INNOVATIONS IN TEACHING

Application of Quality Assurance Principles: Teaching Medication Error Reduction Skills in a “Real World” Environment

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Objectives. To create an instructional sequence that would encourage students to acquire the knowledge, skills, and abilities required to decrease medication errors in the pharmacy practice setting.

Methods. A course on medication error reduction was developed for third professional year pharmacy students. Students (N=157) were divided into 30 project teams and assigned to a preceptor in a community or health-system pharmacy. Teams met with their preceptors and, using concepts learned in class, developed site-specific medication error reduction projects. Students collected, analyzed, and evaluated data to measure plan impact, presented their results at a poster forum, and self-evaluated their knowledge, skills, and abilities.

Results. Students demonstrated improvement in the following areas: (1) awareness of medication error impact on patient health, (2) motivation to implement methods to decrease errors, (3) knowledge of methods to reduce errors, (4) ability to identify errors, and (5) ability to implement methods to reduce errors.

Conclusion. The increased student awareness of the pharmacist’s role in medication error reduction and the actual use of error reduction skills will enable them to improve future patient outcomes.

Keywords: Medication error, Rasch model, curriculum

INTRODUCTION

The cost of preventable medication errors to the patient and society is staggering. Numerous studies in the United States, the United Kingdom, and European countries have demonstrated that patients are frequently hospitalized as a result of medication-related problems that were preventable.1-8 Studies have also shown that pharmacists are able to identify, resolve, prevent, and reduce medication errors.9-11

The Institute of Medicine (IOM) has stated, “Health care has safety and quality problems because it relies on outmoded systems of work. Poor designs set the workforce up to fail, regardless of how hard they try.”12 The report called for the workforce to learn the knowledge and skills necessary to facilitate change that will result in a reduction in the number of medication errors. Schools and colleges of pharmacy in the United States have begun to implement educational strategies to attain this goal.

A literature search was performed in Pub Med and International Pharmaceutical Abstracts (IPA) databases using medication error and education as key words. Several authors described medication error education for undergraduate, graduate, and on-the-job didactic training for pharmacists, physicians, and nurses.13-24

One abstract reported the results of a survey to determine the extent to which pharmacists had obtained medication-error training.16 A survey instrument administered to 237 participants at a national pharmacy meeting in 2000 was used to determine that 65% of those responding had received medication-error instruction when in pharmacy school.

A similar survey, which was conducted by Johnson, Latif, and Gordon, inquired about medication error instruction in schools of pharmacy and showed that many schools have indeed integrated some form of medication error instruction into their curriculum.17 Of the schools of pharmacy that completed and returned usable surveys, 15 (44%) of 34 indicated that some form of medication error instruction was included in their curriculum. Sixteen (47%) of the schools responding taught medication error education using a didactic approach, 3 (9%) used a skills lab format, and 12 (35%) schools used a combination of the two. However, the quality and quantity of error instruction varied and domains were not defined for respondents. There were no

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reports of an experiential application of medication error reduction skills in a pharmacy practice setting where students were provided with an opportunity for “real world” project site experience.

In collaboration with the Institute for Safe Medication Practices (ISMP) and the US Food and Drug Administration (FDA), Temple University developed an optional 12-credit certificate program in medication safety for doctor of pharmacy degree students. The program is extensive and includes on-site rotations at the FDA, in health-system pharmacies, in industry, and at the ISMP.

Thus, a course entitled “Quality Assurance and Effective Pharmacy Practice” (QA & EPP) was developed by the author with the express intent of teaching pharmacy students the knowledge and skills needed to improve healthcare safety over the course of a single quarter. To the author’s knowledge, no other pharmacy school in the United States requires students to enroll and complete a course designed specifically with a medication error reduction focus that facilitates learning and subsequent skill application in a “real world” pharmacy practice setting.

Quality Assurance and Effective Pharmacy Practice (QA & EPP) is a 3-credit course taught by the author at Midwestern University Chicago College of Pharmacy. Third professional year students must successfully complete this course to earn their doctor of pharmacy degree. The goal of QA & EPP was to create an instructional sequence that encouraged students to acquire the knowledge, skills, and abilities required to decrease medication errors in the pharmacy practice setting and then implement those quality assurance techniques to decrease medication errors in a community or health-system pharmacy practice environment.

The objectives for QA & EPP were to improve the students’ understanding: (1) awareness of the impact of medication errors on patient health, (2) ability to identify medication errors, (3) knowledge of methods to reduce medication errors, and (4) ability to implement methods to decrease medication errors. While this may seem like a narrow focus, a broad “systems” view of medication errors was stressed in QA & EPP and all errors throughout the medication use system were discussed (ie, prescribing, dispensing, administration, and monitoring). Students were taught that 100% dispensing accuracy is not equivalent to 0% error.

The instructional sequence of the QA & EPP was designed so that students could apply material that was learned in class in a “real world” environment.

METHODS

The Office for the Protection of Research Subjects at the Midwestern University Chicago College of Pharmacy granted approval for this research project. Students (N=157) self-selected members of their project teams (4 to 7 students per team; N=30 teams). Each team was then assigned to one of 30 pharmacy preceptors practicing in either a community or health-system pharmacy in the Chicago area. Teams then met with their preceptor to select a medication error reduction goal specifically chosen to benefit the specific practice site. These goals could focus on any portion of the medication use system. The team and their preceptor then outlined a plan in writing that would achieve the defined medication error reduction goal and submitted it for approval to the course coordinator. Once plan approval was obtained, the team began to implement their plan for medication error reduction at the pharmacy site using concepts learned in a classroom setting during the first 6 weeks of the course.

Classroom Component

The general, in-class format included a short lecture (20 minutes) followed by a brief (20 minutes) active learning exercise. All in-class activities were followed with a debriefing and/or group discussion that lasted approximately 10 minutes. The coordinator served as a resource for clarification and to answer any questions the students had during the activity and then as a facilitator during the following group discussions. A detailed list of the learning activities for each in-class topic is shown in Table 1. An example of an in-class exercise is provided in Appendix 1.

Project Development

Teams assigned to health-system pharmacy practice sites worked directly with the pharmacy director or quality assurance officer, while those assigned to the community pharmacy sites worked with the pharmacy manager.

One of the tools that teams assigned to a community pharmacy practice site had at their disposal was the Pharmacy Quality Commitment Sentinel System. The Sentinel System is a systematic continuous quality improvement program developed by PMC Quality Commitment, Inc. The system uses risk management guidelines as a mechanism to assist community pharmacists in identifying, evaluating, and preventing medication errors. The guidelines include the following: (1) standardizing workflow; (2) risk management techniques; (3) peer-review documentation; (4) peer-review coordination; and (5) day-to-day risk management proactive suggestions.
Table 1. Class Content and Active Learning Techniques Used

<table>
<thead>
<tr>
<th>Class Content</th>
<th>Active Learning Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>How to Work as Part of a Team</td>
<td>Think / Pair / Share</td>
</tr>
<tr>
<td>Introduction to Medication Error</td>
<td>Practice Questions</td>
</tr>
<tr>
<td>Incidence of Medication Error in Pharmacy Practice</td>
<td>Impact Calculation Worksheet</td>
</tr>
<tr>
<td>Errors in Community Pharmacy Practice</td>
<td>Scenario &amp; Practice Questions</td>
</tr>
<tr>
<td>A Quality Improvement System Model that Works</td>
<td>Practice Worksheet</td>
</tr>
<tr>
<td>The Sentinel System: What it is and How to Use It</td>
<td>Software Demonstration</td>
</tr>
<tr>
<td>Quality Control &amp; Quality Assurance</td>
<td>Case Evaluation</td>
</tr>
<tr>
<td>Pharmacy Design Changes You Can Implement</td>
<td>One-Minute Paper</td>
</tr>
<tr>
<td>Organizational Changes that Have Error Impact</td>
<td>Practice Questions</td>
</tr>
<tr>
<td>Healthcare Failure Modes and Effects Analysis</td>
<td>Practice Worksheet</td>
</tr>
<tr>
<td>How Stress Effects Medication Error</td>
<td>One-Minute Paper</td>
</tr>
<tr>
<td>Doing Your Own Root Cause Analysis</td>
<td>Root Cause Analysis Practice</td>
</tr>
<tr>
<td>How to Use Excel to Analyze Data</td>
<td>Hands-on Computer Session</td>
</tr>
<tr>
<td>Systematic Drug Utilization Review (DUR)</td>
<td>Case Evaluation</td>
</tr>
<tr>
<td>Patient Information and Medication Error</td>
<td>Case Evaluation</td>
</tr>
<tr>
<td>Identifying Medication Errors with Patient Counseling</td>
<td>Role Playing Cases</td>
</tr>
<tr>
<td>Preparing a Scientific Poster for Presentation</td>
<td>One-Minute Paper</td>
</tr>
<tr>
<td>Medication Error Reporting</td>
<td>Error Reporting Worksheet</td>
</tr>
<tr>
<td>How to Use Power Point</td>
<td>Hands-on Computer Session</td>
</tr>
</tbody>
</table>

Students continued to visit their site and preceptor to work on these team projects for the remainder of the quarter. Student-generated progress reports were submitted to the coordinator weekly as an indicator of project development, reflections about lessons learned, project problems, and plan changes. In this manner, the coordinator was kept abreast of project progress in writing and could intervene if a project needed additional assistance or guidance.

**Outcomes Documentation**

Students were required to measure the impact of their medication error reduction plan. They were required to use research design skills they had learned in other classes to collect, analyze, and evaluate data. Each team was required to prepare and present a professional poster regarding their team projects. Two independent evaluators (ie, the coordinator and another pharmacy administration faculty member) assessed the posters. Individual evaluator scores were added together to produce each team’s project score. Each poster was judged on the following: (1) appearance, (2) organization, (3) visual appeal, (4) clarity, (5) problem description, (6) problem importance, (7) literature review, (8) global and specific aims, (9) quality assurance or change process implemented, (10) description and justification of the intervention made, (11) process and outcome measures used, (12) data collection procedures, (13) data analysis procedures, (14) nature of results presented, (15) sample description, (16) results, (17) conclusions, (18) implications, (19) limitations, and (20) recommendations for future research. All posters were displayed and evaluated at the end of the quarter at a quality assurance poster forum that was developed specifically for the students to disseminate their results. This poster session was held at Midwestern University where University students, faculty members, staff members, and preceptors were invited and encouraged to attend. Attendees viewed and discussed the displayed results with team members over a 2-hour period.

As an additional incentive, the student team that received the highest project score was awarded $100 per member to use toward presenting their team’s medication error-reduction project poster at a state or national meeting. Members on the winning team also received a framed wall certificate indicating their accomplishment. The members of the second- and third-place teams also received framed certificates.

**Student Attitudinal Survey**

On the last day of class, the students were asked to complete an attitudinal survey. This survey was designed as a retrospective preassessment postassessment of student perceptions regarding medication errors and QA & EPP. Retrospective pretest-posttest is defined as a “self-report during the course or at the end of treatment that measured subjects’ recall of how they were functioning before program outset.” The retrospective pretest-posttest was chosen as a method of limiting response-shift bias, a phenomenon that may occur when the internal construct changes as a result of the experience. Retrospective pretest- posttest methods have
Table 2. Community Pharmacy Site Projects

- Implementing the Sentinel System™ in a community pharmacy setting
- Identifying & measuring the incidence of medication-related errors in a community pharmacy
- Implementation and evaluation of a process to assess pharmacy baseline error rate
- A systems perspective on spontaneous medication error reporting
- Implementing effective ways to decrease medication errors at a chain pharmacy
- Implementing the Pharmacist Mutual Sentinel System™ at an independent pharmacy
- Quality assurance in a community pharmacy
- Reducing technician errors in a chain community pharmacy
- Development of a continuous quality improvement training video for chain pharmacy
- Development of a quality improvement training video
- Developing a protocol to reduce medication errors and improve patient quality of care
- Effects of standardizing workflow in a community pharmacy setting
- Implementing a quality assurance system in a grocery store chain pharmacy
- Decreasing medication errors by standardizing workflow in a community pharmacy
- Adding quality control principles to decrease medication error

Table 3. Health System Pharmacy Site Projects

- Medication turnaround time at a local community hospital
- Analysis of satisfaction with nursing services
- Cost effective and cost effective analysis of Norflex
- Frequency of Misleading abbreviation use in medication orders
- Analysis of medication order entry errors
- Evaluation of a Coumadin protocol and its efficiency
- Evaluating a pharmacist-driven quality improvement project
- Analysis of adherence to requirements for medical documentation
- Incidence of medication allergy documentation in a hospital setting
- Time: pharmacist’s friend or foe?
- Evaluation of patient height, weight and allergy documentation at a medical center
- A study of parental narcotic use
- Patient controlled analgesia (PCA) pump programming audit
- Assessment of patient-specific medication errors in cart filling verification
- Analysis of hypertension control and medication utilization in a cardiology clinic

demonstrated their usefulness in supporting validity when used to obtain attitudinal responses in these situations. In addition to the 9-item attitudinal instrument, 5 additional items were developed to evaluate the overall achievement of the instructional goals and the strengths and weaknesses of the course content. A copy of the Quality Assurance Attitudinal Survey can be obtained from the author upon request.

Statistical Analyses

The Rasch rating scale model was used to evaluate responses on the Quality Assurance Attitudinal Survey. The Wolfe and Chiu procedure was used to compare item and person values on pretest and posttest. The Wolf and Chiu procedure is an anchoring technique for measuring pretest-posttest change with a Rasch rating scale and has been useful in interpreting data using a retrospective pretest-posttest data collection technique. SPSS statistical analysis system version 11.5 for Windows (SPSS Inc, Chicago, Ill) was used to calculate t-tests for evaluating retrospective pretest and posttest competition evaluation data.

RESULTS

The content and methods selected and applied by each of the student teams for completion of their medication error reduction projects was varied. A list of titles for the medication error reduction projects for community and health-system pharmacy sites appears in Tables 2 and 3, respectively.

Student Outcomes

All 30 teams of students completed their projects and presented them during the poster forum. The impact of the medication error reduction projects was very positive overall. The team presentation receiving the highest score during the poster forum achieved excellence based on their analysis of the patient control of hypertension and medication use in a cardiology clinic. Their study, which was a random, retrospective chart review of 120 patients with hypertension, found that the blood pressure in nearly half of the patients on medica-
tion therapy remained uncontrolled. This team recommended practitioner education concerning national practice guidelines as a mechanism for improving prescribing habits.

The second-place team evaluated the frequency of misleading abbreviations in medication orders at a suburban hospital. This team evaluated 2,282 medication orders over an 11-day period and found that 941 (41%) contained a misleading abbreviation. This information became the basis for a new hospital prescribing policy.

One of the teams that received an honorable mention in the poster competition completed an assessment of patient-specific medication errors in cart filling at a local hospital. Over a 10-day period, the team checked 49 medication carts that had been verified for accuracy before leaving the pharmacy. Of 1,563 unit-dose medications inspected, 23 errors were found (ie, 1.5% error rate). Of these, 13 (57%) involved dispensing the wrong drug and 3 (13%) involved dispensing a drug of the wrong strength. A much higher error percentage was discovered on one particular day, and subsequent inquiry using root cause analysis techniques led the team to conclude staffing issues were the source of the problems. This issue was then addressed by the preceptor and other hospital administrators.

Another team that received an honorable mention in the poster competition analyzed the quality-related events at a community pharmacy to determine the nature and frequency of the most common dispensing errors. To accomplish this, the team implemented the Sentinel System and evaluated a total of 5,715 new and refill prescriptions over a 5-week period. The team detected 44 errors for a total error rate of 0.75%. Forty of these errors (91%) were discovered by the pharmacist upon their final check of the prescription before dispensing. Further review of the 44 errors showed that 13 (30%) were data entry errors. That is, the directions written by the physician on the prescription were incorrectly entered into the pharmacy computer system. This led the team to recommend several risk management techniques to the data entry person at the pharmacy such as double-checking the hard copy with the data actually entered for every new prescription.

Of the remaining 26 teams, several chose to evaluate the effect of implementing standardized procedures in a hospital or community pharmacy, while others focused on medication error estimation and analysis. Two teams produced quality improvement training videos for use by pharmacists at a national chain.

Quality Assurance Attitudinal Survey

The retrospective pretest-posttest Quality Assurance Attitudinal Survey was completed by 145 of 157 (92.4%) students. The response rate reflects the number of students who attended class the day the survey was distributed. The raw scores for students responding to the retrospective pretest and posttest survey (ie, number and percent of students who responded to each of the 4 rating scale categories for each item) are shown in Tables 4 and 5. These results suggest that students were more apt to agree with or rate their abilities higher when responding to the statements after completing the QA & EPP course.

Rasch Rating Scale Analysis and Model Fit

The requirements for demonstrating proper rating scale function were met as follows: (1) the number of observations in each category was greater than 10; (2) the average category measures increased with the rating scale categories; (3) INFIT and OUTFIT MNSQ statistics for the measured steps were 0.92 and 1.09, respectively; (4) category thresholds increased with the rating scale categories; (5) category thresholds were at least 1.4 logits apart; and (6) the shape of each rating scale distribution was peaked (see Figure 1). The specific
Table 5. Quality Assurance Survey Attitude Assessment Results *

<table>
<thead>
<tr>
<th>I feel...</th>
<th>Before</th>
<th>Somewhat Agree</th>
<th>Somewhat Disagree</th>
<th>After</th>
<th>Somewhat Agree</th>
<th>Somewhat Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. It is important for pharmacy students to learn Quality Assurance.</td>
<td>6 (4)</td>
<td>72 (50)</td>
<td>13 (9)</td>
<td>0 (0)</td>
<td>18 (13)</td>
<td>125 (87)</td>
</tr>
<tr>
<td>7. Decreasing medication errors is a major issue.</td>
<td>1 (1)</td>
<td>112 (77)</td>
<td>2 (1)</td>
<td>0 (0)</td>
<td>2 (1)</td>
<td>142 (99)</td>
</tr>
<tr>
<td>8. Taking this class will help me to be a better pharmacist.</td>
<td>6 (4)</td>
<td>71 (49)</td>
<td>18 (13)</td>
<td>1 (1)</td>
<td>32 (22)</td>
<td>108 (75)</td>
</tr>
<tr>
<td>9. This class provided information that I will use.</td>
<td>8 (6)</td>
<td>40 (28)</td>
<td>26 (18)</td>
<td>0 (0)</td>
<td>5 (3)</td>
<td>107 (75)</td>
</tr>
</tbody>
</table>

* Percents may not equal 100 due to rounding
† N=145

Table 6. Summary of Category Structure

<table>
<thead>
<tr>
<th>Category Label</th>
<th>Observed Count</th>
<th>INFIT MNSQ</th>
<th>OUTFIT MNSQ</th>
<th>Category Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Weak and Disagree</td>
<td>225</td>
<td>1.05</td>
<td>1.08</td>
<td>-3.84</td>
</tr>
<tr>
<td>2-Fair and Somewhat Disagree</td>
<td>445</td>
<td>0.93</td>
<td>1.09</td>
<td>-1.55</td>
</tr>
<tr>
<td>3-Good and Somewhat Agree</td>
<td>838</td>
<td>0.92</td>
<td>0.97</td>
<td>1.35</td>
</tr>
<tr>
<td>4-Very Good and Agree</td>
<td>853</td>
<td>1.03</td>
<td>1.04</td>
<td>4.21</td>
</tr>
</tbody>
</table>

Results for the rating scale function are listed in Table 6. Evaluation of INFIT and OUTFIT statistics for the items in the Quality Assurance Attitudinal Survey showed that MNSQ values for the 9 items were greater than 0.6 and less than 1.4. Thus, these data exhibited good fit and supported the unidimensionality and local independence requirements of the model, demonstrating that the 9 items measured the same construct (ie, unidimensionality) and produced additivity of measures (ie, true interval level data). Thus, categorical data were converted to interval level data, enabling the use of parametric statistical procedures in testing the differences between responses to the pretest and posttest.

The separation index (ie, the extent that items are sufficiently spread out to define distinct levels of ability) for the 9-item survey was 13.62 and 6.38, which translate to an item reliability of 0.99 and 0.98 for the pretest and posttest, respectively. The student separation index was 2.12 and 1.53, which translate to a person reliability of 0.82 and 0.71, respectively (analogous to Cronbach alpha), for the 9 items in the pretest and posttest.

Student Ability Measures Pretest to Posttest

The group means for student ability measures were 0.40 logits (± 1.7 logits) and 4.47 logits (± 2.03 logits) for the pretest and posttest, respectively, showing a major improvement (ie, difference of 4.07 logits) in the endorsement of the 9 items collectively. This difference between group means (ie, dependent student’s t-test) was significant from pretest to posttest (t = 23.51, p < 0.001). In addition, Rasch analysis allowed evaluation of individual person measures and each item’s contribution to the overall instrument. The use of this model in evaluating responses from pretest to posttest presents an advantage over other statistical methods, allowing quantification of changes in attitudes and ability for each student.
Individually, all students completing the class demonstrated a perceived improvement in their ability as measured by the attitudinal survey. However, for 119 (82.1%) of 145 students, this perceived improvement was statistically significant ($t > 2.05$, $p < 0.05$). An additional 20 students demonstrated perceived improvement that was noteworthy, with greater than a 0.5 logits change from pretest to posttest. The remaining 6 students showed only a small self-perceived improvement.

**Item Evaluation Pretest to Posttest**

**Items 1-9.** Figure 2 depicts the hierarchical ordering of item endorsement and what can be expected from each person/item interaction (expected score map). The right side of Figure 2 shows the item hierarchy, with items at the bottom of the hierarchy being the easiest to endorse positively and items at the top being the most difficult for students to endorse positively. For example, item 7, “Decreasing medication errors is a major issue,” was the easiest item for students to endorse positively (ie, to agree). The item hierarchy shows that item 3, “My ability to identify medication errors,” was the most difficult of the 9 items to endorse positively (ie, to assess a high level of ability).

Student responses relative to each item are evaluated using the pretest and posttest normative distributions provided in Figure 2. For example, the normative distribution for the pretest shows that for item 1, “My ability to identify medication errors,” nearly all of the students rated their ability as weak or fair. This is in contrast to the interpretation of the normative distribution for this item on the posttest where it is shown that no students rated their ability as weak and only a few students rated their ability as fair while the majority of students now perceived their ability as good or very good. Similarly, the results for the other 8 items would be interpreted using the pretest and posttest normative distributions provided.

While improvement in performance was noted for all 9 items, calibration values for 2 items changed significantly from pretest to posttest, resulting in a shift in the hierarchical ordering of items 1, 2, and 4. In the pretest, the hierarchical ordering of these items, from easier to more difficult to endorse, was 1, 4, 2, but in the posttest the hierarchical ordering changed to 4, 2, 1. This indicated that item 2, “My knowledge of methods to reduce medication errors,” and item 4, “My motivation to implement methods to decrease medication errors,” became easier for students to endorse positively in the posttest relative to the other items. The rating scales functioned similarly in both the pretest and posttest. Thus, the use of normative distributions to describe expected responses continues to function for interpreting item responses as regards Figure 2.

**Items 10, 11, 12, and 15.** Item 10, “Indicate how much the team project contributed to your learning in this class,” was designed to evaluate the contribution of the team design to learning while completing the student projects. Of the students responding, 28 (19.3%) of 145 students indicated the team project contributed “a little,” 81/145 (55.9%) indicated the project contributed “a lot,” and 34 (23.4%) chose “all” (“All” was interpreted to in-
dicate the project was the only portion of the class that contributed to learning). Only 2/145 (1.4%) answered “none.” indicating that they did not perceive the project contributed to their learning. Thus, over 90% of the students indicated that using a team-based format contributed to their learning.

When answering questions 11, “Do you feel the instructional goal was met?”, and 12, “Did you get what you wanted from this class?” each student provided a dichotomous response of either yes or no. Over 92% indicated they achieved the overall instructional goal, and 92% indicated they achieved what they wanted from the class.

Question 15 asked the student to give QA & EPP an overall rating. When answering this question, 39 (26.9%) chose “excellent,” 92 (63.4%) chose “good,” 13 (8.9%) chose “fair,” and 1 (0.07%) chose “poor.”

**Items 13 and 14.** Students were given the opportunity to respond to a few open-ended questions (survey question numbers 13 and 14). Of the 145 students completing the survey, 139 took the opportunity to respond to question 13, “What was the best part of this class?” The most frequently cited responses were the project (N=67); the active learning (N=26); the energy level of the coordinator (N=18); understanding the importance of avoiding errors and learning the tools for avoiding error (N=8); and guest speakers and/or talking about real life examples (N=5). Representative comments about the worth of the project included the following: “(The best part was) getting to use classroom knowledge in a real life setting.”; “It really made me think.”; “I never thought little changes could make such a big difference.”; and “There is a definite need for every RPh to have a QA background.”

Of the 145 students responding to the survey, 139 also took the opportunity to respond to question 14, “What is the one thing that would improve this class?” The suggestions most frequently made were: give class/block schedule time for site visits (N=84); invite preceptors to be present on the first day of class (N=13); and provide more guidance on the project (N=5).

**DISCUSSION**

**Student Outcomes**

The student projects gave students an opportunity to use the knowledge, skills, and abilities that they had learned in class in a “real world” setting. The students appreciated this experience and, while the content and methods selected and applied by each of the student teams for completion of their medication error reduction projects was varied, all but one team met or exceeded the coordinator’s expectations. The success of the projects was influenced by 3 major factors. Foremost, the students had a great deal of control in creating a plan they believed was feasible and would lead to success. This had the effect of empowering the students and encouraged them to demonstrate accountability. Second, the projects were orientated toward the specific needs of the pharmacy practice site. Third, site preceptors had input into student projects and received frequent progress reports from the students.

When presenting their results, the students were very proud of their work and eager to discuss their accomplishments with poster forum attendees (ie, other faculty members, students, and staff members). The students and coordinator received much positive feedback, leaving them with a feeling of accomplishment and hope for the future of pharmacy practice.

**Quality Assurance Attitudinal Survey**

**Interpretation of student ability measures pretest to posttest.** The group means for student ability measures showed a marked increase from pretest to posttest. This was somewhat unexpected because this was the first time QA & EPP was offered using this format. That 139 out of 145 students demonstrated a measurable improvement in perceived attitude and ability was gratifying to the author. However, the instructor noted that the 6 students who performed at a lower level than desired were members of the same project team. The members of this team allowed several weeks to pass during which they had only minimal contact with their preceptor. This put the team behind in collecting their data. Had the members of the team asked for assistance earlier, their project and their learning experience would probably have been less compromised. While these projects were designed to foster self-directed learning and responsibility, to further encourage this goal, the instructor will implement additional indicators for tracking the progress of student projects from the perspective of the preceptors.

**Item Evaluation Pretest to Posttest.** The first 9 items of the retrospective pretest-posttest survey will be discussed in hierarchical order from the easiest to endorse to the most difficult to endorse.

**Interpretation for Items 6, 7, 8 and 9.** These 4 items are discussed first because they were the easiest items for students to endorse positively (ie, had the highest probability of agreement). Item 7, for example, was designed to assess student attitude toward medication errors in general. The normative distribution showed that on both the pretest and posttest most students agreed that decreasing medication errors is a major issue. This is consistent with the coordinator’s expectation that the students already would recognize medication errors as a problem before attending QA & EPP.

Items 6, 8, and 9 were developed to assess student
attitude toward class content and its perceived relevance to pharmacy practice. The course coordinator wanted to assess these attitudes because anecdotal experiences indicate that pharmacy students have difficulty understanding the relevance of many pharmacy administration classes (QA & EPP is considered a pharmacy administration class at Midwestern University). The normative distribution showed that on posttest most students somewhat agreed with the following statements: “It is important for pharmacy students to learn QA” (item 6); “The class will provide useful information” (item 9); and “This class will help me be a better pharmacist” (item 8). However, on the normative distribution for the pretest, many students (ie, those approximately one or more standard deviations below the mean) indicated that they “somewhat disagree” or “disagree” with these statements. On posttest, however, all students indicated “agree” or “somewhat agree.” This reinforces that after completing QA & EPP the students understood the relevance of the class content to pharmacy practice.

Interpretation for Items 5, 4 and 2. Items 5, 4, and 2 comprise the midlevel difficulty items (ie, those items that had a midlevel probability of being endorsed positively). These items were designed to assess students’ awareness of the impact of medication errors (item 5), their motivation to implement methods to decrease medication errors (item 4), and their knowledge of medication error reduction methods (item 2).

The first goal for QA & EPP was to facilitate student awareness of the impact of medication errors on patient health. This goal was assessed using item 5, “My awareness of the impact of medication errors on patient health.” The normal distribution for the pretest shows that the majority of students rated their ability as good or fair, with some students estimating their ability as weak. Upon posttest, however, the majority of students rated their ability as very good. This may be attributable to several components of QA & EPP. That is, several class periods were dedicated to presenting material on the impact of medication errors (eg, introduction to medication error, incidence of medication error in pharmacy practice, errors in community pharmacy practice). In addition, the practical experience gained through participation in the medication error team projects also resulted in heightened student awareness.

Motivation, assessed by item 4, “My motivation to implement methods to decrease medication errors,” also demonstrated significant improvement from pretest to posttest, with the mean student perceived ability improving from fair to very good. This item also exhibited a significant calibration change and became easier for students to positively endorse (ie, to indicate a high level of ability) on the posttest relative to their ability to positively endorse other items. This may be attributable to the encouragement the students received from preceptors during participation in the medication error team projects as the preceptors showed their eagerness to work with the students and the students were, in turn, eager to assist the pharmacists. In addition, students saw the positive effects of their efforts, which served to further increase their motivation.

The third goal for QA & EPP was to facilitate student knowledge of methods to reduce medication errors. The normative distribution demonstrates that this goal, assessed by item 2, “My knowledge to reduce medication errors,” was achieved. Additionally, the student perceived growth in their knowledge was so dramatic that it also resulted in a hierarchical shift from pretest to posttest relative to other items. There are several reasons for this positive outcome. First, several class periods were dedicated to presenting material on methods to reduce medication errors (eg, quality improvement systems that work, the Sentinel System, and pharmacy design changes you can implement). In addition, the practical experience gained though participation in the medication error team projects also reinforced the students to acquire and apply the knowledge of error reduction techniques. Since methods for medication error reduction were a common theme in lectures, class activities, and team projects, it makes sense that students became more apt to rate their ability as higher in these areas after completing QA & EPP.

Interpretation for Items 1 and 3. The second goal for QA & EPP was to improve the student’s ability to identify medication errors. Achievement of this goal was assessed using retrospective analysis of the pretest and posttest responses to item 1, “My ability to identify medication errors.” As a group, the normative distribution for responses to this item indicates this goal was also reached. Student ability improved according to posttest responses, with the average response changing from “fair” to “good.” On the pretest, many students assessed their ability as weak, but none gave this assessment on posttest. This is not surprising in light of the methods used to address the identification of medication errors in class. Considerable instructional time was dedicated to medication error identification via case evaluation.

The fourth goal for QA & EPP was to facilitate student ability to implement methods of decreasing medication errors. This goal, which was assessed using item 3, “My ability to implement methods to decrease medication errors,” was also achieved as demonstrated in Figure 2. Most students rated their ability as weak or fair on pretest and as good or very good on posttest. However, this was also the most difficult item for students to endorse positively as shown by the item’s
placement in the item hierarchy. While improvement was demonstrated, their ability to take a leadership role in implementing change from a systems perspective will require additional practice and experience above and beyond what a quarter-long class could incorporate.

Interpretations for Items 10, 11, 12 and 15. The fifth goal for QA & EPP was to facilitate student application of “real world” skills in medication error reduction. This goal was assessed with retrospective pretest-posttest item 10, “Indicate how much the team project contributed to your learning in this class,” and item 11, “Do you feel you have achieved [the instructional] goal.” It was encouraging to the instructor that almost all students indicated the project was beneficial and the instructional goal was met. The practical experience gained through participation in the medication error team projects was essential in this regard, as they provided a safe learning environment for students to gain experience while improving pharmacy practice.

In addition, most students indicated they did get what they wanted from AQ & EPP (item 12, “Did you get what you wanted from this class?”). Many of those students who indicated they did not get what they wanted elaborated on their feelings. Interestingly, many of these students indicated that they wanted to be recognized as first-prize winners in the poster contest. Because of the incredible amount of work students put into their projects, several of the students were disappointed that their team did not win first place. However, the instructor reinforced to the students that “in my mind and in the lives of the patients whom your projects impacted, you are all winners.”

Retrospective pretest-posttest item 15 asked students to provide an overall rating for QA & EPP. At first review, the responses to this question were disappointing. However, upon further evaluation of the students’ comments, the instructor gained a different perspective. Most of the students who rated QA & EPP as fair or good added the caveat that when some of the “bugs” were worked out, it would be an “excellent” class. This assessment of the course was consistent with the instructor’s self-evaluation since she expected there would be a few logistical “bugs” in the first administration of this course, such as scheduling times for students to meet with their preceptors.

Interpretations for Items 13 and 14. In keeping with the theme of the class, pretest-posttest items 13 and 14 gathered information concerning the student-perceived best and worst portions of QA & EPP. The most frequently cited responses indicated that the goals of the class indeed had been met and that students appreciated the “real world” experiences provided by the team projects. The student-perceived “bugs” mentioned above were cited as some of the worst parts of QA & EPP. Several quality improvements have since been made to address these issues, such as allocating class time for site visits, inviting preceptors to be present on the first day of class, and providing additional guidance to students on their projects.

CONCLUSIONS

The instructional goals for QA & EPP were met. Improvement from preassessment to postassessment was seen on item-by-item analysis, person-by-person analysis, and analysis of the group as a whole. Students gained confidence in their ability to decrease medication errors. They discovered that small, realistic practice changes could have a dramatic effect on patient health and safety, and overall they were proud of their efforts and accomplishments in this area.

The QA & EPP was beneficial and well received. The benefits for students were numerous. They gained practical experience using their newly acquired quality assurance skills in a “real world” environment. This gave them confidence and a greater understanding of the impact they can have in error reduction. Students had the opportunity to actually impact patient care and to see the effects of their efforts.

Preceptors also benefited. In large part, the preceptors themselves received little if any formal training on error reduction; thus, they learned from helping the students implement their projects. In addition, preceptors had the opportunity to utilize student work hours to start or expand their medication error reduction plans.

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Appendix 1. Error Risk Worksheet

Calculating Your Risk

Will dispensing errors affect YOU? Find out by completing the calculations below.

Question: How many prescriptions does your practice site fill daily? ________ Rx/Day

Use this number to complete the following calculation:

<table>
<thead>
<tr>
<th>#Rx/Day</th>
<th>Days/Week</th>
<th>Weeks/Year</th>
<th>Years of Work</th>
<th>Error Rate</th>
<th>Dispensing errors during your career</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>5</td>
<td>x</td>
<td>x</td>
<td>x 1%</td>
<td>=</td>
</tr>
</tbody>
</table>

Now, assume that 1% of the errors are of a serious nature – will cause extreme harm or death. Write that number here ____________________.

Think about the numbers you calculated. How will dispensing errors affect you?

To date, how has medication error had an affect on you? (As a technician, patient or family member)

What did this experience teach you?