INSTRUCTIONAL DESIGN AND ASSESSMENT

Patient Simulation to Demonstrate Students' Competency in Core Domain Abilities Prior to Beginning Advanced Pharmacy Practice Experiences

Deepti Vyas, PharmD,^{a*} Nilesh S. Bhutada, PhD,^a Xiaodong Feng, PhD, PharmD^a

^aCalifornia Northstate University, College of Pharmacy, Rancho Cordova, CA

Submitted May 2, 2012; accepted July 5, 2012; published November 12, 2012.

Objective. To implement a simulation-based introductory pharmacy practice experience (IPPE) and determine its effectiveness in assessing pharmacy students' core domain abilities prior to beginning advanced pharmacy practice experience (APPE).

Design. A 60-hour IPPE that used simulation-based techniques to provide clinical experiences was implemented. Twenty-eight students were enrolled in this simulation IPPE, while 60 were enrolled in hospital and specialty IPPEs within the region.

Assessment. The IPPE assessed 10 out of 11 of the pre-APPE core domain abilities, and on the practical examination, 67% of students passed compared to 52% of students in the control group. Students performed better on all 6 knowledge quizzes after completing the simulation IPPE. Based on scores on the Perception of Preparedness to Perform (PREP) survey, students felt more prepared regarding "technical" aspects after completing the simulation experience ($p < 0.001$). Ninety-six percent of the respondents agreed with the statement "I am more aware of medication errors after this IPPE."

Conclusion. Simulation is an effective method for assessing the pre-APPE abilities of pharmacy students, preparing them for real clinical encounters, and for making them more aware of medication errors and other patient safety issues.

Keywords: standardized patients, introductory pharmacy practice experience, simulation, ability, advanced pharmacy practice experience

INTRODUCTION

The Accreditation Council for Pharmacy Education (ACPE) has identified 11 core domain competencies and abilities that pharmacy students should demonstrate prior to starting their APPEs.¹ ACPE has indicated that a majority of these competencies can be demonstrated within the IPPE, but colleges and schools may use other modalities instead of or in addition to IPPEs, such as simulations, practice laboratories, and objective structured clinical examinations (OSCEs). While IPPEs represent an ideal platform to demonstrate these competencies, it is difficult for colleges and schools of pharmacy to ensure that the IPPEs provide the experiences necessary to truly determine that the student has achieved minimal competencies in these core domains and abilities. In

addition, there is little opportunity for remediation should the student fail to demonstrate minimal competencies. To elicit these competencies, students must be immersed in clinical situations that allow the educator to assess students' abilities in a consistent and controlled environment. Patient simulation is a tool that can be used to create a consistent environment using predetermined case scenarios that accurately measure a student's competency in various arenas. In the past 2 decades, simulation has been adopted in a wide spectrum of healthcare education and training programs to improve the quality of patient care and enhance patient safety. Worldwide, universities have been using state-of-the-art healthcare simulation techniques to train healthcare professionals in a range of areas including anesthesia, emergency medicine, intensive care, pain service, radiology, and surgery. Simulation training provides an intensive and interactive learning environment for interdisciplinary communication, collaboration, and crisis management among healthcare team players, such as physicians, pharmacists, and nurses.²⁻²⁰ The impact of simulation on pharmacy students has been demonstrated in pharmacy education, including in various clinical arenas.⁹⁻²⁰ For example Seybert and colleagues

Corresponding Author: Deepti Vyas PharmD, Thomas J. Long School of Pharmacy and Health Sciences, University of the Pacific, 751 Brookside Road, Stockton, CA 95207. Tel: 765-490-7698. Fax: 209-946-2402. E-mail: vyas80@gmail.com

*Affiliation at time of writing. Dr. Vyas' current affiliation is with the Thomas J. Long School of Pharmacy and Health Sciences, University of the Pacific, Stockton, CA.

successfully used simulation to teach blood pressure technique and to reinforce concepts in a pharmacotherapy course, while Mieux used simulation to teach advanced cardiac life support (ACLS) basics.^{18,19} Seybert and colleagues also described a hybrid acute-care elective course that used online learning modules and 3 simulation exercises per week, and resulted in significant increases in knowledge, pre- and post-simulation, on 9 out of 10 tests ($p \leq 0.05$).²⁰ Although simulation has been used in a variety of training settings for pharmacy students, its role in assessing and remediating ACPE, pre-APPE core domain competencies has not been defined.

In this paper, we describe a 3-week, 60-hour simulation-based IPPE that incorporated scenarios and experiences in multiple arenas, such as the emergency department, community pharmacy, acute care setting, immunization clinic, medication therapy management (MTM) setting, and intravenous (IV) medication compounding laboratory, to teach and assess 10 out of the 11 pre-APPE core competencies. The primary emphasis of this IPPE was to teach patient safety concepts and reinforce human fallibility.

DESIGN

California Northstate University College of Pharmacy enrolls 90 to 100 doctor of pharmacy (PharmD) students per academic year. Students are required to complete 300 hours of IPPE within the immediate Sacramento region. Twenty-eight students in their third year of the program were randomly assigned to the simulation IPPE, while the other 60 were assigned to various traditional IPPE practice sites in the community. Five clinical faculty members were involved in the simulation IPPE and served as content experts and observers during each simulation session.

Pedagogy

The course solely used a mock pharmacy, standardized patient and family members, and high fidelity simulation. The mock community pharmacy incorporated pharmacy technology, such as an informatics database, simulated medications, and online medication resources. The mock hospital pharmacy incorporated 4 intravenous (IV) preparation hoods, prescription medications, IV medications, aseptic technique attire, IV syringes, and chemotherapy drugs.

Prior to each simulation day, actors who served as either a patient or a family member were trained for 30 minutes to 1 hour (depending on the scenario) by the primary investigator and provided with specific scripts to follow during the simulation. Standardized patients were provided algorithms to guide their reactions to students'

responses to each situation during the simulation. Additionally, standardized patients were trained to use a checklist to provide feedback to students regarding their performance.

To reduce the high overhead cost of purchasing high-fidelity equipment, adult and infant simulators were rented from the University of California Davis Medical Center simulation center and programmed to simulate various clinical scenarios. The high-fidelity simulators were used to simulate physical anomalies, changes in vital signs, and physiologic changes after medication administration including therapeutic, toxic, and anaphylactic reactions.

Content

The panel of 5 clinical faculty members developed specific scenarios based on the general pre-APPE minimal core domain abilities, which are: (1) patient safety; (2) basic patient assessment; (3) medication information; (4) identification and assessment of drug related problems; (5) pharmacy calculations; (6) ethical/professional, and legal behavior; (7) general communication abilities; (8) counseling patients; (9) drug information analysis and literature research; (10) health and wellness; and (11) insurance and prescription drug coverage. The pre-APPE competencies and abilities and the curricular content and specific strategies to develop and assess these competencies are described in detail in Appendix 1.

The 3 main objectives for the IPPE were that students: (1) demonstrate an understanding of human fallibility and medical errors; (2) demonstrate the ability to communicate effectively with healthcare providers and patients; and (3) develop and refine technical skills such as patient profile review, aseptic technique, laboratory data interpretation, order/prescription writing, vaccine administration, management of emergencies, advanced cardiac life support compressions, blood pressure measurement, blood sugar measurement, and SOAP (subjective, objective, assessment, plan) note writing.

All of these opportunities were provided in dynamic, high-stress environments to give students an understanding of the pressures of taking care of patients in real practice settings. Students were divided into 10 teams of 2 to 4 students (on days 2 through 6 and day 12 students completed the scenarios individually rather than in teams).

Specific knowledge, skills, and attitudes were identified based on the 10 pre-APPE competencies (Table 1). Instruction and training in these areas of knowledge, skills, and attitudes were incorporated into the simulation scenarios to ensure that the learning objectives were achieved. Grading rubrics and checklists were developed for observers to provide meaningful formative feedback

after each session. For each scenario, actor/simulator scripts were developed. Vague and specific cues were incorporated into each script to prompt interventions by the student. The approach followed Benner's Theory of teaching novice learners.²¹ The vague cue provided subtle guidance to students regarding the care of the patient, and if not detected, was followed by a specific cue to provide further direction.

Session Design

This study was approved by the Independent Institutional Review Board, Inc. Students completed most scenarios individually. However, for some sessions, students were divided into 10 teams of 2 to 4 students each. Arrival times were staggered so that at any given time, there were only 1 or 2 teams in the simulation laboratory. Prior to each simulation day, students were given treatment guidelines or a handout of readings to help them prepare for the scenario. The simulation experience was divided into 3 sections (case preparation, patient encounter, and debrief session), each 30 minutes long. During the case preparation period, students were given the patient's history and physical findings and were expected to develop an assessment and plan.

During the patient encounter, students were oriented to the equipment and people in the room and instructed to recommend therapy based on the patient's presentation.

The scenarios were dynamic in that the patient's status changed during the encounter based on the student's therapy recommendations and disease progression.

The last step of the simulation session was the debriefing period, which was led by the faculty observer. The debrief period was used to provide formative feedback and allowed students to reflect on their performance during the patient encounter.

After each debrief period, students were asked to complete documentation on that day's simulation. Documentation could include a SOAP note, history and physical examination note in the patient's chart, a Food and Drug Administration MedWatch form for a drug adverse event, or submission of a report in the Vaccine Adverse Event Reporting System. This provided at least 4 to 5 IPPE hours each day.

EVALUATION AND ASSESSMENT

To aid in observation, volunteer faculty members were recruited to monitor each student team to document their care delivery. One faculty member was assigned to each student/team. Observers completed a detailed checklist which highlighted student responses to various teamwork, communication, and safety concerns. Additionally, the standardized patients completed their own observation forms. Video recordings were taken from multiple angles throughout the simulation rooms. The video recordings were used to identify gaps in the student's understanding and practice skills in order to provide immediate formative feedback and remediation. The video recordings were also used to determine how many errors each student/team made during the simulation. Pre- and post-simulation knowledge quizzes specific to each simulation scenario consisting of 5 to 15 questions were administered. The quizzes were used to gauge whether the student's knowledge was enhanced through participation in the simulation IPPE and to increase student accountability for completing the assigned readings prior to the simulation.

Students enrolled in the simulation IPPE completed the Perception of Preparedness to Perform (PREP) survey, a measure of their readiness to perform during APPEs. The PREP survey was developed by Ried and colleagues with the objective of measuring student readiness on 41 different survey items which load onto 5 different factors (technical, psychosocial, communication, management aspects, and research).²³ Students also completed a human fallibility survey and a self-perceived confidence survey on the first day to provide some understanding of their baseline level of preparedness. After the 60-hour IPPE, the students completed the surveys again to determine if they felt better prepared after the intensive simulation IPPE. Satisfaction

Table 1. Knowledge, Skills, and Attitudes Incorporated into Each Simulation Session and the Pre-APPE Core Domain Competency That the Curricular Content Addresses

Knowledge/Skill/Attitude	ACPE Pre-APPE Competency
Health assessment skills	2
Blood sugar/cholesterol testing	2, 10
Care plan development	2
Communication with other healthcare providers	7
Patient education	7, 8
Acute management	1, 2, 3, 4, 5, 9, 10
Aseptic technique	1, 5
Medication administration	1, 2, 4, 6, 7, 8, 9
Embedded patient safety issues	1
Physiologic effects of medication	3
Drug-drug interactions	1, 3
Drug dosing	3, 5
Practical calculations	1, 3, 5
Using drug resources	9
Interpreting laboratory data and vital signs	2
Emergency management	1, 2, 7
Ethics/cultural competency	6

Table 2. Patient Safety Issues Embedded Into Each Day of an Introductory Pharmacy Practice Experience

Day ^a	Topic Emphasized	Patient Safety Issue
1	Aseptic Technique	NA-Teaching Session
2	Basics of aseptic technique and skills lab	Heparin order- wrong concentration on the shelf Insulin- other types of insulin on the shelf in place of regular insulin Must use a fluid for potassium order and choose an appropriate rate Students should use a filter needle for the Astramorph ampule
3	Vaccine scenarios with subsequent emergencies	Live vaccines ordered in a patient who has AIDs Choosing the appropriate vaccines in a splenectomy Patient has a bout of shingles and asks about getting the Zostavax
4	Health assessment skills	NA-Teaching session
5	Medication therapy management	Patient presents with signs of extrapyramidal symptoms from haloperidol
6	Chemotherapy scenarios/Aseptic technique	Student receives physician orders vincristine in the subarachnoid space Student should use of in-line filter for paclitaxel Physician orders the wrong pre-medications Pre-medications ordered in the wrong fluid. Interaction with oxaliplatin Dose adjustment of carboplatin in reduced kidney function
7	Asthma exacerbation	Physician orders theophylline which is not evidence based Tachycardia due to albuterol use Home medications inappropriately reconciled by RN. New labs show white blood cells and blood glucose elevated due to prednisone MD orders a Combivent prescription in a patient with a peanut allergy Home Advair ordered as needed instead of twice daily
8	Acute overdose and toxicity	Paramedic indicates patient took acetaminophen and diphenhydramine but patient also took bupropion (home med) Patient shows signs of a bezoar N-acetyl Cysteine ordered 'per mouth' for a patient who is vomiting Patient has an acute seizure in the emergency room
9	Diabetic ketoacidosis with a pulmonary embolism	Physician orders kayexalate for hyperkalemia Physician fails to order DVT prophylaxis
10	Emergency contraception and ethics scenarios	Patient brings a prescription for Ortho Tri-cyclen but the patient is a smoker. Drug-cigarette contraindication. Patient with history of epilepsy. Recommend smoking cessation product. Home medications are simvastatin and lisinopril in a pregnant patient.
11	Myocardial infarction in a community pharmacy	Patient has an acute asthma exacerbation Patient has an acute MI while in the pharmacy
12	Congestive heart failure	Nitroglycerin tablets in a transparent bag instead of original package Patient on metformin as a home medication Missing evidence based therapy-aspirin and statin Patient's favorite soup has a high sodium content
13	Advanced cardiac life support (ACLS)	Recognize hyperkalemia is causing arrhythmia
14	Wrap –up and reflection	NA

^a Each day was 4 to 6 hours resulting in a total of 60 hours of contact time.

survey and course evaluations were administered to ensure course/instructor effectiveness.

To provide a comparison between simulation students and the control arm, all students in the class year completed a practical examination at the end of the summer semester. The practical examination required students to interview a standardized patient, order pertinent laboratory work, conduct a physical examination,

and finally develop a care plan based on the results of the interview. The patient had a history of hypertension, type 2 diabetes (with new peripheral neuropathy on examination), and hyperlipidemia. A second component of the practical examination was to measure the students' ability to complete a series of practical calculation problems. Embedded within the examination were patient safety issues including the risk of a fatal

Table 3. Practical Examination Mapped to Accreditation Council for Pharmacy Education's Core Domain Abilities Students Should Have Before Beginning Advanced Pharmacy Practice Experiences

Skill Tested	C1 ^a	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
Obtain History and physical	X	X				X	X		NA ^b		
Conduct a limited physical exam and identify abnormalities		X							NA		
Assess any drug-related problem		X	X	X					NA		
Measure blood pressure and heart rate		X							NA		
Measure blood glucose		X							NA		
Order a fasting lipid panel		X							NA		
Order liver function tests		X							NA		
Review laboratory data for abnormalities		X							NA		
Order new medications based on new data	X		X						NA		
Develop a treatment plan and document the plan by writing up a SOAP note		X					X		NA		X
Recommend appropriate preventative strategies such as statin therapy, weight loss etc									NA	X	
Counsel a patient on new and existing medications								X	NA		
Calculation Problems					X				NA		

^aACPE Pre-APPE Competency

^bNA = Not assessed during the examination.

mistake, which students had to address in their SOAP note.

The sequence for the Milestone practical examination was:

Case preparation (15 minutes) → standardized patient interview (30 minutes) → care plan development and SOAP note write-up (45 minutes) → clinical calculation scenarios (15 minutes).

The examination assessed student performance on 10 of the 11 pre-APPE core domains (Table 3) and consisted of a checklist completed by a faculty observer who was required to check "pass or fail" upon student completion of the assessment. Observers could give the student a bonus point for excellent performance. Observers were blinded as to which students were enrolled in the simulation versus direct patient care IPPEs.

Statistical Analysis

Data from the PREP survey, the human fallibility survey, and the self-perceived confidence survey were analyzed using the paired student *t* test. Results from the Milestone examination were analyzed using the independent samples *t* test. A *p* value of < 0.05 was considered significant.

On average, students made 3 fatal errors and student teams made 2.5 fatal errors and 3.8 non-fatal errors throughout the 3-week IPPE. Students performed significantly better on the knowledge-based quizzes, post-simulation

(Figure 1). On the PREP survey, students felt more prepared on the technical aspect after completing the simulation IPPE (*p* < 0.001), but not on the other aspects as outlined by Ried. On the human fallibility survey, 96% of the respondents agreed with the statement "I am more aware of medication errors after this IPPE" and "This IPPE helped me realize the importance of patient-centered care." One hundred percent of respondents agreed with the statements "It is easy to make medication errors in pharmacy" and "This IPPE helped me realize the importance of patient safety training."

On the self-perceived confidence survey, students felt more confident on 9 of 15 items after completing the IPPE. The 15 items were divided into 3 major units: technical, communication, and management of an acute emergency. The results of the self-perceived confidence survey are summarized in Table 4. Students felt more confident preparing for clinical cases, writing drug orders in a patient's chart, calculating drip rates for intravenous medications, and managing an acute emergency.

On the satisfaction survey, all students agreed or strongly agreed with the statements "I learned more new information from this IPPE" and "I would prefer more courses with a simulation component" (Table 5). Overall, student evaluations were positive and the course achieved a mean score of 3.5 out of 4. More importantly, individual student comments highlighted how much the students learned in the course and how much they appreciated the opportunity to apply knowledge learned in the

Figure 1. Pharmacy students' performance on knowledge-based quizzes before and after completing an introductory pharmacy practice experience involving simulated patient care settings (N=28). Quizzes were comprised of 5-15 questions and administered during the pre-simulation case work-up time, and then again after the debrief period. All p values <0.05 .

classroom in a non-threatening clinical environment. The formative feedback provided during the simulation and debrief period provided constructive criticism, which students seemed to value. Several students mentioned that they learned a lot about their own strengths and weaknesses through the formative feedback provided during the IPPE.

On the practical examination, faculty observers subjectively passed 67% of the simulation IPPE students versus 52% of the students enrolled in other IPPEs in the

community. The scores from the observer checklists were 52% vs 44% for the simulation vs the control arm, respectively ($p = 0.02$). More students in the simulation arm received a bonus point for excellent performance (48% vs 34%), and fewer simulation students made a fatal error than students in the control arm (8% vs 32%). Typical errors were on the calculation exercises (90% were due to errors in picking a diluent for intravenous potassium chloride, calculating rate of infusion, and insulin dosing).

Table 4. Student Confidence Survey

Skills	Question	<i>P</i>	Mean Pre-simulation/ Post-Simulation ^a
Technical skills	Using drug information resources to find appropriate answers	0.161	2.3/2.5
	Identifying medication errors	0.574	2.6/2.5
	Working up clinical cases in a limited time frame	0.025	3.0/2.6
	Looking up patient information in a patient's medical record	0.85	2.5/2.4
	Calculating drip rates for intravenous medications	0.03	3.0/2.7
	Identifying drug-drug interactions	0.136	2.9/2.7
	Identifying physiologic effects of drugs on the human body	0.026	2.9/2.6
Communication skills	Creating a care-plan for a patient	0.45	2.6/2.5
	Writing drug orders in a patient chart	0.016	3.1/2.5
	Counseling a patient	0.015	2.8/2.3
	Communicating with a physician and nurse	0.444	2.5/2.4
Emergency Management	Managing a patient who faints after a vaccine administration	0.002	3.1/2.2
	Managing a patient with acute asthma attack	<0.001	3.3/2.2
	Managing a patient having an acute myocardial infarction	0.013	2.9/2.4
	Managing an acute anaphylactic reaction	0.001	3.1/2.3

^a Survey based on a Likert scale ranging from 1 = very confident to 4 = not confident.

Table 5. Pharmacy Students Who Strongly Agreed or Agreed^a With Statements Regarding a Patient Simulation Exercise to Demonstrate Competency in Core Domain Abilities (N=28)

Statement	Students, %
Simulation reinforced didactic coursework	96
I better understand physiologic effects of medications	92
Simulation is a helpful tool for training	100
I would prefer more courses with simulation component	100
Simulation was a positive experience	100
Compared to team based learning, I learned clinical patient care better using simulation	100
Simulation learning should be offered to each year of pharmacy students	100
I learned more new information from this IPPE	100
This IPPE reinforced previously learned concepts in a manner that was meaningful	100
I would recommend this IPPE to other pharmacy students	96

^aSurvey responses based on a Likert ranging from 1 = strongly disagree to 4 = strongly agree.

DISCUSSION

The number of errors that students made during the simulation IPPE was higher than desired and highlights the importance of patient safety training and awareness of human fallibility. Typically, students had the greatest difficulty with calculation problems and the acute care simulations where stress levels were high. Students also failed to pay attention to new diagnostic data and did not make pertinent changes to the management of their patient. These types of errors and omissions bring to light a deficiency in knowledge that should be addressed with further learning exercises. The positive improvements in self-perceived skills and performance on the practical examination were encouraging and showed the impact that providing immediate feedback can have on student performance. Simulation-based students were better prepared for a minimal competency examination than were students enrolled in traditional patient care sites. This finding further reinforces the need to teach and assess the pre-APPE core domains in a consistent manner within the pharmacy curriculum. In this course, students were taught and their skills were assessed in at least 10 of the 11 pre-APPE core domains competencies. This is extremely difficult for any 1 course to achieve.

One of the most important objectives of the course was to increase students' awareness of human fallibility and that even the most knowledgeable person can make errors. However, there was no significant change in

students' confidence in identifying medication errors after completing the simulation IPPE. This may have been because students realized their own limitations after making several fatal and non-fatal errors during the IPPE. Encouragingly, 100% of the students felt that the course increased their awareness of patient safety. The clinical impact of this awareness was apparent 3 months later when students who had completed the simulation IPPE made fewer fatal errors than students in the control arm (8% vs 32%, respectively) on the practical examination.

Overall, this 3-week course was successful in reinforcing patient safety concepts and was able to touch on several of the ACPE pre-APPE competencies. While the course emphasized and assessed students on several of the competencies, it was not all encompassing and there were several gaps that need to be filled with pertinent IPPEs and lecture-based coursework. This is especially true of competency 11 (insurance and prescription-drug coverage) as well as competency 10 (population wellness strategies). While this course was successful in meeting its objectives, educators should note that simulation-based courses are extremely time and resource intensive. For the course coordinator, each IPPE simulation required at least 8 hours of direct contact time daily and 3 hours of indirect preparation time. In addition to the human resources, this course required a budget of at least \$7500 for direct and indirect costs. For colleges and schools looking to use a simulation-based IPPE, considerations should be made regarding dedicated faculty time as well as budget allocations. Additionally, any college or school looking to incorporate simulation into the curriculum should carefully select those experiences that would be best suited for a simulated experience. This would depend on the availability of diverse practice sites as well as those student deficiencies identified by each program.

SUMMARY

By providing simulated experiences in diverse clinical arenas, an IPPE course was implemented to teach and assess student skills in 10 of 11 pre-APPE core domains of competency outlined by ACPE. Students met the learning objectives of the course and their awareness of human fallibility and patient safety increased.

ACKNOWLEDGEMENTS

The authors thank Drs. William Ofstad, PharmD, Bradley Brazill, PharmD, Sonya Frausto, PharmD, John Battisti, PhD, Jennifer Lackey, PharmD, Grant Lackey, PharmD, David Carroll, PharmD, and Ms. Karen Sproates for their assistance with this project.

This study was supported by a New Investigator Award from the American Association of Colleges of Pharmacy (AACP).

REFERENCES

1. ACPE. Accreditation standards and guidelines for the professional program in pharmacy leading to the doctor of pharmacy degree. S2007, Guidelines 2.0, Preamble Addendum, Appendix D. Chicago, ILL: 2011. <http://www.acpe-accredit.org/pdf/FinalS2007Guidelines2.0.pdf>. Accessed August 29, 2012.
2. Falcone RA Jr, Daugherty M, Schweer L, et al. Multidisciplinary pediatric trauma team training using high-fidelity trauma simulation. *J Pediatr Surg*. 2008;43(6):1065-1071.
3. Dillon PM, Noble KA, Kaplan W. Simulation as a means to foster collaborative interdisciplinary education. *Nurs Educ Perspect*. 2009;30(2):87-90.
4. Baker C, Pulling C, McGraw R, et al. Simulation in interprofessional education for patient-centred collaborative care. *J Adv Nurs*. 2008;64(4):372-379.
5. Bergman S, Deckelbaum D, Lett R, et al. Assessing the impact of the trauma team training program in Tanzania. *J Trauma*. 2008;65(4):879-883.
6. Birch L, Jones N, Doyle PM, et al. Obstetric skills drills: evaluation of teaching methods. *Nurs Educ Today*. 2007;27(8):915-922.
7. Crofts JF, Ellis D, Draycott TJ, et al. Change in knowledge of midwives and obstetricians following obstetric emergency training: a randomized controlled trial of local hospital, simulation centre and teamwork training. *Br J Obstet Gynaecol*. 2007;114(12):1534-1541.
8. Dagnone JD, McGraw RC, Pulling CA, Patteson AK. Interprofessional resuscitation rounds: a teamwork approach to ACLS education. *Med Teach*. 2008;30(2):e49-e54.
9. Vyas D, Wombwell E, Russell E, Caligiuri F. High-fidelity patient simulation series to supplement introductory pharmacy practice experience. *Am J Pharm Educ*. 2010;74(9):Article 169
10. Marken PA, Zimmerman C, Kennedy, Schremmer R, Smith KV. Human simulators and standardized patients to teach difficult conversations to interprofessional health care teams. *Am J Pharm Educ*. 2010;74(7):Article 120.
11. Tofil NM, Benner KW, Worthington MA, Zinkan L, White ML. Use of simulation to enhance learning in a pediatric elective. *Am J Pharm Educ*. 2010;74(2):Article 21.
12. Fernandez R, Parker D, Kalus JS, Miller D, Compton S. Using a human patient simulation mannequin to teach interdisciplinary team skills to pharmacy students. *Am J Pharm Educ*. 2007;71(3):Article 51.
13. Zagar M, Baggarly S. Simulation-based learning about medication management difficulties of low-vision patients. *Am J Pharm Educ*. 2010;74(8):Article 146
14. Robinson JD, Bray BS, Willson MN, Weeks DL. Using Human Patient Simulation to Prepare Student Pharmacists to Manage Medical Emergencies in an Ambulatory Setting. *Am J Pharm Educ*. 2011;75(1):Article 3.
15. Raney EC. Assessment of anticoagulation management in a simulated ambulatory care clinic. *Am J Pharm Educ*. 2007;71(5):Article 97
16. Seybert AL, Kobulinsky LR, McKaveney TP. Human patient simulation in a pharmacotherapy course. *Am J Pharm Educ*. 2008;72(2):Article 37.
17. Seybert AL, Laughlin KK, Benedict NJ, Barton CM, Rea RS. Pharmacy student response to patient-simulation mannequins to teach performance-based pharmacotherapeutics. *Am J Pharm Educ*. 2006;70(3):Article 48.
18. Seybert AL, Barton CM. Simulation-based learning to teach blood pressure assessment to doctor of pharmacy students. *Am J Pharm Educ*. 2007;71(3):Article 48.
19. Mieure KD, Vincent WR, Cox MR, Jones MD. A high-fidelity simulation mannequin to introduce pharmacy students to advanced cardiovascular life support. *Am J Pharm Educ*. 2010;74(2):Article 22.
20. Seybert AL, Kane-Gill SL. Elective course in acute care using online learning and patient simulation. *Am J Pharm Educ*. 2011;75(3):Article 54.
21. Benner P. *From Novice to Expert*. Menlo Park, CA: Addison-Wesley; 1984.
22. Kohn LT, Corrigan JM, Donaldson MS, eds. *To Err Is Human: Building a Safer Health System*. Washington: National Academies Press; 1999.
23. Ried LD, Brazeau GA, Kimberlin C, Meldrum M, McKenzie M. Students' perceptions of their preparation to provide pharmaceutical care. *Am J Pharm Educ*. 2002;66(4):347-356.

Appendix 1. Competencies and abilities demonstrated by pharmacy students who completed a patient simulation.

Competency 1: Patient Safety

Ability Statement: *Demonstrate a commitment to and a valuing of patient safety by ensuring accurate preparation, labeling, dispensing and distribution of prescriptions and medication orders.*

In order to reinforce patient safety concepts, various patient safety issues were embedded into each simulation scenario. These issues were based on the following over-arching errors as identified by the Institute of Medicine:²² 1) Treatment errors; 2) Diagnostic errors (failure to act on diagnostic tests); and 3) Prevention errors (inappropriate use of prophylactic medications).

A deliberate effort was made to include at least one category of these types of patient safety issues within each simulation session (Table 2). As an example, in the aseptic technique and chemotherapy simulations, students were expected to determine the accuracy of a physician order for IV medications by individualizing each order to patient specific data. Following this review, students were expected to compound the medications by performing accurate calculations, determining the appropriate fluid/piggyback, and by using effective sterile technique. Within the clinical simulations, students were expected to identify the most appropriate medications based on evidence-based medicine, accurately dispense or administer the medications, and take into account proper ethical, cultural, and legal considerations.

Competency 2: Basic Patient Assessment

Ability Statement: *Collect record and assess subjective and objective patient data to define health and medication-related problems. Patient information must be collected in a manner demonstrating knowledge of patient educational level, the unique cultural and socioeconomic situations of patients, and comply with requirements for patient privacy.*

Students were taught basic physical assessment techniques on the fourth day of the IPPE and each day of the clinical simulations required minimal assessment of the patient depending on the scenario. The asthma and congestive heart failure (CHF) simulations required assessment of lung and heart sounds. The diabetes scenario required a foot examination and an assessment of pedal pulses. The MTM and emergency in the community pharmacy scenarios required blood pressure and heart rate assessment.

Besides physical assessment, all clinical simulations required students to obtain a physical history, record, and interpret the findings. Students were also required to review the patient's medication profile to identify any drug related problems (DRP). All scenarios included at least one DRP such as a drug allergy, drug-food interaction, drug-disease interaction, incorrect doses, and duplicate medications. Students were also assessed on their awareness of the patient's cultural and socioeconomic situation. The MTM scenarios incorporated cultural issues and health literacy issues which impacted the student's treatment decision.

Competency 3: Medication information.

Ability Statement: *Demonstrate knowledge of and accept responsibility for that knowledge of commonly used medications, formulations and drug products.*

All clinical scenarios required a working knowledge of commonly used medications especially the top 200 medications. Students were expected to understand the mechanism of action of these medications and use this knowledge to provide patient centered care. For drugs with a narrow therapeutic index, students were expected to document their monitoring plan and determine target therapeutic levels in their SOAP note. For the aseptic technique and chemotherapy simulations, students had to check the compatibility of the drug with various diluents, determine the infusion rate, and determine the appropriate storage and stability considerations for each medication.

Competency 4: Identification and assessment of drug related problems.

Ability Statement: *Correlate drug related variables and patient related variables to identify and assess drug related problems. Evaluate how the unique characteristics of patients and patient populations impact on manifestations of drug-related problems*

With an overarching goal of teaching patient safety issues, various DRPs were incorporated into the simulations and student oversight of those issues resulted in further deterioration of the patient. For example, during the vaccine administration simulation, one of the standardized patients had an anaphylactic reaction to the vaccine. The students were expected to immediately identify the problem and appropriately manage the emergency. During all the clinical simulations, students reviewed medication orders and evaluated them for any DRPs. For example, during the MTM simulation, a schizophrenic patient presented with dyskinesias such as lip smacking and tongue thrusting. If gone unnoticed, the student was informed that the patient later presented with tardive dyskinesia possibly due to the haloperidol.

Competency 5: Mathematics applied to pharmaceutical calculations, compounded medications, dose calculations, and applications of pharmacokinetic calculations.

Ability Statement: *Use pharmaceutical and pharmacokinetics mathematics to perform accurate medication calculations. Value the importance of total accuracy in performing and applying these calculations.*

Various calculations were incorporated into the aseptic technique and chemotherapy scenarios. In addition, during the diabetic ketoacidosis (DKA) and CHF scenarios, students were expected to calculate appropriate doses and rates of administration and communicate that to the nurse taking care of the patient. If students miscalculated any of the medication doses, the patient deteriorated or had a mishap from the error. In some cases, if the error was severe enough, it resulted in a fatality and early termination of the simulation.

Competency 6: Ethical, professional, and legal behavior.

Ability Statement: *In all health-care activities, demonstrate knowledge of and sensitivity towards the unique characteristics of each patient. Comply with all federal, state, and local laws related to pharmacy practice. Demonstrate ethical and professional behavior in all practice activities.*

Students were expected to demonstrate professional and ethical behavior during all simulation exercises. At least 2 simulation scenarios (MTM and emergency contraception) required the student to follow ethical principles while taking care of the patient. Students had to take into account a 15-year-old patient's right to confidentiality when the parent demanded to know if the patient had purchased emergency contraception. For most clinical scenarios, students were expected to demonstrate empathy and use effective communication skills while providing discharge counseling. For several of the scenarios, students had to demonstrate

an understanding of a patient's cultural, spiritual, and other needs while providing care. For example, in one scenario, the patient was a Muslim female who fasted during the month of Ramadan. Students had to take this into account when counseling on her insulin regimen.

Competency 7: General communication abilities.

Ability Statement: *Demonstrate effective communication abilities in interactions with patients, their families and care givers, and other health care providers. Communication should be consistent with education level, cultural issues, and be empathetic. Elicit feedback validating understanding of communication.*

All checklists and rubrics had a communication component and students were given daily feedback about their counseling style, their professional interaction with other healthcare providers, and their overall ability to communicate with patients and their families. Specific attention was given to health literacy principles and students were provided feedback regarding the use of medical jargon in their communication with the patient. For written communication, students were given feedback and assessed on the layout and content of their SOAP notes and chart notes.

Competency 8: Counseling patients.

Ability Statement: *Provide effective health and medication information to patients and/or care givers and confirm patient and/or care giver understanding of the information being provided.*

Students were given feedback regarding their counseling technique during the clinical simulations. Several scenarios were multidimensional and required the student to identify drug-drug interactions or drug-disease interactions and relay that message to the patient while providing an alternative solution for the problem. For instance, during the smoking cessation scenario, the patient brought in a prescription for Ortho Tri-cyclen® and was also a current smoker. The student was expected to identify this interaction and offer alternative solutions including smoking cessation tools. Besides, appropriate counseling and communication technique, the student was also assessed on their ability to verify the patient's understanding of the information provided. During the acute care simulations such as ACLS, CHF, DKA, etc. The students were assessed on their ability to communicate alternative treatment options to the provider in a confident but respectful manner.

Competency 9: Drug information analysis and literature research.

Ability Statement: *Assess information needs of patients and health providers and apply knowledge of study design and literature analysis and retrieval to provide accurate, evidence-based drug information.*

All scenarios required the use of drug information resources and the use of evidence-based medicine to provide safe and effective patient care. During the acute care simulations, students were provided clinical guidelines, where applicable, to improve their ability to use guidelines to support their treatment decisions. Students were allowed to use electronic resources such as Lexi-Comp or ePocrates to emulate real life practice of pharmacy.

Competency 10: Health and wellness – public health.

Ability Statement: *Know and apply principles of health and wellness in provision of individual and population-based health and wellness information. Integrate unique characteristics of individuals and populations in design of health and wellness information.*

All scenarios required the students to keep health and wellness principles in mind while taking care of the patient. During the MTM simulations, students provided smoking cessation counseling. During the clinical scenarios, students identified appropriate preventative strategies such as the use of statin therapy or daily aspirin therapy to avoid further complications. Population wellness strategies were not addressed during this IPPE.

Competency 11: Insurance /prescription drug coverage.

Ability Statement: *Using knowledge of a wide array of private and public health insurance options assist patients and care givers to obtain their medications and related para-pharmaceuticals in an affordable manner that meets their health care needs.*

Students used the patient's socioeconomic status and insurance coverage to determine the most appropriate therapy choice. However, different insurance options were not addressed during the IPPE.