible patterns served as a catalyst to facilitate the development of ways to learn from previous errors and prevent future mistakes by improving systems, policies, proce-

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**Dr. Polnariev is a board certified pharmacist with a master’s degree in Patient Safety and Risk Management from the University of Florida in Gainesville, where he is Assistant Instructor for several courses in the Master of Science program in Pharmaceutical Outcomes and Policy.**

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dures, and overall safety of medication delivery throughout the health care system. The results of this aggregate review would eventually lead to initiatives undertaken by the administration toward improved safety outcomes.

RESULTS

All medication errors submitted between April and September 2011 were analyzed and categorized by multiple factors to ascertain patterns. During this time, 491 medication errors were submitted to the online database and 18 errors were reported by a paper method that preceded the online tool. An average of 82 errors were captured electronically per month, compared with six errors per month prior to the implementation of the web-based tool. The events were classified by each of the following: reporting site, month, medication, and error type. Each of the figures described below depicts every categorization. Medication errors were subdivided by site and further differentiated by inpatient versus outpatient (Figure 3). A majority of the captured errors (54%) involved the outpatient department of the main hospital (Hospital 1); together with its inpatient department (21%), Hospital 1 accounted for 75% of the errors captured during the review period. Figure 4 shows the medications listed most frequently in the reported errors. Amoxicillin alone and/or in combination with clavulanate had the highest number of associated errors (16), followed by ciprofloxacin (13) and cephalosporins and metformin (with 12 each). Generalizations were made in groupings when differentiating individual medications (for example, separating amoxicillin from amoxicillin with clavulanate) proved infeasible due to the quality of and variations in free-text reporting.

It is important to note that individual pharmacists’ subjective reporting was a drawback of the online database reporting system. Different pharmacists may have different interpretations of an event, and the depth of their detailed reports might be influenced by factors such as the lag time between the identification of an event and the actual entry of the incident into the database.

Finally, Figure 5 categorizes error types. The largest number of errors (20%) was found to result from a pharmacy technician picking the wrong dosage form from the shelf. A provider selecting the wrong or inappropriate drug was the next most frequent error type (18%), followed by selecting an incorrect dose (14%). The column listed as miscellaneous reflects errors that do not fit into any of the 16 listed categories. Two examples of events deemed miscellaneous are a provider ordering a nonformulary item and a missing creatinine level for a patient using metformin.

Reporting from front-line staff is important and beneficial because it can lead to hospitalwide system improvements. However, many health care facilities may not have the resources to employ a team of health care professionals readily available to meticulously review every reported event. Limitations of resources and staff necessitate a system that can efficiently prioritize events, separating the most important errors from the ones that do not have to be reviewed in a time-sensitive manner. The need for a system to classify and prioritize medication errors led to the inception of the Medication Error Prioritization System (MEPS): A Novel Tool in Medication Safety.
System (MEPS). The system was developed by the author to organize the wealth of information generated by reports based on entries submitted to the online database. Details of events were made available for the author to collect and develop an algorithm that reflects important qualitative variables of a medication error and incorporates them in a calculation as a quantifiable measure of the event.

MEPS includes specific details of the error in the algorithm to calculate an objective value based on the weight of those details. This data includes: error preventability, ability of the organization’s system to detect and/or prevent the error, frequency of the error type, potential for harm of the medication involved with the error, and ability to teach employees how to prevent the error in the future. Each of these elements of an event is clinically evaluated by a pharmacist, assigned a value from a scale, and submitted to the MEPS system. The scales are based on a rubric created by the author to minimize the effect of subjectivity on the part of the pharmacist performing the evaluation. The system then tabulates all information entered by the pharmacist to derive a numeric value (with a maximum score of 40) for every event. Based on all the assigned values, MEPS will assess the priority of each event and generate a listing of all errors in order of priority.

All medication errors reported by pharmacy staff using the online database from April to September 2011 were categorized into one of three classes based on a severity scale and depicted in a simple three-tiered structure (Figure 6). MEPS scores with a value above 20 are classified as high priority (on the left side of the graph) and are regarded as the most critical errors. The event considered to be the most serious in this period involved warfarin that was mistakenly given to the wrong patient, who took one dose. Fortunately, no harm to the patient was observed, but because of the circumstances of the error, this incident scored a 35 out of a possible 40, the maximum value on the MEPS scale. The factors involved in this incident provide insight into what MEPS considers high-priority
events. Warfarin is a potentially injurious drug well known for its narrow therapeutic index. This medication is commonly used in the hospital, and this error reached the patient, bypassing all lines of defense meant to prevent errors. Upon examination of the systems failures in this event, feedback and education could be provided to staff and action could be taken by administrators to prevent this type of error from happening in the future. These factors (drug toxicity, medication use frequency, and error preventability and detectability) were reflected in the high scores given by pharmacists and factored into the MEPS algorithm to produce a high MEPS score and thus signal a high-priority event.

Scores ranging from 12 to 20 have intermediate priority (in the middle of Figure 6). An example of an intermediate-priority error involved a unit nurse’s administration of medication. A patient received an extra dose of acetylsalicylic acid 325 mg during rounds, despite safety precautions such as bar code scanning technology and mandatory confirmations for overrides made by the administering nurse. Although the patient took an additional dose of acetylsalicylic acid, no clear signs of harm were observed. This mistake was the only one of its kind reported in this batch of errors; the nurse was re-educated on proper medication administration.

Finally, scores below 12 have low priority (on the right side of Figure 6); low-priority events do not need to be evaluated with urgency, as they are either very unlikely to recur and/or they pose minimal threat of harm to a patient. The first example of a low-priority event involved a missing strength on a prescription for hydrocortisone cream. The hospital’s computer order-entry process would make it impossible for medication to be processed without an indicated strength, so the pharmacist would easily recognize the error and take corrective action. In a second example of a low-priority error, a provider entered a quantity of “1ml” instead of what was actually intended, which was one 15 mL bottle of carbamide peroxide. Such mistakes are not particularly dangerous to a patient and can be easily identified and corrected by the pharmacist. This incident provides insight into what MEPS considers to be a low-priority event. The medication in this case, carbamide peroxide, is sold over the counter to help remove ear wax. It is not considered harmful, the error would have had minimal effect on the patient even if the patient had received the incorrect dose of the medication, but the system in place in the pharmacy does a good job preventing such errors from reaching the patient. Further evaluation to avoid such rare and sporadic errors, especially with a relatively innocuous medication, would not normally take precedence for the pharmacy department.

The mean MEPS score calculated for all the errors reported between April and September 2011 was 14.4. One standard deviation is 6.4; in a normal distribution of data, 67% of all events occur within one standard deviation of the mean.13 The first standard deviation of this set of errors has a MEPS score of between 8.0 and 20.8. The second standard deviation (not shown in Figure 6), in which 95% of all data points should fall, is between 1.6 and 27.2. To assess the distribution of data in this aggregate review, 77% of all errors fall within the first standard deviation and 95% are within the second standard deviation, indicating that this data set approximates the normal distribution of data.

DISCUSSION

Advances in patient safety can come only from an in-depth understanding of how systems failures may result in errors or injury. As the number of patients needing medical care and the quantity of medications prescribed continue to rise, there is an ever-expanding need for a comprehensive system that can methodically review all medication errors but can also identify the most critical events to make the most efficient use of available resources.7,8

The Safety Assessment Code (SAC) Matrix used by the Veterans Health Administration National Center for Patient Safety is an early model of a medication error classification system that focused on factors relating to an error.9 This matrix assesses errors with a four-by-four grid based on the severity and probability of an event’s occurrence. The Institute for Safe Medication Practices (ISMP) uses a system, called the Medication Errors Reporting Program (MERP), that utilizes a small group of clinical staff to review all reports, identify potential new warnings, prioritize errors for action, and inform health care professionals through its publications.10 The ISMP’s program is a good example of a hazard identification model, but it requires a team of professionals to critically review all reported events and inform the health care community in general of cross-institutional issues. The MEPS system, on the other hand, focuses on specific reports at individual institutions. A report commissioned by the World Health Organization and prepared by the Joint Commission (formerly the Joint Commission on Accreditation of Healthcare Organizations) describes the ideal medication error classification system:11

- It addresses a wide range of patient safety issues and dimensions spanning multiple disciplines.
- It takes into consideration the dynamics of how medication errors may occur.
- It addresses possible methods that can be used to prevent known medical errors from occurring.
- It connects the contributing factors of errors to systems failures that may result in adverse events.
- It assists health care professionals in the monitoring, reporting, and examination of adverse events. This will serve to pool data to allow broader analysis of errors.

An ideal classification scheme, such as the one described above, can provide a means to organize medication errors by noting several factors relating to the actual mistake, including dose, route, and patient.11,12 Determining the priority of events permits the reviewer to focus his or her attention on the most critical and time-sensitive errors. With meticulous observation and evaluation of reported events over time, it may be possible to see trends that identify significant problems in a system that would suggest holes, analogous to the Swiss cheese model of system failure proposed by James Reason.13

The Swiss cheese model, commonly implemented in the fields of aviation, engineering, and health care, is used to analyze the causes of failures and/or accidents in an organization’s system.13 The model describes error causation as a series of events that must occur in a specific sequence for an accident to take place, comparable to the holes of several pieces of Swiss cheese lined up in a row. The holes are opportunities for a failure to occur, and each slice is a metaphorical layer of a
health care setting’s multidisciplinary system. A “hole” allows a problem to pass through one layer, but in the next layer, the holes might be in different places, and the problem may or may not be caught before it reaches the patient. Each layer should serve as a barrier against potential mistakes, and if an error bypasses every layer (or line of defense within a system) it has the potential to reach the patient and cause serious harm.

The benefit of MEPS is its ability to emulate the ideal medication error classification system as described by the Joint Commission. To gain maximum output from MEPS, certain limitations relating to data input must be addressed. Pharmacists often cited a concurrent overabundance of responsibilities and underabundance of staff and time as reasons why events may go unreported. Pharmacy technicians can help enter data into the system to alleviate the pharmacist’s workload and expand their clinical functions. Administrators play a vital role in encouraging staff to invest the time to report an event so that the same mistake may be avoided in the future. MEPS can help efficiently assess all errors and highlight the incidents that have the potential for causing the most harm and are most likely to be repeated, as well as those that may be the most preventable with additional employee training.

Upon review of all the reported events in this study, several recurring mistakes were observed. Some of the most common yet potentially hazardous errors were the incorrect filling of a medication order by the technician, the selection of an incorrect or inappropriate drug by the provider, and the choice of the wrong dose by the provider. The most common medications involved in reported errors included antibiotics, diabetes drugs, and narcotics used to manage pain. In addition to demonstrating the need to evaluate the means by which those medications are prescribed, processed, and administered, MEPS is able to determine any recurring mistakes made by facility staff and provide recommendations, organized by a classification system. This aspect of MEPS presents specific, short-term recommendations in a three-tiered system, based on the importance of the change needed. These recommendations were made by the author in a final report, presented to senior-level pharmacy staff, and subsequently disseminated to frontline pharmacy personnel. Class A recommendations take priority over class B recommendations, which in turn are more urgent than those in class C.

The following recommendations are samples from the final report based on events between April and September 2011:

Class A
• Emphasize that antibiotics are to be taken as directed (on schedule), not “as needed” (PRN).
• Emphasize that extended-release narcotics for pain are to be taken as directed, not “as needed” (PRN).
• Clearly differentiate tramadol 50-mg tablets versus tramadol 50-mg tablets.

Class B
• Educate providers on the doses and dosages of morphine available for use in the formulary.
• Remind staff that alprostadil is not to be used as a subcutaneous medication.

Class C
• Clearly signify and differentiate triamcinolone cream versus tretinoin cream.
• Clearly signify and differentiate triamcinolone cream versus tretinoin cream.

CONCLUSION
The health care industry is faced with many problems, such as limited staff, budget, time, and resources, and an overabundance of priorities that demand administrative attention. A system is needed to help streamline the process of evaluating priorities, at least for medical errors, in a detailed yet efficient manner. The purpose of MEPS is to categorize all reported events, examine the plethora of information while identifying the most important errors, and pinpoint potentially problematic areas that may need immediate attention. Upon prioritization of all medication errors, MEPS presents a three-tiered list of recommendations, in order of urgency, based on the observation of reported events. The suggestions can help administrators determine where to focus and allocate their limited resources. With MEPS, administrators can reduce error rates by identifying which areas need the most attention. Promoting patient safety enables continuous quality improvement for any health care organization.

REFERENCES