RESEARCH

Enhancing Student Knowledge Through a Comprehensive Oncology Simulation

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Objective. To evaluate the impact of a comprehensive oncology simulation on pharmacy students’ knowledge and perceptions related to oncology pharmacy practice.

Methods. Third-year pharmacy students at the University of South Florida completed an ovarian cancer case-based simulation. Stations involved patient-specific order set completion, counseling, order verification, and aseptic technique. Pre- and post-simulation assessments regarding therapeutic knowledge and aseptic technique as well as perceptions of pharmacists’ roles in oncology practice were evaluated.

Results. All students (n=109, 100%) completed the pre- and post-simulation assessments. There was an increase in knowledge after the simulation, which was statistically significant in three of the six questions. Furthermore, students’ perceptions regarding pharmacist roles and self-confidence in ability to prepare patient-specific regimens increased on a 5-point Likert scale from 3.8 and 3.2 to 4.5 and 4.2 on the post-assessment, respectively.

Conclusion. Participation in the simulation improved students’ oncology-related knowledge and perceived understanding of the roles of oncology pharmacists.

Keywords: oncology, simulation, laboratory, sterile compounding, counseling

INTRODUCTION

According to the Accreditation Council for Pharmacy Education (ACPE) 2016 Standards, instruction should be provided to students in a variety of modalities including didactic, simulation, and experiential activities. Simulation activities, specifically human patient simulations (HPS), allow students to bridge the knowledge they learned in didactic courses to clinical practice while maintaining a safe and controlled environment. Written assessments can quantify cognitive learning from didactic education, but these assessments may not accurately reflect a student’s performance in a clinical setting. Ideally, simulations should be created to mimic challenging scenarios in actual pharmacy practice with direct oversight from pharmacy educators or other qualified facilitators. Furthermore, the Center for Advancement of Pharmacy Education (CAPE) 2013 Educational Outcomes encourage the inclusion of problem-solving skills in the approach to patient care in various aspects including communication as well as patient education and advocacy.

The use of instructional technology, laboratory exercises, patient case studies, guided group discussions, and simulation activities can augment the student’s ability to develop appropriate critical-thinking and problem-solving skills.

Simulation activities are a well-established component of the medical and nursing curricula. These simulations are used to enhance technical, clinical, and teamwork skills and have been associated with improved final assessment scores for students who participated in the exercises. Vyas and colleagues demonstrated that HPS and high-fidelity simulations have been used to reinforce concepts including pharmacotherapy, advanced cardiac life support, and other topics within the pharmacy curriculum. Published studies reflect improvement in students’ perception of their problem-solving skills and ability to make clinical recommendations. Scores are significantly improved in post-simulation quizzes compared to those taken before the exercise. Additionally, students report higher levels of satisfaction with simulation-based activities than traditional didactic teaching modalities. Oncology-specific pharmacotherapy simulation exercises have also been previously described in the literature. Olin and Cole implemented computer-based clinical simulation cases in an oncology pharmacotherapy
In this oncology specific simulation activity, students appeared to agree that simulated cases reinforced important concepts and helped to identify gaps in study knowledge.7

The objective of this study was to evaluate the impact of an expanded oncology simulation on students’ knowledge related to oncology pharmacy practice and how it affects their perceptions regarding roles of an oncology pharmacist.

**METHODS**

Purposeful alignment of topics and utilization of Malcolm Knowles’s theory of andragogy allow for abundant active learning opportunities in the Pharmaceutical Skills course sequence, which is intended to apply pharmacy practice principles.8 The Pharmaceutical Skills course series includes six semester-long courses throughout the first three years of the didactic curriculum to implement higher levels of Bloom’s taxonomy through various activities that align with content taught in other courses for vertical and horizontal integration.5,9 The oncology simulation encompassed several ability-based course objectives including development of evidence-based, patient-specific therapeutic plans, engagement in empathetic patient counseling strategies, competence in accurately solving pharmaceutical calculations, and accurate and efficient prescription verification. As such, this experience remains consistent with Fink’s Taxonomy of Significant Learning experiences.10

During the initial planning stages for the simulation, ACPE standards were taken into consideration to ensure maximal reinforcement of curricular outcomes.1,5

The oncology simulation afforded third-year pharmacy (P3) students an opportunity to thoroughly address a patient case related to ovarian cancer and aligned with the associated topic in the oncology module of the Pharmacotherapeutics III course since students had already learned this topic. Furthermore, students had been introduced to principles of aseptic technique during the second semester of the P1 year in the Drug Delivery Systems course and laboratory. An oncology pharmacist panel discussion was scheduled during class one week prior to the simulation to introduce students to the roles and responsibilities of oncology specialty pharmacists in multiple settings including ambulatory care, inpatient clinical settings, bone marrow transplant setting, and an infusion center at Moffitt Cancer Center. During this presentation, oncology pharmacists discussed training requirements, advantages/disadvantages of specialization, opportunities for interprofessional practice, and practical pearls for how to best serve patients during such difficult times. The panel discussion was conversational and allowed for questions to enhance student engagement. The purpose of the simulation exercise was for students to actively engage in pharmacist roles and functions as they relate to caring for a cancer patient by rotating through three 30-minute stations (Table 1). As such, objectives of the simulation were for students to complete a patient-specific chemotherapy order set (including supportive care medications), conduct a medication counseling session related to a newly started chemotherapy regimen, perform order verification, and review principles of aseptic technique.

The simulation was a required activity and students worked within their academic groups of five to six students per group, which were randomly pre-assigned at the start of the academic year. Students groups started in the first simulation station and then rotated to the second and third stations in a progressive order. For this reason, students were able to follow a single patient case in chronological order. There were 16 student groups and each station had the capacity for four groups to work at a time. The simulation was conducted over four cycles during a single class period.

Prior to the simulation date, learners received the case and were expected to prepare by reviewing treatment modalities for ovarian cancer as well as readings regarding proper aseptic technique by USP 797 Clean Room Guidance and Standards. On the date of the simulation, a brief orientation session was held to outline the schedule, station layout, expectations, and answer any remaining questions. Students were instructed to rotate their lead roles throughout the simulation to remain actively engaged in all aspects of the activity. Students were also allowed to use electronic resources such as tablet computers or laptops during the simulation, which mimics clinical practice. After the simulation, students participated in a live verbal debrief session to provide feedback and answer any remaining questions.

The case involved a 56-year-old female with newly diagnosed ovarian cancer who had undergone surgery prior to chemotherapy initiation. The first station focused on drug information and students were to use appropriate references to properly complete a detailed order set including drug(s), doses(s), route, and schedule for chemotherapy and pertinent medications for supportive care. Students were permitted to ask questions to the facilitator and affirm their selected regimen since subsequent stations were dependent upon findings. In the second station, which involved patient counseling, students assumed the role of the clinical pharmacist on the oncology unit and spoke with a standardized patient (SP) to provide education on ovarian cancer, prognosis, the chemotherapy schedule, expectations and side effects of
the chemotherapy regimen, and appropriate supportive care medications that would accompany the regimen. Due to the group size and so as not to overwhelm the patient, two students led the counseling session and other group members were able to provide further clarification in an organized manner as needed. Students were given 5 minutes to prepare for the session, 20 minutes for counseling, and the last 5 minutes were allotted for detailed feedback from oncology specialty pharmacists, who observed the interaction. The third station focused on chemotherapy preparation including aseptic technique using an abbreviated skills checklist derived from USP 797 Standards (Table 2), prescription verification, and pharmaceutical calculations. Students functioned as the pharmacist working in the IV room and prepared a mock intravenous sterile product using

Table 1. Stations and Associated Concepts Utilized in the Oncology Simulation

| Station | Setting        | Activity                           | Core Concept(s)                                                                 |
|---------|----------------|------------------------------------|---------------------------------------------------------------------------------|
| 1       | Drug Information| Order set completion               | Patient-specific dosing of chemotherapy and supportive care                      |
|         |                |                                    | Renal/hepatic dosage adjustments Calculation                                     |
| 2       | Infusion Clinic | Patient counseling                | Review of chemotherapy regimen-specific education points Communication skills |
| 3       | IV Room        | Order verification & aseptic technique review | Errors and omissions USP 797 standards                                           |

Table 2. Aseptic Technique Checklist Used in Simulation from USP 797 Standards

| Skill Tested                      | Competency Demonstrated | Competency Not Demonstrated |
|-----------------------------------|-------------------------|----------------------------|
| Hand Hygiene and Garbing          |                         |                            |
| Removes jewelry upon entry into ante-areas. |                         |                            |
| Aware of the line of demarcation in the clean room. |                         |                            |
| Puts on shoe covers one at a time, placing covered shoe on clean side of demarcation as appropriate. |                         |                            |
| Puts on appropriate protective equipment in proper order. |                         |                            |
| Hair and beard cover as appropriate. |                         |                            |
| Face mask                        |                         |                            |
| Hand hygiene                     |                         |                            |
| Washes hands and forearms using soap and warm water for at least 30 seconds. |                         |                            |
| Dries hands and forearms with lint-free towel/hand dryer. |                         |                            |
| Puts on gown and ensures full closure. |                         |                            |
| Puts on sterile gloves and ensures tight fit with no excess glove material at fingertips. |                         |                            |
| Sterile Compounding\(^a\)       |                         |                            |
| Disinfects laminar flow hood with 70% isopropyl alcohol (IPA). |                         |                            |
| Disinfects components/vials with 70% IPA prior to placement in work area. |                         |                            |
| Does not interrupt, impede, or divert flow of first-air to critical sites. |                         |                            |
| Disinfects stoppers, injection ports, and ampule necks by wiping with 70% IPA and allows sufficient time to dry. |                         |                            |
| Affixes needles to syringes without contact contamination. |                         |                            |
| Punctures vial stoppers and spikes infusion ports without contact contamination. |                         |                            |
| Disinfects sterile gloves routinely by wiping with 70% IPA during prolonged compounding manipulations. |                         |                            |
| Disposes of sharps and waste according to institutional policy. |                         |                            |
| Labels preparation(s) appropriately outside of laminar hood. |                         |                            |

\(^a\)Adapted from USP-NF General Chapter <797> Pharmaceutical Compounding – Sterile Preparations
standard aseptic technique in a mock horizontal laminar airflow hood and were instructed that chemotherapy products are prepared in vertical laminar airflow hoods in clinical practice settings. Due to the group size, only one student completed the garbing and sterile compounding, while remaining group members provided guidance and feedback. Afterward, students verified mock IV chemotherapy bags compared to printed orders for carboplatin and paclitaxel, which were assumed to be prepared by a pharmacy technician, and identified any errors or discrepancies such as incorrect volume of active ingredients, volume of the final product, diluent, etc. This was intended to mimic the second pharmacist verification role for chemotherapy medications to ensure that the correct final product is being dispensed.

Four core pharmacy practice faculty members were involved in developing the case, corresponding student worksheets and answer key, aseptic technique checklist, and logistics of the oncology simulation, one of whom is a Board Certified Oncology Pharmacist (BCOP). The abbreviated aseptic technique checklist was derived by faculty based on the USP 797 Standards with priority for consideration given to key concepts that should be reinforced in the clean room setting and time limitations for completion of the simulation. Approximately 40 hours were spent collectively on planning the simulation activity. On the simulation day, four faculty members and four oncology specialty pharmacists from Moffitt Cancer Center were involved with the live activities to serve as facilitators and direct students in the station rotation. Two core faculty members facilitated the orientation and the first station (order completion), four oncology specialty pharmacists observed and provided feedback in the second station (patient counseling), and two core faculty members facilitated the third station (order verification and aseptic technique) as well as debrief. Additionally, four standardized patient (SP) actors were involved in playing the role of the female cancer patient. Both facilitators and SPs were sent an email with an overview of the logistics, schedule, worksheet answer key, and/or SP script one week before the simulation. An orientation session for both participating faculty members and SPs also occurred prior to the simulation. Specific SP instruction included reviewing details of the case to answer students' questions, how much information to divulge in their responses, level of prodding to ensure thorough answers by students, intensity of emotional level, and time allotment for each session.

The simulation was held at the University of South Florida Center for Advanced Medical Learning and Simulation (CAMLS), a state-of-the-art health care simulation and training center with rooms that resemble various clinical settings, such as the emergency room and critical care units in the inpatient setting, ambulatory care clinics, and inpatient and outpatient pharmacy settings. The simulation center had ample space to allow multiple student groups to rotate through each station simultaneously for the whole class to complete the activity during the designated class time. Additionally, the simulation center has the ability to coordinate timing for each station with announcements and offers classroom space as needed.

Furthermore, several materials were necessary for the hands-on portion of the simulation involving medication verification and aseptic technique in the third station. These items are listed in Table 3 to facilitate potential reproduction of this activity. Departmental funds were requested at the start of the academic year to financially support the simulation. Cost-saving strategies were considered and faculty concluded that consolidation of students to work within academic groups allowed for cost reduction. For example, garbing materials for a single student from each group (20 students) averages $15 compared to having all 109 students garb, which would cost $82. Additional costs would also entail those of the mock IV bags, saline, syringes, etc.

A student worksheet was developed to guide students with specific instructions throughout the stations. The patient case was provided in the form of a SOAP (subjective, objective, assessment, and plan) note as well as specific questions to complement each task. Upon completion of

Table 3. Budgetary Considerations for Procurement of Simulation Space and Supplies

| General            |                  |
|--------------------|------------------|
| Simulation center  |                  |

| Patient Counseling |                  |
|--------------------|------------------|
| Standardized patient actors |            |

| Order Verification |                  |
|--------------------|------------------|
| Mock IV bags       |                  |
| Mock drug vials    |                  |
| Syringes without needles |                |

| Aseptic Technique Review |                  |
|--------------------------|------------------|
| Nurses’ caps             |                  |
| Isolation gowns          |                  |
| Face masks               |                  |
| Shoe covers              |                  |
| Exam gloves (various sizes) |            |
| IV bags                  |                  |
| Syringes with needles    |                  |
| Alcohol swabs            |                  |
| Isopropyl alcohol bottle |                  |
| Sharps containers        |                  |
the simulation, one assignment was submitted on behalf of each group for a grade. In the first station, a chemotherapy order set accompanied the worksheet and was to be completed by students. Additionally, students received the abbreviated aseptic technique checklist (Table 2) as a guide in the third station.

Students completed anonymous, voluntary pre- and post-simulation assessments in Qualtrics (Provo, UT), which evaluated their knowledge of ovarian cancer treatment, aseptic technique and their perceptions regarding pharmacists’ roles in the oncology setting. Assessment questions, which were developed and peer-reviewed by core faculty, reflected the simulation objectives and the patient case. There are currently no validated instruments available for this type of simulation. Student responses to the pre- and post-simulation assessments were linked and analyzed using matched-pair methodology. Students were able to provide written, free-text response feedback in the post-simulation assessment and verbal feedback during the debrief session. Additionally, course evaluations upon completion of the semester allowed a final opportunity for students to provide comments regarding course structure, including simulations. Students completed the assessments individually during the orientation and debrief sessions, respectively, on the same day as the simulation activity.

Responses to the pre- and post-simulation assessments were analyzed using Wilcoxon signed-rank test for Likert-type responses and McNemar’s test comparing the differences between proportions of correct answers for the knowledge-based questions. Statistical analysis was done using NCSS 10 Statistical Software (Kaysville, UT). The study was determined to be non-human subject research by the Institutional Review Board at the University of South Florida. None of the authors have any conflicts of interest to disclose.

RESULTS

All students (n=109, 100%) completed both the pre- and post-simulation assessments. The first component of the assessment evaluated student knowledge regarding ovarian cancer treatment (Table 4). Baseline knowledge was already relatively high for questions 1-4, but a significant

| Question | Percentage of Students Answering Correctly Pre-simulation Assessment | Percentage of Students Answering Correctly Post-simulation Assessment | p * |
|----------|---------------------------------------------------------------|---------------------------------------------------------------|-----|
| 1. Which of the following is a common chemotherapy regimen for the treatment of ovarian cancer? | 86 | 99 | .0016 |
| 2. Which of the following chemotherapy agents requires pre-medication to prevent severe hypersensitivity reactions? | 72 | 92 | .0002 |
| 3. Which of the following is/are common side effects of carboplatin? | 80 | 87 | .11 |
| 4. Jewelry should be removed prior to entering the ante-area of an IV room. | 92 | 97 | .17 |
| 5. Which of the following is the recommended duration of hand washing with regard to proper aseptic technique? | 57 | 92 | <.0001 |
| 6. Which of the following are true statements? | 50 | 61 | .15 |
| i. The laminar flow hood should be disinfected prior to each use. | | | |
| ii. Stoppers, injection ports, and ampule necks should be disinfected prior to use. | | | |
| iii. Flow of first-air to critical sites may be blocked during aseptic preparation of IV products. | | | |

*McNemar’s test; student responses to the pre- and post-simulation assessments were linked and analyzed using matched-pair methodology.*
increase in the proportion of correct answers occurred following completion of the simulation activity regarding choice of chemotherapeutic regimen (question #1) and prevention of adverse effects (question #2). A significant proportion of students also demonstrated a gain in knowledge regarding proper hand washing technique (question #5). A lack of difference in question #6 responses may have been due to misinterpretation of one of the answer choices (choice #iii) since the wording “flow of first-air to critical sites may be blocked...” may not have been understood to mean it is acceptable to allow airflow to be blocked (as opposed to blocked air flow is something that can occur). Furthermore, all student groups correctly identified the discrepancies in the order verification component of the last station.

The second component of the assessment evaluated student perceptions regarding pharmacists’ roles in the oncology setting (Figure 1) using a Likert scale (1 = strongly disagree, 5 = strongly agree). The first question evaluated whether students understand the professional roles of an oncology pharmacist. Based on the pre- and post-simulation responses, students perceived they had a better understanding of the role of such pharmacists (pre-simulation response mean 3.8 (SD 0.9), median 4; post-simulation response mean 4.5 (SD 0.8), median 5; p < .0001). The second question assessed students’ comfort level in preparing patient-specific orders for chemotherapy and supportive care regimens. It appears that the simulation increased students’ perceptions of their abilities to prepare chemotherapy orders (pre-simulation response mean 3.2 (SD 1.2), median 3; post-simulation response mean 4.2 (SD 0.8), median 4; p < .0001).

Based on responses from the post-simulation assessment and course evaluations, students generally enjoyed the oncology simulation and appreciated the opportunity to practice key concepts learned earlier in the curriculum, such as pharmaceutical calculations and aseptic technique. Students identified areas of improvement for future offerings of this simulation activity, including a desire to conduct the patient counseling session individually and the need for additional time within the stations. Furthermore, the oncology specialty pharmacists provided favorable feedback since the simulation offered students a unique exposure to the spectrum of care for an oncology patient and were impressed with students’ overall performance in patient counseling.

**DISCUSSION**

Simulation activities within the pharmacy curricula have been well described in the literature ranging from the use of high fidelity mannequins to teach Advanced Cardiac Life Support to computer-based simulations for community practice experiences. However, the literature is limited in the use of simulation to enhance learning for oncology-related topics. Olin and Cole implemented computer-based clinical simulation cases (CBCSC) in an oncology pharmacotherapy course. The CBCSC included breast and colon cancer cases, which allowed for students to make decisions that could lead to different outcomes. Based on student survey results, authors concluded that the simulated cases reinforced important concepts and helped identify gaps in knowledge. Olin and Cole also reported that students felt the simulation should be continued in the course and built into others. However, the study was limited to computer-based simulation and the survey assessed the usefulness of the CBCSCs and did not evaluate its impact on students’ knowledge.

The learning opportunity described in this study allowed students to serve as an oncology pharmacist developing treatment plans, counseling a standardized patient, and working within a sterile compounding environment to reinforce aseptic technique skills. The objectives of this comprehensive oncology simulation allowed for the integration and application of concepts which align with ACPE Standards 2016 and the 2013 CAPE Outcomes. The activity provided students the opportunity to critically evaluate
a patient case and chemotherapy order to develop an evidence-based plan, use appropriate aseptic techniques to prepare and verify a chemotherapy order, apply pharmaceutical calculations concepts, and provide patient counseling. Specifically, the activities can be mapped to ACPE Standards 2016 and CAPE Outcomes 2013 sub-domains 2.1 (patient-centered care), 2.2 (medication use systems), 3.1 (problem solving), 3.6 (communication). Furthermore, the use of simulation through the prescription preparation process using aseptic technique and patient counseling with the use of HPS allowed for a more real-life experience within a protected learning environment.

The results of the study showed an increase in knowledge after the simulation regarding selection of a chemotherapy regimen and counseling on adverse effects compared to before the simulation. In addition, students’ perception of their ability to prepare patient specific chemotherapy orders improved after the simulation activity. Students completed the assessment individually and were not allowed to use outside resources. The assessment was given immediately prior to and after the simulation to ensure that results directly correlated with the intervention. There were no potential confounders identified.

The ability to use simulation training is one of the major strengths of this educational intervention. The activity was multi-faceted and allowed for application of knowledge and reinforcement of critical thinking skills, not only of oncology concepts, but also of concepts taught earlier in the curriculum such as pharmaceutical calculations, aseptic technique, and practicing errors and omissions. Students had the opportunity to work in groups, which helped to reinforce the importance of teamwork, communication, and collegiality. The patient counseling session provided students with a unique opportunity to counsel a standardized patient on her chemotherapy regimen and reinforced the importance of empathy and addressing difficult questions or concerns that may be asked by patients, such as “am I going to die?” Students appreciated receiving real-time verbal feedback on the counseling session from the standardized patient and practical pearls from the oncology pharmacist. Strategic placement of the oncology pharmacists allowed them to share their own practice experience in how to approach difficult conversations and their roles in patient education and counseling in the oncology setting. This counseling session was not formally graded due to concerns for inter-rater reliability since the oncology specialty pharmacists were not trained core faculty. The use of station specific questions, rubrics, and checklists also helped students focus on the task at hand for each station in the time allotted.

Although the study had a 100% response rate, it only included one cohort of students. In addition, the assessment questions used were not validated, which could limit the generalizability of the results. There was no formal power analysis conducted to ensure that there would be adequate power to show a difference in the pre- and post-simulation assessments. A limitation of this activity involved time constraints since students would have benefitted from having additional time to complete each task and have further opportunity for feedback. In the order verification station, only one student from each group had the opportunity to practice garbing and completing the sterile preparation of the chemotherapy order. For future offerings, it has been considered to separate this station into two to allocate more time and space for all students to practice garbing and practice preparing the chemotherapy regimen under the IV hood. However, it would require additional planning and budget considerations given the cost of additional space needed in the simulation center and cost of the aseptic garbing materials and IV bags. A video tutorial regarding order verification and aseptic technique will also be made available for future offerings.

A simulation activity such as this requires timely planning and availability of resources such as space, content experts, and additional faculty to help with facilitating and evaluating the student groups as they rotate through the different stations. Though it is appreciated that not all pharmacy programs may have availability of a simulation center or standardized patients, this activity could be modified to take place in smaller classrooms with the use of APPE students or faculty members playing the role of the patient.

Future considerations include enhancing the simulation to an interprofessional endeavor with a focus on empathy and breaking bad news with medical and nursing students. This would allow each discipline to further appreciate each other’s roles as part of the health care team and communicate and work together to provide quality care. Individual completion of the activity by each student may also help to enhance knowledge and critical thinking skills. Additionally, utilization of an electronic medical record (EMR) for the chart would also allow for a more real-life simulation experience.

CONCLUSION

The comprehensive nature of this oncology simulation activity aligns with both the ACPE Standards 2016 and the 2013 CAPE Outcomes. The activity appeared to improve students’ oncology-related knowledge through reinforcement of a multitude of concepts presented throughout the curriculum. Additionally, students reported gaining a better understanding of the role of an oncology pharmacist upon completion of this activity. Although time consuming to
plan and execute, the beneficial effects of this simulation support implementation of similar activities in other areas of the pharmacy curriculum.

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