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INSTRUCTIONAL DESIGN AND ASSESSMENT

Using a Human Patient Simulation Mannequin to Teach Interdisciplinary Team Skills to Pharmacy Students

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Objectives. To determine the effectiveness and student acceptance of using a human patient simulation (HPS) training module focused on interdisciplinary teamwork skills.
Design. During their second-professional year, all pharmacy students were in enrolled in *Principles of Pharmacotherapy 4: Cardiovascular Diseases* and *Patient Care Lab IV*, a problem-based learning course. As part of the patient care laboratory, students participated in a simulated case of an acutely ill patient with a hypertensive emergency. During the simulation, students performed a history and physical examination. They then worked as a team to make treatment recommendations to the nursing and physician staff members. Following the exercise, a facilitated debriefing session was conducted. Students completed satisfaction surveys to assess the quality and effectiveness of the session.
Assessment. Over 98% of students agreed or strongly agreed that they learned material relevant to their current studies. When compared to student lectures, 90% of students felt that they learned clinical patient care better when using a HPS mannequin in simulated patient scenarios.
Conclusion. HPS-based learning offers a realistic training experience through which clinical knowledge and interpersonal teamwork skills can be taught. Students enjoy the experience and find it relevant to their future practice. Simulation-based training may teach certain topics better than traditional lecture formats and as such could help to fill gaps in the current pharmacy curriculum.

Keywords: simulation, interdisciplinary training, curriculum development

INTRODUCTION

Pharmaceutical education and curricular guidelines have undergone major changes in the past decade. Beginning with the Pew Health Professions Commission's 1993 report, there has been an increased emphasis on developing critical thinking, problem solving, and professionalism in pharmacy education.[1,2] Pharmacy programs have been charged with training students to communicate within a multidisciplinary setting to "engender a team approach to patient care."[3] This need for strong teamwork skills among healthcare professionals was echoed in a 2003 Institutes of Medicine report *Health Professions: A Bridge to Quality*.[4] As a result, the Accreditation Council for Pharmacy Education (ACPE) 2007 recommendations site communication skills, patient safety, and interprofessional teamwork as important cornerstones for pharmacy curricula.[3] While these recommendations are logical and are supported by the current literature, it is not entirely clear how these educational goals are best accomplished.

Pharmacy programs are required to provide practice experiences designed to give students the opportunity to apply knowledge and skills learned in the classroom in a real clinical setting. Due to limited clinical learning sites, faculty time, and already full curricula, the majority of programs concentrate most experiential learning at the end of the training program.[5,6] This means that students do not have the opportunity to truly integrate and practice their skills until the end of their training. In a review of excellence in curriculum development, Abate et al state that the opportunity to practice skills should not be limited to the final experiential year, but should be supported throughout an integrated curriculum.[7]

As in the pharmacy community, leaders in medical education have faced demands for education reform. Pushed forth by the recent patient safety movement and the need to move toward competency-based curricula, the

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American College of Graduate Medical Education (ACGME) and the ACPE have called for the use of simulation in medical and pharmacy education, respectively.[3,8] Simulation encompasses all levels of technology, from actors portraying patients, family members, or medical staff members, to fully immersive virtual reality systems and high-fidelity full-body human patient simulators (HPS).[9] High-tech HPS trainers realistically portray a multitude of disease states and respond accurately to drug administration and procedural interventions, allowing students to "learn by doing" in a safe setting with direct observation and immediate feedback.[10] Simulation has been suggested to facilitate the transfer of learning from the classroom to the clinic as well as or better than real patient encounters, making it an extremely powerful teaching tool.[11] There are several reports of various forms of simulation in pharmacy education; however, the reports on the use of HPS are limited.[12-14]

Currently, students admitted to the doctor of pharmacy (PharmD) program at Wayne State University Eugene Applebaum College of Pharmacy and Health Sciences (WSU-EACPHS) are enrolled in primarily didactic courses for the first 2 years. The first year curriculum is organized in a traditional format to cover the basic sciences, including pharmacology, biochemistry, pathology, and pharmacy calculations. Course work during the second year is organized to deliver relevant material in medicinal chemistry, pharmacology, and therapeutics in an integrated fashion within modules of a course entitled *Principles of Pharmacology*. Throughout these first 2 years, there is also a longitudinal *Patient Care Lab* sequence where students learn and practice communication skills, patient assessment, and drug therapy monitoring, informatics, and practice management.

Problem-based learning is incorporated into the *Patient Care Lab* sequence to engage students in small group discussion surrounding topics that are not covered elsewhere in the curriculum. The cardiovascular module of *Principles of Pharmacology* takes place in the spring, after students have completed modules in immunology, hematology, infectious diseases, and respiratory disease. The cardiovascular module includes lectures on the physiology of the cardiovascular system, pathophysiology of hypertension, and the pharmacology and therapeutics of all classes of available antihypertensive agents. Prior to participating in the simulation, all students had attended introductory lectures in cardiovascular pathophysiology and pharmacology. In addition, the topic of hypertensive emergency was discussed in a problem-based learning session.

This manuscript describes a pilot curriculum that utilizes HPS-based training to teach pharmacy students teamwork skills in a realistic simulated environment. The objective of this curriculum was to offer students the opportunity to provide real-time care to an acutely ill patient as part of an interdisciplinary team. Faculty member observers were able to directly observe students and provide focused feedback. Poststudy satisfaction survey instruments were used to evaluate student acceptance and enjoyment of the experience. This project was undertaken to address the limited opportunity for structured experiential learning early in the pharmacy curriculum.

DESIGN

A simulation-based exercise was designed and implemented at the simulation center located within WSU-EACPHS, a 4000-square foot area consisting of 4 HPS simulation rooms and other peripheral rooms (locker room, 3 debriefing rooms). All simulation training was done using the HPS Standard Man mannequin (Medical Education Technologies, Inc, Sarasota, Fla). Standard Man was connected to a cardiac monitor and displayed real-time vital signs and physical findings, including a palpable pulse, constricting/dilating pupils, and heart and lung sounds. The mannequin is able to speak and respond to questions via an operator with a radio transmitter. For this training exercise the patient's voice was operated by a pharmacy faculty member. The patient's responses were loosely scripted, allowing us to provide consistency between scenarios without losing the spontaneity of normal conversation. Any unanticipated questions were answered in a way that was consistent with the patient's clinical presentation. Patient charts and ancillary information (laboratory results, radiographs, etc) were available as needed for each scenario. A two-way radio in the simulation suite allowed participants to call consults, patient family members, etc, as needed.

All second-professional year pharmacy students enrolled at Wayne State University (WSU) in 2006 took part in the *Patient Care Lab* and simulation exercise (Table 1). All students agreed to abide by a standard confidentiality

Table 1. Demographics of Second-Year Pharmacy Students Who Participated in a Human Patient Simulation Training Session (N = 73)

Male, %	24
Age, Mean (SD)	24.7 (4.7)
Students with prior degrees (BS or higher), %	8
Ethnic Background, %	
White, Non-Hispanic	64
Middle Eastern	21
Other	15

contract used by the EACPHS Simulation Center. This contract was designed to protect the integrity of the training session and prevent students from learning the simulation design in advance. Failing to abide by the contract was considered a violation of the College's Honor Code. This study was approved by the University's Institutional Review Board.

During the *Patient Care Lab* and concurrent with the cardiovascular integrated module (*Principles of Pharmacotherapy 4: Cardiovascular Diseases*), students were divided into groups of 3-5 and each group was scheduled to participate in a 1-hour simulated patient encounter. Prior to the session, students were shown a videotape outlining the mannequin's features and demonstrating a short scenario of a pharmacist/ patient/nurse interaction. Students were then given a review article covering key topics in the treatment of hypertensive emergencies. Over the next week, they were asked to review the article as well as key information covered in their cardiovascular module. The students were told that they could use their calculators and any resource materials they wished during the scenario. In addition, a current edition of *American Hospital Formulary Service Drug Information* (American Health Systems Pharmacists, Inc, Bethesda, Maryland, 2006) was also made available to students during the simulation.

The scenario designed replicated an interaction with a patient with severely high blood pressure and a headache. The students were given a brief orientation to the mannequin and simulation room. They were then told they would be acting as a pharmacy team to make treatment recommendations for a simulated patient. The fact that this was a team activity was stressed; however, no clear roles were assigned by the facilitators. Participants were then paged ''stat'' to the simulated emergency room and introduced to their patient. The nurse confederate at the patient's bedside informed the team that the doctor ordered a medication that was not on the hospital formulary. He was busy dealing with a critically ill patient, so he had requested the input of the pharmacy team. The students were then given the patient's emergency room chart and encouraged to interview the patient. Throughout the simulation, both the nurse confederate and patient used verbal prompts to encourage the participants to make a treatment recommendation as well as to provide feedback. The nurse required the team to write an order telling her how to mix the drug and how it should be administered. The case ended with the patient's physician entering the room and asking for an update. The pharmacy team was then expected to present their recommendation to the patient's physician. Although the students had formulated their recommendations in a way that was ''nurse friendly'' (ie, mL/hr drip rate), they were further prompted by the physician confederate to use standardized pharmacy terms (ie, mg/hr dose rate). The team was then asked to make any further monitoring recommendations. The scenario ended with the physician and nurse thanking the team for their help.

Each team was expected to complete the scenario in approximately 15-20 minutes. This was by design and accomplished the goal of maintaining uniformity within each case while also imparting the realism of an acutely ill patient. Time constraints were communicated to the students via verbal cues from the patient and nurse. For example, the patient would reiterate how sick he felt approximately every 3 minutes and ask the nurse when he was going to receive medicine to help him every 5 minutes. The nurse commented on the patient's severely high blood pressure about every 3 minutes.

Verbal cues were also utilized when the team was making an error or if a critical action was missed. For instance, if the team did not assess the patient's allergies, the nurse would do so just before administering a medication and the patient would thank her for asking. If the team made an error in calculations, the nurse would report that her pump would not run that fast, or some statement to cue the students that they had made an error. This also assisted the team in staying within the specified timetable while meeting all of the simulation objectives.

Immediately following the simulation exercise, students were debriefed. The debriefing sessions were led by content experts in pharmacotherapy and interdisciplinary team training. The students' opinions of the exercise were solicited and they were asked to critique their performance. The case was summarized and both communication issues and relevant pharmacotherapeutics were discussed. Students were asked to evaluate the information they obtained from the patient and how that process could be improved. The students' interactions as a team were analyzed, particularly in cases where the team fractured into multiple parts and lost cohesiveness. The concepts of interdisciplinary teamwork training were introduced. Specifically, the discussion focused on leadership and communication issues. Using the different expectations of the nurse and the physician during the scenario as an example, the participants were asked to develop ideas about how they might better assess what is needed from them in a patient care situation/setting. They also discussed how they could better use the team's resources to obtain more information from the simulated patient. Postintervention surveys were completed immediately following the simulation debriefing. The survey instrument consisted of a 5-point Likert scale (Table 2) as well as freeform comments.

Table 2. Survey Responses of Second-Year Pharmacy Students After Participating in a Human Patient Simulation Training Session (N = 73)

Survey Item	Strongly Agree, %	Agree, %	Neutral, %	Disagree, %	Strongly Disagree, %
I learned things in today's course that will be useful in my practice.	86	12	1	0	0
Today's exercise helped me understand what my role would be in an emergency room setting.	74	26	0	0	0
When compared to standard lectures, I feel that I learn clinical patient care better using simulated patient scenarios.	59	32	8	1	0
I feel that participation in simulated patient cases will better prepare me for my clinical rotations.	73	26	1	0	0
The inclusion of simulation exercises during my second year would enhance my knowledge base.	70	27	3	0	0
If given the choice, I would participate in simulation exercises in the future.	71	25	4	0	0
I enjoyed today's exercise, it was a great way to learn.	64	25	11	0	0
After today's simulation session, I feel more comfortable interacting with a patient.	21	37	36	4	3

ASSESSMENT

All 73 students enrolled in *Principles of Pharmacotherapy 4: Cardiovascular Diseases* and *Patient Care Lab IV* completed the simulation exercise and the post-exercise survey (Table 2). The demographics of our student population suggested a diverse group (Table 1). Over 98% of students agreed or strongly agreed that they learned material relevant to their practice as pharmacists, and all the participants felt that they learned what their role as a pharmacist would be in an emergency setting. Likewise, over 95% of students agreed that inclusion of similar simulation exercises would enhance their knowledge base as well as better prepare them for future clinical practice experiences. One student wrote that he/she was able to "put the knowledge that we learn to a practical test" and "realize what we need to focus on." Over half of the students stated that they would feel more comfortable interacting with a patient as a result of the simulation exercise.

This study attempted to assess students' opinions of simulation-based training versus more traditional lecture-based education. When compared to student lectures, 90% of students felt that they learned clinical patient care better with a simulated patient scenario. Specifically, students stated that they were "able to learn more in this exercise than in a lecture" and learned "more in the debriefing than I did all semester reading on my own." They were very clear, however, that they enjoyed the fact that this exercise was for training purposes and was not formally graded. Specifically, they stated that these experiences "would be very useful . . . but should not be graded to prevent the stress of performing well." This theme was echoed throughout 18% of the students' written comments.

The vast majority of student comments mentioned how much they enjoyed the simulator. Over 90% reported that, if given the choice, they would participate in similar exercises in the future. Seventy-five percent of all written comments mentioned a desire to incorporate more simulation in the curriculum. This is consistent with the survey results demonstrating that over 90% of students felt that they would like a similar simulation training session at least every 6 months.

While we did not specifically solicit evaluation of the realism of the simulation, some students verbally commented "the acting and situation seemed very realistic." Students also wrote "it (the simulation) was very intense" and "a very good experience, but yet scary." One student felt that the scenario "was a great atmosphere to be able to engage in an emergency situation, a real world experience."

In verbal comments that were informally solicited during the debriefings, students in several of the groups commented that the time pressures applied using verbal cues made the sessions more realistic. While it added to their level of stress, they said it made them feel more like "real pharmacists." They also recalled the redirections given to them by the nurse, suggesting that verbal prompts can be a powerful learning component in HPS training.

DISCUSSION

This study outlines a curriculum designed to introduce interdisciplinary skills to doctor of pharmacy students in a realistic practice setting. The goals of this curriculum were twofold: (1) to reinforce the concepts of evaluation and treatment of a patient with hypertension, and (2) to introduce the principles of interdisciplinary teamwork. Our post-exercise satisfaction surveys indicate that students overwhelmingly enjoyed the curriculum and felt they learned more effectively than in a standard lecture. The students recognized both the simulation exercise and the debriefing components as important and appreciated the realism of the simulation. This positive response agrees with previous studies that show simulation to be a powerful educational tool for the adult learner.[15]

In 2005, Issenberg et al conducted a review of the medical simulation literature to assess what components of simulation-based education lead to effective learning.[16] The components cited include (1) involvement of learners as active participants, (2) use of multiple different learning strategies, and (3) application of deliberate practice. These are almost identical to the advantages of experiential learning described by Grant and Marsden.[17] Human patient simulation-based training has been cited for its ability to provide a realistic, experiential-type learning environment and is perfectly designed to act as a surrogate for true experiential learning.[18] Currently, pharmacy students at WSU have limited practical experience built into the first 3 years of their training program. During these experiences, their roles are primarily observational and are not designed to encourage active participation. In true experiential learning, there is a learning cycle that occurs: DO → REVIEW → LEARN → APPLY.[19] Using HPS-based training, students can acquire skills and knowledge through active participation in "patient" care, reflect and learn from their clinical decisions during faculty-led debriefing periods, and then experience another simulation to apply what they have learned. In this way, HPS is able to meet many of the ACPE guidelines and recommendations for experiential learning in a faculty-supervised, patient safety-oriented manner.

During the development of HPS training sessions, much of the focus is geared toward designing and executing clinical scenarios. To successfully provide "experiential learning," students must be completely engaged in the simulation, acting as they would in a real clinical situation. This is accomplished by maintaining psychological fidelity. In other words, a flow of events and believable cues that carry learners through the scenario in a realistic way must be established. By providing an emotionally realistic environment, learners are apt to react to planned stressors and challenges in a realistic way. This gives the learner an increased awareness of the complex nature of the task and the multiple skills required to perform it successfully.[15] Our curriculum employed time constraints to provide external pressures on our learners, forcing them to make clinical decisions. This pushed the envelope of their comfort zone, and in some cases altered their communication with the other professionals in the scenario. This may have been a factor that led some students to describe the experience as "scary" and "stressful." While we acknowledge that there could be a fair amount of stress experienced by students, it does not appear to be a deterrent. The same students who indicated feelings of stress also expressed the desire for future HPS training. This suggests that we were successful in providing a learning environment that was seen by the students as safe yet challenging.

Human patient simulation has been used for teamwork training in both nursing and medical fields.[20-22] The demonstration that teamwork training improves team performance and significantly decreases error[21,23] supports the mandate by the ACPE that educators provide this training to pharmacy students. The purpose/goal of our curriculum was to provide an introduction to team training by exposing students to some of the issues that arise when working with several different types of medical professionals. By providing the physician and nurse as confederates in the scenario, we were able to manipulate the students' environment more carefully. This was done intentionally to provide a more standard experience for all of the students, thus allowing the establishment of basic communication concepts. Once basic skills were established, true interdisciplinary training could be utilized. To introduce too many concepts at once might be seen as overwhelming and intimidating, thus impeding the learning process.[13,24]

While it is clear that the students enjoyed HPS-based training, there are several issues and limitations that warrant mentioning. First and foremost, the design of this simulation was clearly instructional. Students were told at the beginning of the training session that the purpose of the exercise was instructional and that no grading or evaluation would occur. This was done for several reasons. First, the instructors wanted the students to see the simulation environment as a "safe" place to try out new skills. Second, we purposely set our requirements for mastery of the material high, knowing that most if not all students would not meet all of the requirements. It was our goal to expose students to a new learning environment and a new skill set rather than to evaluate their clinical knowledge. As a result, students were given minimal directions

regarding preparation for the course. Under these conditions, it would not be fair to evaluate student performance for grading purposes. This may have biased the students' ratings and expectations of the experience; however, the increased anxiety levels reported suggest that the exercise was taken seriously by the majority of participants. While other medical fields have used HPS for student evaluation, its validity as an assessment tool requires further study.[25]

One of the major limitations of implementing an HPS-based curricular component is cost. While the hardware and technology are expensive, the faculty time required is even more so. To truly provide a complete experience, faculty members are required to provide direct observation and feedback. Debriefing sessions are extremely critical to the learning process and are routinely cited as the most important part of the entire simulation session.[26, 27] They are also very time consuming. Other educators have used preplanned PowerPoint lectures or computer-based tutorials to teach the "ideal" performance or management of a patient. While this addresses the issue of faculty time, it does not allow the students the opportunity to reflect, nor does it provide the student with direct feedback—a crucial component to HPS-based learning.[28] Thus far there does not appear to be a satisfactory way to circumvent the need for faculty members as direct observers and discussion facilitators.

Another limitation is the dearth of existing data to support the need for simulation-based training. While HPS and teamwork training have a great deal of face validity, few studies offer any solid proof of training advantages over more traditional methods. This makes it difficult to justify the costs mentioned above and difficult to know how to best implement this technology.

CONCLUSION

This report describes the use of HPS training to introduce interdisciplinary team skills and reinforce pharmacotherapeutics in a pharmacy curriculum. Pharmacy students readily accepted HPS-based training and preferred it to traditional didactics. Further work is necessary to evaluate educational outcomes, simulation techniques, and specifically the application of HPS in pharmacy education.

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