INTRODUCTION

Preventable medical errors are the third leading cause of death in the United States after heart disease and cancer, a problem that may worsen as medicine becomes increasingly complex and reliant on advanced technologies.¹ According to a study published in 2013 in the Journal of Patient Safety, the annual number of fatalities caused by medical errors in hospitals may be as high as 210,000 to 440,000.² The Johns Hopkins Center for Innovation in Quality Patient Care estimates that two-thirds of such errors could have been prevented.¹ For every known medication error that injures a patient, as many as 100 errors go undetected and unreported.³ The low rates of error detection and reporting make it challenging to assess the effectiveness of tactics to prevent these errors.⁴

According to the Institute of Medicine, the most successful error-reduction strategies rely heavily on open and responsible reporting of errors.⁵ Health care professionals are generally encouraged to report medication events through one or more of several conventional voluntary medication error reporting systems (e.g., the Joint Commission’s Sentinel Events reporting program, the Food and Drug Administration’s MedWatch Program, the U.S. Pharmacopeial Convention’s MedMARx program, and the Institute for Safe Medication Practices [ISMP] Medication Errors Reporting Program [MERP]). The ISMP uses a small dedicated team of clinical professionals to review and interpret the plethora of data reported to MERP.⁶ The Medication Error Prioritization System (MEPS), on the other hand, was designed with the limited availability of staff and resources in mind and automates part of the medication-error review process. This expedites the rate at which institutions can learn from previous medication events and enhance patient safety efforts.⁷

This article examines how the use of MEPS in the patient safety program has led to incremental improvements for an integrated health care system comprising two hospital sites and 10 satellite clinics that dispense a quarter-million outpatient prescriptions annually. This was achieved through the administration’s support of an action plan that prompted staff members from various disciplines to work together to promote quality of care and a culture of patient safety. MEPS, developed in 2011 to improve medication-error reporting, has evolved into a comprehensive error prioritization system that has demonstrated the ability to help catalyze organization-wide changes in patient safety.

Using the online MEPS database, pharmacists answer a series of questions to report a medication error, including medication name, type of error, and location of event. The

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Figure 1 Medication Errors by MEPS Score

Each of the approximately 500 errors reported from April to September 2011 is represented by a vertical line along the X axis, which in composite forms the area shaded in orange. MEPS scores are listed along the Y axis; the highest MEPS score in this figure is 35 and the lowest is 2. The mean MEPS score is identified with a solid horizontal line and the two dashed horizontal lines denote the range of the first standard deviation. The two solid vertical lines separate the three tiers of priority (highest, intermediate, and lowest priority).
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“category” section of the database lists 16 types of errors the pharmacist can select, including adverse drug reactions, types of allergies, dosing errors, and drug interactions of varying severity. A free-text space is available to describe details of an event that does not fit into the 16 provided error types.7

A MEPS algorithm uses important qualitative variables of the error to calculate a quantifiable measure of the event. These variables include 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 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.7

As depicted in Figure 1, MEPS classifies reported events into one of three categories (high, intermediate, and low priority) based on an objective numerical value (ranging from 2 to 40) assigned to each error listed in a data set in descending order in a specific time frame (e.g., April to September 2011). The events with the highest MEPS scores have the highest priority and therefore must be reviewed by clinical staff before events with lower scores. In other words, medication errors with the highest potential to cause patient harm take priority over events that may not pose such a threat to patient safety. For example, an event in which a patient was mistakenly given a dose of warfarin and experienced an adverse reaction received the maximum MEPS score of 40. As a high-priority error, it took precedence for review over low-priority events, such as a missing dose on a prescription for hydrocortisone cream.7

Moving from left to right in Figure 1, the MEPS scores decrease toward the lowest-priority event (with a score of 2). The average MEPS score for this data set, 14.4, is represented by a bold horizontal line. The first standard deviation range for this set is scores ranging from 6.4 to 20.8 (represented by a horizontal dotted line above and below the mean line); any MEPS-scored event that falls within this range is assigned to the intermediate priority group. Any score above 20.8 is considered a high-priority event and any score below 6.4 is considered a low-priority event. The bell curve below illustrates the proportion of errors that belong to the three categories (high, intermediate, and low priority). Figure 2 depicts the first standard deviation with two vertical, dotted lines that separate the high-, intermediate-, and low-priority events. The high-priority events are highlighted in red; the intermediate group in the middle of the curve represents the bulk (77%) of the events.

Upon review of MEPS scores and events, especially those in the high-priority group, clinical staff can identify trends in the data, such as repeated errors involving a particular medication, location of event, date, and type of medication error or other important factors that describe the error. Using MEPS, raw data can be refined into meaningful information, generating site-specific and evidence-based recommendations to advance patient safety directives at a systems level.7 MEPS has helped provide insight for the clinical staff into how the organization can improve patient safety by reviewing medication errors based on their priority relative to all reported events in a data set.

MEPS’s capacity to help track emerging data for trends was immediately evident to the organization’s leadership, but the system is heavily reliant on and thus limited by staff reporting efforts—that is, buy-in from front-line staff. Also, to optimally calculate the MEPS score for each medication error, MEPS requires a large pool of data. A final aspect of MEPS is guiding short-term and long-term recommendations that are categorized into a three-tiered classification system based on the importance of the change warranted. Similar to the high-, intermediate-, and low-priority rating system for medication errors, a gradient is created based on the immediacy of action required: class A recommendations take priority over class B recommendations, which are more urgent than those in class C. The author uses these recommendations to compile a report that is presented to a safety committee and organization leadership and subsequently disseminated to front-line personnel.

At the time of this writing, five groups of medication-error data for five time periods of data collection—April to September 2011, October 2011 to March 2012, April to September 2012, October 2012 to March 2013, and April to September 2013—have been evaluated for the health care system. Recommendations generated through MEPS have led to modifications of several medication-administration policies and patient-safety procedures.

For instance, one event (listed as a class A recommendation in a final report) that resulted in a policy change involved 20 outpatients and 11 inpatients inadvertently receiving divalproex delayed-release (DR) tablets that were packaged and dispensed or administered as divalproex extended-release (ER) tablets. The cause was attributed to a pharmacy technician ordering the DR formulation of divalproex rather than the ER formulation during a national product shortage. In response to this event, the local P&T committee added both formulations to the Look-Alike Sound-Alike Medication Errors Policy; the divalproex DR formulation was subsequently removed from the drug formulary.

Another example of an error that led to changes in medication administration involved the dosing of vancomycin. Multiple errors involving vancomycin prescribed at intervals of every
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Table 1 MEPS Recommendations for Addressing Medication Errors

<table>
<thead>
<tr>
<th>Medication(s) involved</th>
<th>Description of Medication Error Observed via MEPS</th>
<th>Action(s) Taken</th>
<th>Outcome Assessment After Action(s) Taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Divalproex extended release (ER) and delayed release (DR)</td>
<td>Divalproex DR tablets were packaged and dispensed/administered as Divalproex ER tablets.</td>
<td>The P&amp;T committee decided to add the formulations to the Look-Alike Sound-Alike Medication Errors Policy; the Divalproex DR formulation was later removed from the drug formulary.</td>
<td>No further errors of this type have been reported.</td>
</tr>
<tr>
<td>Vancomycin IV</td>
<td>Multiple errors involving vancomycin prescribed at intervals of every 18 and/or 36 hours were discovered due to a software glitch.</td>
<td>The capability to prescribe vancomycin at 18- and 36-hour intervals was removed from the computerized prescriber order-entry system.</td>
<td>No further errors of this type have been reported.</td>
</tr>
<tr>
<td>Tramadol 50 mg and trazodone 50 mg</td>
<td>Pharmacy technicians incorrectly filled prescriptions for tramadol with trazodone and vice versa.</td>
<td>Applied tall-man lettering to both medication names; physically separated stock bottles; used automation to fill prescriptions of trazodone; tramadol was eventually classified as a controlled substance.</td>
<td>Errors between tramadol 50 mg and trazodone 50 mg were virtually eliminated.</td>
</tr>
<tr>
<td>Glyburide and glipizide</td>
<td>Mix-ups occurred between the medications when filling and prescribing.</td>
<td>Applied tall-man lettering to both medication names; glyburide was eventually taken off the formulary; physically separated stock bottles; used automation to fill prescriptions of glipizide.</td>
<td>Errors involving the incorrect use of glyburide and glipizide were virtually eliminated.</td>
</tr>
<tr>
<td>Alprostadil</td>
<td>Prescribed with incorrect route of administration.</td>
<td>Education was given to providers and pharmacists.</td>
<td>Errors involving the incorrect route of administration for alprostadil still occur.</td>
</tr>
<tr>
<td>Tiotropium (Spiriva Handihaler)</td>
<td>Several reports of patients swallowing the capsules prompted changes to the patient counseling process.</td>
<td>Improved pharmacist counseling techniques; initiatives to empower patients to be more proactive in their health care.</td>
<td>Errors involving the incorrect use of tiotropium occur less frequently than they did before the actions were implemented.</td>
</tr>
<tr>
<td>Various ear drops and eye drops</td>
<td>Pharmacy technicians incorrectly filled prescriptions for eye drops with ear drops and vice versa.</td>
<td>Physically separated medications for the eyes and ears; posted large signs to identify shelves containing eye drops and ear preparations.</td>
<td>Very few errors of this nature occurred after the actions were implemented.</td>
</tr>
<tr>
<td>Various antibiotics and ER narcotics</td>
<td>Several orders were prescribed with “PRN” (as needed) in the directions.</td>
<td>Providers were reminded that antibiotics and ER narcotics are not to be prescribed “PRN” (as needed).</td>
<td>Very few errors of this nature occur after the actions were implemented.</td>
</tr>
</tbody>
</table>

18 or 36 hours were discovered because a software glitch prevented the system from properly registering dosing at these frequencies, leading to numerous missed doses. To mitigate future errors, the capability to prescribe at such intervals was removed from the computerized prescriber order-entry system until the software glitch could be remedied.

Many of these changes have resulted in quantifiable improvements in health care outcomes (i.e., lower mean MEPS values for data sets). As a result of a recommendation made in the first MEPS report, leadership and the local patient safety committee made a concerted effort to revise and execute an action plan with a robust focus on medication safety. The action plan encompasses a wide range of topics integral to patient safety, including: the safety culture of the organization, patient counseling, and the use of technology. Some recommendations made by the patient safety committee address trends in medication errors identified with the help of MEPS, while others focus on problematic processes that may span several departments. Every recommendation presented to management is tailored to the specific problem with short-term and/or long-term approaches to address the issue and the safety culture as a whole. Examples appear in Table 1 with the methods used to prevent the event(s) from reoccurring and the outcomes observed up to one year after the corresponding actions were implemented. The actions taken had varying degrees of success. Some errors were virtually eliminated (e.g., mix-ups between tramadol 50 mg and trazodone 50 mg), while despite efforts, other errors continued to appear (e.g., alprostadil prescribed as a subcutaneous injection). The action plan addresses an array of issues (e.g., medication errors with
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the highest MEPS scores, specific medications commonly involved in events) and affects members of varying disciplines (e.g., medicine, nursing, pharmacy). The underlying theme of the action plan and patient safety committee is an emphasis on a systems approach to resolving local issues using the staff members most directly involved with patient care. MEPS has helped the organization improve key elements of its health care delivery process, including: better utilization of automation to enhance the process of filling prescriptions, streamlining patient-professional communication, and encouraging patients to be more involved in their care.

Each of the following sections describes specific efforts made to enhance overall patient safety and was identified after analyzing the data produced by MEPS from the medication-error data sets listed in Table 2.

REVISING AN ACTION PLAN

Continuous quality improvement is closely tied to the accreditation process of every health care organization. One fundamental recommendation made in the first MEPS report was for the local patient safety committee to regularly update the existing action plan in conjunction with the hospital’s overall quality management program. The action plan was revised to place greater emphasis on medication safety initiatives and goals. The patient safety committee’s primary focus is early detection—that is, to anticipate safety concerns and prevent errors before they escalate into major health risks.

The committee is headed by a patient safety manager with representation from a variety of disciplines, including nursing, medicine, pharmacy, risk management, and other essential patient-care staff. The committee is responsible for discussing and evaluating patient-safety concerns and working together to review potentially serious events, faulty processes, and trends in medication errors identified by MEPS.

SUPPORTING A SAFE CULTURE

In addition to the measures taken to address specific medication errors, initiatives have been suggested to enhance a culture of safety. First and foremost, it was imperative that front-line staff feel comfortable reporting medical errors that occur and discussing unsafe practices that they observe. An anonymous reporting system was proposed to encourage the sharing of information, urge staff to report errors more often, and overcome any negative connotations associated with reporting events. The goal was to improve the processes in place and not to assign blame. Specialized training was given on how to report errors properly and to provide the information necessary to accurately describe the error. Staff received constant reinforcement that errors are considered opportunities for education and not punishment. The purpose of this nonpunitive system of error reporting is to encourage learning from mistakes and determine where flaws in the system may exist. This safety culture promotes an environment where the sharing of information reinforces the ethos that the events of today will help create the strategies that will prevent the errors of tomorrow. Encouraging the staff to become more proactive in patient safety is an ongoing process of repeated efforts by safety leaders, such as sending out facility-wide emails on safety-related topics (e.g., teamwork, effective communication strategies) and creating posters to promote awareness of a maturing safety culture throughout the organization. This includes reiterating to staff the importance and value of meticulously reporting medication errors by providing as much detail as possible as soon as possible after the events occur. The continuing high volume of medication errors reported in each of the data sets testifies to the regard employees have for reporting errors. Table 2 shows the number of errors and the trend toward decreasing mean MEPS score, indicating that an increasing majority of reported errors involved less severe events.

IMPROVING PHARMACY SERVICES

Research indicates that approximately half of all potential medication events can be identified and prevented during the patient education process. Simply asking if the patient has any questions is not enough. The manner in which a pharmacist communicates with a patient can greatly influence the quality of care provided; educating patients properly prevents medication errors. Training sessions were arranged for pharmacists to improve their communication skills and help them maximize the effectiveness of counseling sessions with patients. A portion of the training (outlined below), modeled after the Indian Health Service’s “Three Prime Questions” approach, emphasizes the use of open-ended questions to assess a patient’s level of comprehension upon being prescribed a medication:

- **Asking open-ended questions**
  1. What did your provider tell you the medication is used for?
  2. How did your provider tell you to take this medication?
  3. What did your provider tell you to expect?

- **Confirmation of patient understanding**
  Just to make sure I did not leave anything out, how are you going to take this medication?

The benefit of this structured approach to counseling was twofold. It gave pharmacists direction and a foundation to provide clinical information based on the patient’s individual needs and to assess the patient’s level of understanding. It also gave patients a stronger sense of empowerment and ownership of their own health care by providing them with the knowledge and tools necessary to understand what medications they are taking and why.

EMPOWERING PATIENTS

All error-prevention efforts and strategies are rooted in health care professionals’ desire to ensure patients’ well-being.
However, it is also important to consider the role of patients and their families. It is the author’s opinion that if the health care professional is responsible for providing medication that is appropriate and correct and teaching the patient how to properly take the medication, then the patient and/or the patient’s family is responsible for the patient taking the medication exactly as instructed. A variety of tactics were used to help empower patients in a manner that best matches their individual learning styles and preferences, including easy-to-understand educational pamphlets, physical tools such as medication organizers, medication diaries, individualized technologies when applicable (e.g., smartphone applications that remind patients to take their medication), and continuous support from dedicated health care professionals.

**USING TECHNOLOGY TO IMPROVE PHARMACY TECHNICIAN SERVICES AND FUNCTIONS**

The use of computers, machines, and robotics in medicine is more prevalent than ever, and reliance on intricate technology can have a dramatic, positive effect on health outcomes. However, meticulous attention to detail is needed when automating these tasks, since using machines to operate an already defective process could exacerbate existing problems and generate new potential sources of errors. Sarter and Woods, in a study of highly automated machinery, found that while automation eliminated some errors, it created new ones. Nevertheless, when used successfully, technology can reduce the potential for human error by automating repetitive tasks that require high levels of precision (such as filling prescriptions). Evidence suggests that advanced medical technology can have a largely positive impact in health care settings, improving safety, quality, and efficiency by reducing errors due to human fallibility.

In April 2013, an automated medication-filling machine was installed in one of the facility’s pharmacies. Errors arising from the incorrect filling of certain prescriptions have been virtually eliminated because this technology has replaced much of this formerly human function. The most pronounced, quantifiable result was a 2.5-point reduction in overall mean MEPS score in the data set following the installation, indicating that the overall severity of all the medication errors reported was less severe than in previous reports. Figure 3 demonstrates the drop in mean MEPS score between the reports before and after the installation of the automated equipment to fill prescriptions in April 2013.

Using technology in the pharmacy also has indirect benefits. The suggestion to advance the use of automation in the pharmacy was made based on MEPS’ identification of numerous medication errors made during the prescription-filling process. Several proposals have been advanced, such as allowing pharmacy technicians to spend less time filling prescriptions and more time conducting clinical services within their scope of practice. Several studies have been conducted to assess the benefit of using pharmacy technicians in the medication reconciliation process. In one study, pharmacy technicians were able to successfully complete a patient’s medication history with a 95% accuracy rate, and their involvement in medication reconciliation reduced the time spent by physicians, nurses, and pharmacists at the time of admission. When working with a pharmacist, technicians can serve an essential clinical role by obtaining the data necessary for accurate detection and reconciliation of discrepancies, completing medication histories, and thus helping to prevent errors or adverse drug events. Therefore, organizations that successfully utilize technology may benefit in indirect ways, such as expanding the role of pharmacy technicians, freeing pharmacists for other duties, and allowing pharmacists to provide more clinical services and practice at the optimal level of their licensure.

**CONCLUSION**

Since its 2011 inception, MEPS has aided the collection, prioritization, and analysis of medication-error data. MEPS has facilitated many incremental improvements, but these initiatives require the continued collaboration of staff and a commitment to the mission of patient safety. The staff members on the front lines who order, dispense, and administer medical care to patients are the backbone in a culture of safety. Working as a team, the patient safety committee, made up of members from varying disciplines, collaborated on an action plan to achieve strategic goals that its individual members might not have been able to reach had they worked independently with a “silo” mentality. By prioritizing and organizing reported medication errors, MEPS has helped the author identify problematic trends in patient care and offer recommendations to the patient safety committee for review. The committee evaluates which recommendations to act upon and presents them to management for the proper execution of the necessary steps. These recommendations have led to an objective improvement, seen in one facility’s overall decline in mean MEPS scores, which reflect a steady decrease in the clinical severity of reported events.

The primary objective of MEPS is to promote patient safety and quality of care, and to continue doing so at increasing levels of efficiency. In the near future, efforts will be made to further automate MEPS by developing a reporting system that will seamlessly feed it data based on the information provided by
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the user and prompt the user to provide more information as necessary. This will help improve learning from medication errors, deliver better health care outcomes, and offer more opportunities to provide better patient care and clinical services, which would create a heightened level of patient safety—a positive, perpetuating loop of quality health care.

REFERENCES