

INSTRUCTIONAL DESIGN AND ASSESSMENT

A Solid Organ Transplant Elective Course for Pharmacy Students

Lindsay Hahn, PharmD

College of Pharmacy, Belmont University, Nashville, Tennessee

Submitted June 4, 2013; accepted July 31, 2013; published February 12, 2014.

Objective. To develop and implement a solid organ transplant elective course for second- and third-year pharmacy students, and assess its impact on students' knowledge in the management of medications, adverse effects, and complications in organ transplantation patients.

Design. Topics related to the care of solid organ transplant patients were covered in depth. Students were required to complete a group presentation focusing on common infectious disease topics encountered in solid organ transplant patients.

Assessment. Students' solid organ transplantation knowledge was assessed using examinations quizzes, a group presentation, and class participation. With an average class grade of 87%, students demonstrated knowledge of the course material. Most students felt that their knowledge increased significantly with regard to the course objectives.

Conclusion. Students who completed the elective course significantly improved their confidence and knowledge regarding solid organ transplantation, felt more prepared than their peers who did not complete the course, and became open to exploring careers or residencies in this area.

Keywords: solid organ transplant, elective course, curriculum, pharmacotherapy

INTRODUCTION

Solid organ transplantation provides a significant opportunity for pharmacist involvement in the management of drug therapy. The long-term success of solid organ transplantation depends on appropriate pharmacotherapy, strict patient adherence, and proper management of complications and adverse effects. Medication regimens used by transplant patients, such as immunosuppressants, are complicated by adverse effects and drug-drug interactions. Persistent low compliance by patients was associated with an average \$12,840 increase in their medical costs over a 3-year period, suggesting that interventions to improve strict compliance could drastically decrease healthcare costs.¹

Pharmacists are an obvious choice to address not only the issue of patient noncompliance, but the issues of drug interactions and drug-related adverse effects. The impact of pharmacist intervention can increase patient compliance in the community setting, and decrease adverse drug events and prescribing errors in the inpatient setting.^{2,3} Similar results are illustrated by pharmacists in the posttransplant setting. Chisholm and colleagues found that patients who received clinical pharmacist intervention

had a longer duration of compliance and a greater achievement of target immunosuppressive levels.⁴ Clinical pharmacists in a renal transplant clinic improved patient outcomes by assisting in medication selection and the detection of adverse drug events.⁵ In addition to the overwhelming literature supporting pharmacist involvement in organ transplant patient care, the United Network of Organ Sharing (UNOS) has recognized the importance of pharmacist involvement. In 2004, the UNOS bylaws amendment stated that "all transplant programs should identify one or more pharmacists who will be responsible for providing pharmaceutical care to solid organ transplant recipients. The clinical transplant pharmacist should be a designated member of the transplant team and will be assigned primary responsibility for providing comprehensive pharmaceutical care to transplant recipients in a culturally competent manner."^{6,7} Responsibilities of transplant pharmacists include, but are not limited to, medication therapy management, medication reconciliation, discharge counseling, protocol development and adherence, daily rounds with prospective evaluation of individual pharmacotherapy, transplant team education, cost containment, and pretransplant and posttransplant medication education.⁶

Pharmacists play an enormous role in the management of solid organ transplant patients, and because of the UNOS requirements, there has been a drastic increase in the demand for transplant pharmacists.⁶ This increase in

Corresponding Author: Lindsay Hahn, PharmD, College of Pharmacy, Belmont University, 1900 Belmont Blvd., Nashville, TN 37212. Tel: 615-460-8119. Fax: 615-460-6537. E-mail: Lindsay.hahn@belmont.edu

demand has led to a shortage of trained transplant pharmacists, causing many facilities to hire less-qualified individuals. Pharmacists gain transplant experience through completion of a postgraduate year 2 (PGY2) solid organ transplant residency accredited by the American Society of Health-System Pharmacists, of which there are only 22 residencies available.⁸ Not only is training limited in pharmacy practice, but students receive minimal exposure to the field of solid organ transplantation in doctor of pharmacy degree (PharmD) programs. This lack of exposure is mainly because of the large quantity of required topics and the limited amount of time students have in therapeutics classes. According to the 2009 American College of Clinical Pharmacy Pharmacotherapy Didactic Curriculum ToolKit, cardiac and renal transplantation are tier 3 subjects, and immunosuppressants are tier 2 subjects.⁹ Therefore, many institutions do not teach these topics in great depth.

To address gaps in both pharmacy curricula and pharmacy practice, a solid organ transplant elective course was designed at the Belmont University College of Pharmacy (BUCOP), where solid organ transplantation was being taught in the Pathophysiology and Therapeutics III course. The new elective course was developed not to replace the solid organ transplant and immunosuppressive teachings in the therapeutics classes, but to supplement and expand the students' knowledge and exposure to these topics. This elective course intended to strengthen the BUCOP pharmacy curriculum by providing students with exposure to a specialized field rich with opportunities for pharmacists. To the author's knowledge, no literature assessing the development of such a course has been published. Design of this course was also centered on the Accreditation Counsel for Pharmaceutical Education accreditation standards and the Center for the Advancement of Pharmacy Education outcomes, which emphasize the importance of patient-centered pharmaceutical care.^{10,11}

DESIGN

A solid organ transplant elective course was offered in spring 2013. The goal of this 2-hour elective course was to provide students with more advanced, comprehensive knowledge in the management of medications, adverse effects, and complications associated with solid organ transplantation. Students were expected to achieve the following course objectives: (1) understand the basic etiology, pathophysiology, and treatment of solid organ transplants; (2) develop appropriate induction, maintenance, and rejection regimens that are patient and organ specific; (3) discuss the mechanism of action, proper dosing, monitoring, adverse effects, and drug interactions of medications discussed in this course; (4) formulate

patient-specific monitoring and follow-up plans for solid organ transplant patients; (5) determine optimal therapeutic regimens to manage complications of solid organ transplants, including adverse drug reactions, opportunistic infections, and drug interactions; (6) identify relevant drug information sources for accurate, up-to-date information, and use this information in recommending therapy; (7) apply knowledge to patient cases and real world situations; and (8) describe the economic impact of solid organ transplant, including cost and institutional recourse requirements.

The topic of solid organ transplantation was taught to all third-year PharmD degree students during the Pathophysiology and Therapeutics III course. The 1.5-hour lecture only scratched the surface of this extensive topic. Completion of the Pathophysiology and Therapeutics III course was not required for students to enroll in the solid organ transplant elective course; thus allowing both second- and third-year students to enroll. There were 21 students enrolled in spring 2013.

The solid organ transplant elective course was designed by a BUCOP internal medicine faculty member with experience in heart, lung, and renal transplantation with input from other transplant pharmacists and physicians. The following topics were covered in-depth during the course: economic impact, the pharmacist's role, immunology, immunosuppression, infectious disease, long-term management of the transplant patient, and organ specific transplantations (Table 1). The topics were chosen by reviewing several solid organ transplant textbooks and by consulting with other transplant pharmacists and physicians. The consensus was that these topics would provide the students with comprehensive instruction, and an understanding of the most common solid organ transplantations and their management requirements. The elective course instruction was primarily a lecture-based format because of the large amount of content to cover in a limited amount of time. Student presentations incorporated active learning and 1 major student project focused on infectious disease. There were 9 instructor-led lectures and 4 student-led group presentations. The course was taught by the internal medicine faculty member who designed the course, a PGY2 solid organ transplant resident, and a postgraduate year 1 (PGY1) resident with experience in renal transplantation.

The student group presentations focused on infectious diseases in solid organ transplantation. The students were divided into 4 groups and assigned 1 of the following infectious disease topics commonly occurring in the transplant population: cytomegalovirus, pneumocystis pneumonia, posttransplant lymphoproliferative disorder, and histoplasmosis. Each presentation was limited to

Table 1. Solid Organ Transplant Elective Course Topics

Topic	Description
Economic Impact/ Pharmacist's Role	Economic impact of transplantation, the role of the pharmacist in the management of solid organ transplant patients
Immunology	Transplant immunology, mechanisms of allograft rejection
Immunosuppression	Induction immunosuppression, treatment of rejection
Immunosuppression	Maintenance immunosuppression
Infectious Disease	Pneumocystis pneumonia; cytomegalovirus; posttransplant lymphoproliferative disease; histoplasmosis
Long-Term Management of the Transplant Patient	Managing medication and disease related complications
Organ Specific Transplant	Kidney/pancreatic transplantation, heart/lung transplantation, liver transplantation

30 minutes with up to 10 minutes for questions. Required topics to be covered in each of the presentations are listed in Table 2. Grades were determined from a 100-point scale, with a maximum of 70 points given for completeness and accuracy of information, maximum of 15 points given for the oral presentation, and a maximum of 15 points given for the group participation grade. Each group member had to complete a peer evaluation, which was used to calculate the group participation points. (Assignment instructions and peer evaluation forms are available from the author upon request.) Presentations were graded by 2 course faculty members using a detailed grading rubric, with the average of the 2 evaluators' scores resulting in the final grade. Course instructors used class time to clarify and correct any necessary information. Course material covered in these presentations was treated the same as the material taught in class lectures, and it was included on the next examination.

EVALUATION AND ASSESSMENT

Achievement of the predominant course goal and specific course objectives was assessed using 3 examinations (20% each), 6 quizzes (20% total), the group presentations on infectious disease (10%), and class participation (10%). The group presentations on infectious disease assessed course objectives 5 and 6, and the case-based examinations and quizzes assessed the remaining objectives. The 3 examination score averages were 87%,

86%, and 91%, with the overall class average at the end of the course being 87%. The first examination covered the topics of economic impact, pharmacist's role, immunology, and immunosuppression. Examination 2 covered the topics of infectious disease, long-term management of the transplant patient, and heart transplantation. The remaining topics of lung transplantation, liver transplantation, kidney transplantation, and pancreatic transplantation were tested on examination 3. Quizzes were administered at the start of class each week and assessed the topics taught in the preceding week. The predominantly case-based examinations and quizzes were administered via traditional multiple-choice format. Class participation was assessed via mandatory class attendance, classroom attentiveness, and completion of a course evaluation at the end of the semester. Group presentations were graded as discussed in the above design section, with an average score of 88%.

Students were asked to complete a course survey instrument to assess their individual perception of solid organ transplant knowledge gained during the course, as well as their overall confidence in the field of solid organ transplant (Table 3 and Table 4). Three students did not respond to the request and did not complete the survey instrument. Results were analyzed via a paired *t* test. Students were asked to evaluate their level of knowledge relating to each of the course objectives prior to the start of the course and at the completion of the course. For all 8 course objectives, students felt that their knowledge increased significantly with all *p* values <0.001. In addition, students were asked to compare their perceived transplant knowledge to that of their classmates who did not complete the elective course and to rate their potential interest in the field of solid organ transplant after completion of the course. Finally, students ranked their knowledge and confidence in the field of solid organ transplant prior to and after the elective course. There was a significant increase in these areas (*p* <0.001). Overall, the student's

Table 2. Required Student Presentation Topics for Infectious Diseases in the Solid Organ Transplant Elective Course

Causative Organism
Risk Factors
Presentation
Diagnosis
Complications, Prophylactic Treatment
Treatment
Follow-up Recommendations

Table 3. Median Pharmacy Student Survey Responses to Achievement of Solid Organ Transplant Elective Course Objectives Before and After Course Completion^a

Solid Organ Transplant Elective Course Objectives	Prior to Elective Course (n=18)	After Completion of Elective Course (n=18)	P
Understand the basic etiology, pathophysiology, and treatment of solid organ transplants.	2.4	4.7	<0.001
Develop appropriate induction, maintenance, and rejection regimens that are patient and organ specific.	1.8	4.4	<0.001
Discuss the mechanism of action, proper dosing, monitoring, adverse effects, and drug interactions of medications discussed in this course.	2.6	4.3	<0.001
Formulate patient-specific monitoring and follow-up plans for solid organ transplant patients.	1.7	4.4	<0.001
Determine optimal therapeutic regimens to manage complications of solid organ transplants including adverse drug reactions, opportunistic infections, and drug interactions.	1.8	4.4	<0.001
Identify relevant drug information sources for accurate, up-to-date information, and utilize this information in recommending therapy.	3.1	4.4	<0.001
Apply knowledge to patient cases and real world situations.	2.3	3.9	<0.001
Describe the economic impact of solid organ transplant including cost and institutional recourse requirements.	2.2	4.4	<0.001

^a Scale: 5= strongly agree, 4= agree, 3= neutral, 2= disagree, 1= strongly disagree.

knowledge and confidence in the field of solid organ transplant improved significantly during this elective course. After completion of the course, students ranked their knowledge and confidence in the field of solid organ transplant as 7.7 on a scale of 1-10, with 1 being the lowest and 10 being the highest. Prior to the course, students mean rating of their knowledge and confidence was 2.5.

DISCUSSION

This solid organ transplant elective course sought to provide pharmacy students with more advanced comprehensive knowledge in the management of medications, adverse effects, and complications associated with solid organ transplantation. Results from the examinations, quizzes, and group presentations illustrated a solid understanding of the material taught. The average grade at the

completion of the elective course was an 87%, which is notable considering the rigorous and conceptually complex nature of the topics the elective course included. There was significant improvement in students' perceived knowledge of all of areas covered by the course objectives, as well as an increase in students' knowledge of and confidence regarding solid organ transplantation. The course aided in bridging the curricular gaps in the area of solid organ transplantation.

Results from this elective course are consistent with results from other specialty elective courses in the literature. Elliot and colleagues assessed the impact of the addition of a pregnancy and lactation elective course, as well as a pediatric elective course on improvement in student knowledge. Examination results illustrated a significant improvement in knowledge related to the elective course topics.¹² Similar benefits were also encountered with the

Table 4. Student Responses to Solid Organ Transplant Course Survey

Item ^a	Mean (n=18)
By the end of the course, my knowledge in the field of solid organ transplantation improved.	4.9
I feel that I am more prepared than other students who did not take this elective in the management of transplant pharmacotherapy.	4.9
Because of this course, I am more open to exploring pharmacy careers or residencies in the field of solid organ transplant.	4.2

^a Scale: 5= strongly agree, 4= agree, 3= neutral, 2= disagree, 1= strongly disagree.

development of other specialty courses, including oncology and toxicology.^{13,14}

The students ranked the lowest achievement score (3.9/5) for objective 7 (apply knowledge to patient cases and real world situations). This outcome was not surprising considering this course was designed primarily as a lecture-based course, thus, there was not enough time built into the schedule to allow for real-world application of material taught. In future offerings of this elective course, students will be presented with several patient cases throughout the semester, allowing them to apply the material and solve the types of complex pharmacotherapy and compliance problems routinely encountered in the clinical setting. Another area of development for this course includes the possibility of allowing students to spend a day in a transplant clinic. Belmont University is located in Nashville, TN, which is home to 2 transplant centers, one at Vanderbilt University and one at Saint Thomas West Hospital. Ideally, students would spend 1 afternoon during the last week of the course shadowing a transplant pharmacist. This idea was discussed prior to the start of the initial course offering, but could not be carried out because of time constraints.

There were few barriers to the implementation of this course. However, 1 barrier could be the lack of qualified personnel available to teach this specialty topic. This was not an issue at Belmont University, but it may be for other institutions. One possible solution is the use of adjunct professors who work in solid organ transplant settings.

SUMMARY

An elective course in solid organ transplantation was developed to increase student knowledge and exposure to an essential area of pharmacy practice. It provided students with advanced, comprehensive knowledge in the management of medications, adverse effects, and complications associated with solid organ transplantation. There was a significant improvement in pharmacy students' achievement of the elective course objectives. The solid organ transplant elective course will continue to be offered at Belmont University with improvements made to enhance student application.

REFERENCES

1. Pinsky BW, Takemoto SK, Lentine KL, Burroughs TE, Schnitzler MA, Salvalaggio PR. Transplant outcomes and economic costs associated with patient noncompliance to immunosuppression. *Am J Transplant.* 2009;9(11):2597-2606.
2. Munroe WP, Kunz K, Dalmady-Israel C, Potter L, Schonfeld WH. Economic evaluation of pharmacist involvement in disease management in a community pharmacy setting. *Clin Ther.* 1997; 19(1):113-123.
3. Leape LL, Cullen DJ, Clapp MD, et al. Pharmacist participation in physician rounds and adverse drug events in the intensive care unit. *JAMA.* 1999;281(3):267-270.
4. Chisholm MA, Mulloy LL, Jagadeesan M, DiPiro JT. Impact of clinical pharmacy services on renal transplant patients' compliance with immunosuppressive medications. *Clin Transplant.* 2001; 15(5):330-336.
5. Wang HY, Chan AF, Chen MT, Liao CH, Tian YF. Effects of pharmaceutical care intervention by clinical pharmacists in renal transplant clinics. *Transplant Proc.* 2008;40(7):2319-2323.
6. Alloway RR, Dupuis R, Gabardi S, et al. Evolution of the role of the transplant pharmacist on the multidisciplinary transplant team. *Am J Transplant.* 2011;11(8):1576-1583.
7. United Network for Organ Sharing. Designated transplant program criteria. http://www.unos.org/docs/Appendix_B_AttachI_XIII.pdf. Accessed May 1, 2013.
8. American Society of Health-Systems Pharmacists. Online residency directory. <http://accred.ashp.org/aps/pages/directory/residencyprogramDirectory.aspx?pageno=2>. Accessed May 2, 2013.
9. 2008 ACPE Educational Affairs Committee B. Pharmacotherapy didactic curriculum toolkit 2009. Available at <http://www.accp.com/docs/positions/misc/PharmacotherapyToolkit.pdf>. Accessed December 17, 2013.
10. Accreditation Council for Pharmacy Education. Accreditation standards and guidelines for the professional program in pharmacy leading to the doctor of pharmacy degree. <https://www.acpe-accredit.org/pdf/FinalS2007Guidelines2.0.pdf>. Accessed May 10, 2013.
11. American Association of Colleges of Pharmacy. Center for the Advancement of Pharmaceutical Education. <http://www.aacp.org/resources/education/cape/Open%20Access%20Documents/CAPEoutcomes2013.pdf>. Accessed December 17, 2013.
12. Elliot JP, Koerner PH, Heasley J, Kamal KM. The impact of elective active-learning courses in pregnancy/lactation and pediatric pharmacotherapy. *Am J Pharm Educ.* 2012;76(2):Article 26.
13. Brown SD, Pond BB, Creekmore KA. A case-based toxicology elective course to enhance student learning in pharmacotherapy. *Am J Pharm Educ.* 2011;75(6):Article 118.
14. Nystrom KK, Pick AM. An oncology pharmacy practice elective course for third-year pharmacy students. *Am J Pharm Educ.* 2013; 77(1):Article 12.