INSTRUCTIONAL DESIGN AND ASSESSMENT

Laboratory Session to Improve First-year Pharmacy Students' Knowledge and Confidence Concerning the Prevention of Medication Errors

Mary E. Kiersma, PharmD, Patricia L. Darbishire, PharmD, Kimberly S. Plake, PhD,
Christopher Oswald, PharmD candidate, and Brenda M. Walters, PharmD

Purdue University School of Pharmacy and Pharmaceutical Sciences

Submitted October 28, 2008; accepted January 26, 2009; published October 1, 2009.

Objectives. To implement a laboratory session into the first-year pharmacy curriculum that would provide active-learning experiences in the recognition, resolution, and prevention of medication errors.

Design. Students participated in medication error-prone prescription processing and counseling simulations, role-played communication strategies after a medication error occurred, and discussed an introductory pharmacy practice experience focused on prescription processing and prevention of medication errors.

Assessment. Students completed an assessment prior to and after completion of the laboratory on their knowledge of and confidence in identifying medication errors. Students' knowledge and awareness of medication errors improved as did confidence in their ability to (1) recognize and avoid errors, (2) utilize methods to prevent errors, (3) communicate about errors with involved parties, and (4) select and report medication errors on an appropriate form.

Conclusion. Students' awareness of the pharmacist's role in medication error reduction improved and confidence in their ability to recognize, prevent, and communicate medication errors increased.

Keywords: assessment, medication error, introductory pharmacy practice experience (IPPE), role play, active-learning

INTRODUCTION

The Institute of Medicine's (IOM) Committee on Quality of Health Care in America ranked medical errors as the eighth leading cause of death in the United States.¹ In addition, the IOM reported an increase in adverse drug events due to medication errors, suggesting the need for greater recognition and prevention of medication errors by future pharmacists.¹ The IOM acknowledged that medical errors are often due to problems embedded in inadequately designed healthcare systems rather than as a result of negligent healthcare practitioners, which indicates a need to implement systems to decrease medical errors.^{1,2}

Patient safety should be of prime concern in all areas of pharmacy practice.³⁻⁷ Pharmacists should be encouraged to develop and improve safe and effective medication use techniques.⁴⁻⁷ When providing pharmaceutical care, it is a pharmacist's responsibility to direct patients to valid sources of information and safe medication use,

since medication information commonly available to patients is often inaccurate, difficult to interpret, or inconsistent with principles of cultural sensitivity.⁵⁻¹¹ The American Association of Colleges of Pharmacy (AACP) has provided leadership on safe medication use, resulting in their support of innovations that establish and expand interprofessional models for educating students on patient safety.⁴ The AACP encouraged pharmacy faculty members to lead a national collaborative approach to medication safety research that extends beyond measuring accuracy and investigates the components of a broader definition of errors.¹¹

Pharmacy students should be educated to support safe medication practices in various settings and professionalized to consider patient medication safety as their personal responsibility. The Accreditation Council on Pharmacy Education (ACPE) requires that pharmacy schools ensure that their curricula contain aspects of patient safety.¹² ACPE encourages critical thinking and development of problem-solving skills through the use of laboratory experiences, guided group discussions, and simulated practice experiences. Active-learning strategies should be employed to promote the maturation of skills needed in future pharmacy practice. Instructors are encouraged to experiment with teaching methods based on sound

Corresponding Author: Mary E. Kiersma, Purdue University, Pharmacy Practice, 575 Stadium Mall Drive, R. Heine Pharmacy Bldg. Room 502D, West Lafayette, IN 47907. Tel: 219-508-2154.
E-mail: mkiersma@pharmacy.purdue.edu

educational principles and best evidence in educational practice and to assess the effectiveness of these methods.¹²

Efforts have been made nationally to incorporate medication error instruction into pharmacy curricula. Based on the results of a national survey of colleges and schools of pharmacy in 2002, the majority of responding institutions embed medication error instruction in pharmacy administration, therapeutics, or law courses. Six domains of medication error instruction (human error, medical errors, medication errors, quality or process improvement, root cause analysis, and failure mode and effects analysis) were identified.⁶ A number of schools indicated that instruction in these specific domains was lacking in their curriculum, including: human error (44%), medical errors (32%), root cause analysis (62%), and failure mode and effects analysis (79%). The majority of instruction was didactic with few institutions incorporating active learning within laboratories. Of those using laboratories, specific content was not described. The authors of the survey recommended standardizing medication error instruction.⁶

Medication error instruction is incorporated into each professional year of the curriculum at Purdue University School of Pharmacy and Pharmaceutical Sciences. In the first year, didactic instruction is coupled with an introductory pharmacy practice experience (IPPE) called Observations in a Community Pharmacy. The 2 activities culminate in a year-end debriefing laboratory, which provides the student with opportunities to demonstrate knowledge, practice skills, and reflect on optimal methods to prevent errors. In the second year, students complete a similar IPPE assignment, Observations in a Hospital Pharmacy. This assignment is an extension of concepts explored in the first year, which again culminates in a more in-depth debriefing laboratory. In the third year, therapeutics courses continually reinforce medication safety concepts.

Although fairly new in the pharmacy education literature, self-efficacy can assist faculty members in the evaluation of students' performance. Self-efficacy is a measure of an individual's confidence in his/her ability to perform a specific task or behavior to reach a successful outcome. Bandura found that there is a close relationship between perceived self-efficacy and authentic performance, regardless of which sources of information a person utilized.¹² He also found that knowledge and skills alone were insufficient to complete a desired outcome. Self-efficacy intervenes in the connection between knowledge and action.¹²

Self-efficacy measurements have been applied to assess ability in healthcare professions, such as nursing and occupational therapy.¹³ The findings indicate that stu-

dents' knowledge and confidence may not be correlated, suggesting that self-efficacy assessment evaluates a separate construct.¹³ Because these assessments can be used to determine whether students achieve learning objectives, self-efficacy measurements have the potential to provide an additional measure of performance.^{12,13,14}

The purpose of the laboratory was to integrate didactic coursework and observations seen in actual practice settings (from IPPE) into a skills-based laboratory focused on the prevention of medication errors. The primary goals were to provide active-learning opportunities to first-year students to: (1) emphasize the frequency of medication errors, (2) improve recognition and prevention of errors, (3) demonstrate where errors are likely to occur, (4) familiarize students with medication error documentation forms, and (5) practice communication skills when addressing medication errors with patients, caregivers, other healthcare providers, and pharmacy staff members.

The objective of the study was to evaluate the impact of a first-year skills-based laboratory on students' knowledge and confidence in detecting, preventing, resolving, and communicating medication errors. Our hypothesis was that active-learning exercises connected to didactic content on medication safety would result in improvement in students' knowledge and confidence (self-efficacy).

DESIGN

Activities

One hundred sixty students in the first year of pharmacy school received didactic instruction, completed an off-campus IPPE assignment, and participated in a skills-based laboratory, each focusing on the prevention of medication errors. The skills-based laboratory was divided into 5 sections with approximately 32 students in each section. The Investigational Review Board at Purdue University approved this project.

The laboratory session was designed to allow students to apply material from lectures and share experiences from personal observations in a pharmacy setting. In addition, students analyzed scenarios to determine which type of medication error documentation form was most appropriate to submit. Communication skills taught in the introductory practice course were reinforced and applied to a variety of medication error scenarios involving patients, caregivers, healthcare providers, and pharmacy staff members. The IPPE Community Pharmacy Observation assignment allowed students to compare, contrast, and evaluate ideal pharmacy processes learned in lecture with actual practices in pharmacy settings. The laboratory discussions allowed students to reflect on best

practices and begin to create their individual toolkit of skills for future practice.

Didactic Instruction

Students received instruction on strategies for medication error reduction in the Introduction to Pharmacy and Pharmaceutical Care course. The lectures included a review of terminology regarding adverse drug reactions, adverse drug events, and medication errors. Data on the frequency of medication errors were reviewed, as well as best practice strategies to minimize or prevent the occurrence of medication errors. In addition, medication reconciliation was introduced, including when the process should occur, the components of the process, and the importance of checking for drug interactions, contraindications, and allergies. A review of the Institute for Safe Medication Practices (ISMP) dangerous abbreviations was included.

IPPE Assignment

The community-based Pharmacy Observation Assignment was a required component of the first-year IPPE program. Students contacted a community pharmacy and asked permission to observe the practice site for a single visit, lasting approximately 2 to 4 hours. While at the site, students completed a worksheet detailing prescription volume and staffing, the filling and/or dispensing process, patient counseling, the effects of pharmacist interruptions, use of error-prone abbreviations, medication inventory procedures, error reporting forms, and consequences of errors committed in the workplace. The worksheet reflected com-

ponents of didactic content. Students shared their personal observations in a small group format facilitated by a laboratory instructor. Students were asked to compare and contrast best practice processes illustrated in the classroom to the challenges observed in actual practice settings.

Skills-Based Laboratory

The laboratory began with a review of terminology and national statistics to emphasize the importance of content and activities and their link to the didactic course. The first of the 3 laboratory activities involved 2 dispensing and counseling simulations. The goal of the simulations was to develop the students' ability to detect and resolve errors before they occurred. Students were shown a video portraying a scenario where they were asked to simulate a situation where the computer system was inoperable, forcing the student to use the knowledge learned in lecture to gather appropriate information from the patient or caregiver. The simulated prescriptions contained a variety of misinformation, making errors likely to occur during prescription intake, processing, dispensing, and patient counseling. Examples of embedded errors included incorrect or illegible patient name, unknown gender, missing or incorrect address, illegible or missing physician name or DEA number, incorrect medication strength or directions, and a less frequently prescribed indication.

Students were then divided into groups of 4. One facilitator per group acted as the patient/caregiver and the discussion leader following the simulation. A patient scenario sheet (Figure 1) was developed to assist the facilitator and maintain consistency among group role play.

Rx: Baker Pharmacy

Scenario: The prescription for Cameron Williams was called in from the physician's office and left on the pharmacy's voicemail. The patient is your brother and you are picking up the prescription for him. Do not tell the pharmacist that it is not for you, unless asked. Do not provide a clue to the patient's gender. You know the prescription is for back pain, but don't volunteer this information unless asked.

Original Prescription	Correct Information and Rationale
Name: Cameron Williams (gender unknown)	Cameron Williams (Male)
Address: 123 Willow Way	33 Park Place, Lafayette, IN 47905 (The patient moved.)
DOB: unknown	4/3/84
Drug: Vicodin 5/750	Vicodin 5/500 (5/750mg not available)
Indication: unknown	Back pain
SIG: 2 tablets by mouth every 2 hours if needed	Per Physician: 2 tablets by mouth every 6 hours as needed
Qty: unknown	12 tablets
Physician: unknown	Cathy Smith, MD (The pharmacist should call the phone number left on the voice mail and speak to Carl because you don't know who the physician is.)
DEA: Not provided	BS3274658 (Must have for controlled substances)
Insurance: unknown	Pays cash

Figure 1. Patient Scenario Sheet.

Prescriptions were changed daily to prevent students in 1 laboratory from relaying answers to the students in the laboratory held the following day. An instructor played the role of the physician who could be contacted to answer questions or clarify information pertaining to the prescription or the patient.

Each student within a small group was assigned 1 of 4 specific roles: prescription intake pharmacist, recorder, prescription processor, or patient counselor. The students in the group were allowed to combine their knowledge and skills, acting as a "single pharmacist" to complete the steps described below.

The prescription intake pharmacist welcomed the patient/caregiver to the pharmacy (simulation 1) or took the prescription message from the telephone voice mail system (simulation 2). They were responsible for requesting missing information and obtaining clarification from the patient/caregiver or physician and also documenting information on the prescription. In addition, the intake pharmacist was responsible for retrieving and documenting information on disease states, allergies, and medication history (prescription and over-the-counter).

The Recorder completed a prescription worksheet for each prescription. The prescription processor generated a prescription label, filled the prescription, and performed the final check for completeness and accuracy. The prescription processor placed his/her initials and date on the label and prescription to verify its accuracy. The patient counselor was responsible for counseling the patient using 3 prime questions and the "show and tell" method/approach. The patient counselor was required to respond appropriately and professionally to all issues and concerns raised by the patient/caregiver during the counseling session. After receiving the prescription, the student groups were given approximately 10 minutes to address issues and concerns, and complete the prescription and the worksheet before the patient/caregiver returned to pick up the prescription. If the prescription was not ready when the patient/caregiver returned, the patient/caregiver was instructed to "become impatient" and remain at the pharmacy counter until the prescription was ready to be dispensed.

Following each simulation, student groups were required to select and complete an appropriate medication error form, such as MedWatch, the USP Medication Error documentation form, or a pharmacy-specific internal error form for 1 of the prescription errors encountered. Following each simulation, the small group facilitator reviewed the group's performance based on information in the patient scenario sheet and their observations. After the small group debriefing, all students returned to the main laboratory to review general performance, as well

as to review the observations of the faculty member portraying the physician.

Medication Error Scenario

The second laboratory activity was a role play scenario on how to manage and communicate errors once they occurred. The goal of this activity was to prepare and equip students with communication skills needed to address medication misadventures with patients and caregivers, other healthcare providers, and pharmacy staff members. A scenario involving a medication error in a community pharmacy was described to students. The patient in the scenario received a medication of an incorrect strength. Prior to role play, students were asked to identify all problems with the process leading or contributing to the error, who should be notified, and what type of error form should be completed. Following this discussion, students were provided with basic communication strategies to utilize during the role play. Taking turns, each student assumed the role of the pharmacist and initiated a conversation with 1 of the following: the patient, patient's spouse, physician, nurse, pharmacy technician contributing to the error, pharmacy staff member, or store manager. The facilitator and other students (observers) provided immediate feedback to the "pharmacist." Pharmacists were asked to repeat role plays until a general consensus of observers felt the conversation was effective and professional and that the student had appropriately resolved the issues.

IPPE Pharmacy Observation Assignment

Prior to the laboratory sessions, students submitted an IPPE community pharmacy observation assignment to the IPPE director. Assignments were returned to students with written feedback in the laboratory and reviewed in facilitated small groups as the final activity of the laboratory. The purpose was to allow students to reflect on personal observations seen during prescription processing and compare best practice processes as described in didactic lectures to the challenges observed in actual practice settings. Assignment areas for discussion included prescription volume, staffing concerns, the prescription filling and dispensing process, number of interruptions that pharmacists encounter, varying methods used to stock medications (eg by brand or generic names, grouped by use, fast mover shelves), and ISMP error-prone abbreviations commonly seen in practice.

EVALUATION AND ASSESSMENT

Students completed 3 survey instruments pertaining to the laboratory activities: (1) knowledge regarding medication error prevention, (2) confidence in preventing and resolving errors, and (3) a laboratory evaluation. The

knowledge and confidence instruments were administered prior to the start of and at the conclusion of the laboratory activities. The laboratory evaluation was administered at the conclusion of the laboratory.

SPSS statistical analysis system version 15.0 for Windows (SPSS Inc, Chicago, Ill) was used for data analysis. Descriptive statistics were calculated for all instruments. An *a priori* level of significance was established at $\alpha = 0.05$. A paired *t* test was performed to compare overall preassessment and postassessment scores on the knowledge instrument. The Wilcoxon sign-ranked test was utilized to determine significance between pretest and posttest answers for individual questions on the knowledge instrument. Repeated measures analysis of variance (ANOVA) was performed to compare the preassessment, retrospective preassessment, and postassessment responses

on the confidence questionnaire. The Greenhouse Geisser correction was utilized when the assumption of sphericity was violated for repeated measures ANOVA. Bonferroni post hoc comparisons were conducted when significance was detected in the repeated measures ANOVA. Pearson correlation was conducted to determine whether the knowledge and confidence postassessment scores were correlated.

Students' Knowledge of Medication Safety

The knowledge instrument contained 16 open-ended items and true/false questions pertaining to the students' knowledge of medication errors. Students' overall pretest and posttest scores were compared based on the number of knowledge questions answered correctly. The preassessments and postassessments were completed by all 160

Table 1. Assessment of Students' Knowledge in Medication Safety (N=160)

	Pretest, % Correct	Posttest, % Correct
Nonpreventable drug reactions are medication errors. ^a	91.3	99.4
Nonpreventable injury is a medication error. ^a	91.3	98.1
A preventable medication event is a medication error.	97.7	98.8
In the hospital setting, approximately what percentage of doses given is incorrect? ^a	25.0	95.6
In the community setting, risk management experts believe that errors occur in most pharmacies how often? ^a	78.8	91.3
During which part of the processing or counseling do you see the most potential for error?	56.9	49.4
A MedWatch Error Form should to be completed when a patient is hospitalized.	53.8	57.5
A MedWatch Error Form should be completed in a case of suspected product contamination. ^a	86.3	93.8
A pharmacist should complete an Internal Error Form for a counseling error.	78.1	88.1
A pharmacist should complete an Internal Error Form when the wrong dose is given to a patient.	98.1	99.4
All of the following responses would be appropriate when discussing a medication error with a patient EXCEPT:	92.5	95.6
What does the second segment of the NDC number identify?	71.9	68.1
All of the following abbreviations are on the ISMP error prone abbreviation list, EXCEPT:	60.6	71.8
What are the five MOST important things you should check on a prescription?	51.3	47.5
All of the following are strategies implemented to decrease medication errors EXCEPT:	77.5	73.1
The following information should ALWAYS be communicated to the patient or caregiver:	95.0	97.5

^a Pretest vs. posttest scores, $p < 0.01$

students. The mean score for the pretest was 12.1 ± 3.2 out of 16 possible points, and for the posttest, 13.3 ± 2.4 , with an average score improvement of 1.2 points ($t = 1.974$; $p < 0.0001$). On the posttest knowledge questions, 66.9% of students demonstrated improvement.

The results for the individual items in the knowledge assessment are reported in Table 1. The percentage of students answering correctly increased on 12 of the 16 items. Of these 12 items, the pre- and posttest scores for 4 items were significantly different: (1) Nonpreventable drug reactions are medication errors. (91.3% vs. 99.4%; $p < 0.01$) (2) Nonpreventable injury is a medication error. (91.3% vs. 98.1%; $p < 0.01$) (3) In the hospital setting, approximately what percentage of doses given is incorrect? (25.0% vs. 95.6%; $p < 0.001$); and (4) In the community setting, risk management experts believe that errors occur in most pharmacies how often? (78.1% vs. 91.3%; $p < 0.001$).

Students' Confidence in Medication Safety

The confidence instrument included 10 questions based on laboratory objectives. The students were asked to rate their confidence using a Likert scale of 1 = not at all confident, 2 = not very confident, 3 = moderately confident, 4 = very confident, and 5 = extremely confident. A retrospective pretest was administered at the same time as the confidence instrument posttest, allowing students to reassess their prelaboratory confidence. A retrospective pretest is a valid method to utilize when mea-

suring subjects' recall of how they functioned prior to the program's outset.^{12,15} A retrospective pretest allows students to reflect on what they did not know prior to a laboratory session. When utilizing only a pretest, it can bias results because students cannot accurately assess what they do not know. This design was used to limit bias of responses which can occur when the construct being measured is modified as a result of an experience, such as what occurs in a laboratory.^{11,12,15}

The preassessments, retrospective preassessments, and postassessments were completed by all 160 students. Significant differences were demonstrated/seen between preassessment to postassessment confidence scores ($p < 0.0001$). The planned contrasts between pretest and post-assessment scores, as well as retrospective pretest and postassessment scores, revealed significant differences, with improvement in confidence on all items ($p < 0.01$). When comparing students' confidence levels between the pretest and retrospective pretest, however, confidence scores decreased for all items ($p < 0.01$). A summary of results can be found in Table 2.

Correlation Between Knowledge and Confidence Scores

The average knowledge score and individual confidence items were compared to determine whether students' level of confidence was correlated with knowledge. One confidence item, discussing the frequency of medication

Table 2. Students' Confidence in Their Abilities in Medication Safety (N = 160)^a

	Pretest, Mean (SD)	Retrospective Pretest, Mean (SD)	Posttest, Mean (SD)
I can discuss the frequency with which medication errors occur in the workplace. ^{b,c,d}	2.4 (0.7)	2.4 (0.9)	3.6 (0.8)
I can discuss procedures to protect patients from medication errors during prescription processing. ^{b,c,d}	2.7 (0.7)	2.3 (0.9)	3.5 (0.8)
I can implement procedures to protect patients from medication errors during prescription processing. ^{b,c,d}	2.7 (0.7)	2.4 (0.9)	3.5 (0.9)
I can identify potential medication errors. ^{b,c,d}	2.8 (0.6)	2.4 (0.9)	3.6 (0.9)
I can prevent potential medication errors. ^{b,c,d}	2.7 (0.7)	2.3 (0.9)	3.5 (0.9)
I can appropriately communicate to patients about a medication error. ^{b,c,d}	2.5 (0.7)	2.2 (0.8)	3.5 (0.9)
I can appropriately communicate to caregivers about a medication error. ^{b,c,d}	2.4 (0.7)	2.1 (0.8)	3.4 (0.9)
I can appropriately communicate to healthcare professionals about a medication error. ^{b,c,d}	2.3 (0.7)	2.2 (0.9)	3.4 (0.9)
I can appropriately communicate to the pharmacy staff about a medication error. ^{b,c,d}	2.7 (0.8)	2.3 (0.9)	3.7 (0.9)
I can document medication errors and action taken. ^{b,c,d}	2.5 (0.8)	2.2 (0.9)	3.5 (1.0)

^aScale: 1 = not at all confident, 2 = not very confident, 3 = moderately confident, 4 = very confident, and 5 = extremely confident

^bPretest vs. retrospective pretest, $p < 0.01$

^cPretest vs. posttest, $p < 0.01$

^dRetrospective pretest vs. posttest, $p < 0.01$

Table 3. Students' Evaluation of the Laboratory (N = 156)^a

Statement	Mean (SD)
The verbal introduction to the laboratory was clear.	4.7 (0.5)
Written laboratory material was organized and complete.	4.7 (0.6)
Overall the laboratory was valuable.	4.8 (0.4)
I can apply information and skills learned in the laboratory to the real world.	4.8 (0.4)
The relationship between the laboratory content and my overall education is apparent.	4.8 (0.4)
The laboratory review of the Pharmacy Observation assignment helped me understand the concepts.	4.4 (0.4)
I would recommend this laboratory be retained in the curriculum.	4.9 (0.4)

^aScale: 1 = strongly disagree, 2 = disagree, 3 = undecided, 4 = agree, and 5 = strongly agree

errors, was correlated with overall knowledge ($p < 0.05$). However, the remaining confidence items were not correlated with the overall knowledge scores.

Laboratory Evaluation

The laboratory evaluation was completed by 156 students (Table 3). The students indicated the information and skills learned in the laboratory can be applied to real world situations (4.8 ± 0.4) and were relevant to their education (4.8 ± 0.4). In addition, the students rated the overall laboratory positively with a mean response of 4.8 ± 0.4 . In addition, students indicated that the integration of the IPPE assignment helped them understand concepts (4.4 ± 0.4).

DISCUSSION

Many colleges and schools of pharmacy have incorporated medication safety into their didactic curriculum.⁷ However, there exists a lack of skill-based training and/or opportunities for practice within most curriculums. Additionally, there is a need for a standardized approach. This laboratory was developed with the intent to integrate didactic coursework and an actual practice experience (IPPE) with the opportunity for students to practice skills learned in a "low-stakes" environment, along with the provision of feedback on performance from both faculty members and peers. Students shared personal observations from their actual practice experience in a small group format with peers and facilitators, providing opportunities to discuss barriers and solutions to the provision of optimal patient care. The discussions included a variety of aspects, such as pharmacist interruptions, error-prone abbrevia-

tions, and methods for documenting errors. The laboratory was implemented in the first-year curriculum as a basis for more in-depth instruction in subsequent years.

Prior to the start of the laboratory, we expected an improvement in students' knowledge and confidence in detecting, preventing, resolving, and communicating medication errors, and this is supported by the results of the analysis. The group means for student knowledge and confidence measures showed a significant increase from preassessment to postassessment ($p \leq 0.0001$). A higher percentage of students answered correctly on 12 of the 16 knowledge items. Three of the four posttest knowledge items exhibiting decreases that were not significant each included an element of requesting students to select the "best" response. This material may not have been sufficiently or equally emphasized during each of the 5 laboratory sections. Since the laboratory focused on the awareness of multidimensional medication error prevention, students may have realized post laboratory that there were additional aspects to consider, leading to a change in the way these specific questions were answered on the posttest.

As knowledge increases, the expectation might be that students' confidence will increase as well. The data from this assessment suggests otherwise. Evidence from previous assessment studies also demonstrates that knowledge and confidence are not necessarily correlated and suggests that confidence, or self-efficacy, and knowledge are 2 different components of student learning.^{13,20,21} Knowledge and skills are needed to perform a particular action; however, confidence intersects both knowledge and action. By measuring all constructs, educators can gauge whether instruction not only instills the necessary knowledge and skills, but also the confidence to perform the action.

Although the students' confidence improved in respect to medication error prevention, as defined by the laboratory objectives, the confidence scores could be considered conservative since the item postassessment means were in the moderately confident range. The data suggest an awareness among students that more education and practice is necessary before confidence is optimal. The decrease in scores between the preassessment and retrospective preassessment indicates the students reassessed their initial abilities in respect to the medication error training after the laboratory concluded. To successfully take responsibility for education and skill development, students must develop an ability to accurately self-assess performance to make improvements in areas of need. Reflective self-assessment allows students to consider their strengths and weaknesses within specific skill areas. As healthcare practitioners, the ability to accurately self-assess performance is essential to provide optimal patient care.

Using a comparative preassessment and retrospective preassessment methodology for self-assessment creates awareness of the need to reflect upon skills. Students overestimated confidence in their abilities on the initial preassessment. Upon completion of the retrospective preassessment, the students then acknowledged lack of confidence with respect to medication error laboratory content. Without utilizing this methodology, an accurate reflection of abilities would not have occurred.

Study limitations included: (1) potential for misinterpretation of assessment questions (eg negative questions), (2) potential alteration of postassessment performance following a preassessment,¹³ (3) lack of a control group or randomization, making it unclear if the outcome was attributable to the intervention (4) questionable knowledge transfer (ie assessment conducted at a later date could better demonstrate retention of knowledge and skills), and (5) potential inconsistent instruction due to use of different facilitators within small groups and laboratory sections. The investigators attempted to control for the variety of instructors through the use of facilitator and patient scenario sheets and prelaboratory facilitator instruction.

SUMMARY

Improvement from preassessment to postassessment was seen on the item-by-item analysis and analysis of the planned contrasts and paired *t* tests as a whole. The students discovered and communicated an understanding of the prevalence of medication errors and the importance of recognizing and preventing errors. Students gained confidence in their ability to recognize and prevent medication errors and communicate errors to involved parties. By incorporating active-learning techniques, the students appeared to be more prepared in to recognize and prevent medication errors.

REFERENCES

1. Aspden P, Wolcott JA, Bootman JL, Cronenwett LR, eds. Institute of Medicine. *Preventing Medication Errors: Quality Chasm Series*. Washington, DC: National Academy Press; 2007.
2. Greiner AC, Knebel E, eds. Institute of Medicine. *Health Professions Education: A Bridge to Quality*. Washington, DC: National Academy Press; 2003.
3. ASHP Website: News Article. Pharmacist Travels Medication Safety Path. May 1, 2007, AJHP News. Available at: <http://www.ashp.org/import/news/HealthSystemPharmacyNews/newsarticle.aspx?id=2538>. Accessed September 2, 2009.
4. AACP Innovations in Teaching Competition. Available at: <http://www.aacp.org/career/awards/Pages/InnovationsinTeachingCompetition.aspx>. Accessed September 2, 2009.
5. Baciú A, Stratton K, Burke SP, eds. Institute of Medicine. *The Future of Drug Safety: Promoting and Protecting the Health of the Public*. Washington, DC: National Academy Press; 2007:4.
6. Johnson MS, Latif DA, Gordon B. Medication error instruction in schools of pharmacy curricula: a descriptive study. *Am J Pharm Educ*. 2002;66(4):364-71.
7. Alldredge BK, Koda-Kimble MA. Count and be counted: preparing future pharmacists to promote a culture of safety. *Am J Pharm Educ*. 2006;70(4):Article 92.
8. Nahata MC, Beck DE, Draugalis JR, Flynn AA, Kerr RA, Wells BG. The Academy's agenda for improving the safety of medication use: report of the 2006-2007 Argus Commission. *Am J Pharm Educ*. 2007;71(6):Article S18.
9. Davis NM. A medication error prevention educational retreat. *Hosp Pharm*. 2000;35(5):466-7.
10. Jackson TL. Application of quality assurance principles: teaching medication error reduction skills in a "real world" environment. *Am J Pharm Educ*. 2004;68(1):Article 17.
11. Accreditation Standards and Guidelines for the Professional Program in Pharmacy Leading to the Doctor of Pharmacy Degree. Adopted January 15, 2006. Accreditation Council for Pharmaceutical Education (ACPE), Chicago, IL; 2006. Available at: www.acpe-accredit.org/. Accessed September 2, 2009.
12. Bandura A. Self-efficacy mechanism in human agency. *Am Psychol*. 1982;37(2):122-47.
13. Plaza CM, Draugalis JR, Retterer J, Herrier RN. Curricular evaluation using self-efficacy measurements. *Am J Pharm Educ*. 2002;66(1):51-4.
14. Chalmers RK, Grotzinger JJ, Hollenbeck RG, et al. Changing to an outcome-based, assessment-guided curriculum: a report of the focus group on liberalization of the professional curriculum. *Am J Pharm Educ*. 1994;58(1):108-15.
15. Nicholson T, Belcastro PA, Gold RS. Retrospective pretest-posttest analysis versus traditional pretest-posttest analysis. *Psychol Rep*. 1985;57(2):525-6.
16. Slack MK, Coyle RA, Draugalis JR. An evaluation of instruments used to assess the impact of interdisciplinary training on health professional students. *Natl Acad Pract Forum*. 2001;3(1):59-67.
17. Aiken LS, West SG. Invalidity of true experiments: self-report pretest biases. *Eval Rev*. 1991;14:374-90.
18. Skeff KM, Stratos GA, Bergen MR. Evaluation of a medical faculty development program: A comparison of traditional pre/post and retrospective pre/post self-assessment ratings. *Eval Health Professions*. 1992;15(3):350-66.
19. Jackson TR, Popovich NG. The development, implementation, and evaluation of a self-assessment instrument for use in a pharmacy student competition. *Am J Pharm Educ*. 2003;67(2):Article 59.
20. Neafsey PJ. Computer-assisted instruction for home study: A new venture for continuing education programs in nursing. *J Cont Educ Nurs*. 1997;28(4):164-72.
21. Murdock JE, Neafsey PJ. Self-efficacy measurements: an approach for predicting practice outcomes in continuing education? *J Cont Educ Nurs*. 1995;26(4):158-65.