

## INNOVATIONS IN TEACHING

### A Pharmacotherapy Capstone Course to Target Student Learning and Programmatic Curricular Assessment

Joseph J. Saseen, PharmD,<sup>a,b</sup> Sunny A. Linnebur, PharmD,<sup>a</sup> Laura M. Borgelt, PharmD,<sup>a,b</sup>

Jennifer M. Trujillo, PharmD,<sup>a</sup> Douglas N. Fish, PharmD,<sup>a</sup> Scott W. Mueller, PharmD<sup>a</sup>

<sup>a</sup> University of Colorado Skaggs School of Pharmacy and Pharmaceutical Sciences, Anschutz Medical Campus, Aurora, Colorado

<sup>b</sup> University of Colorado School of Medicine, Anschutz Medical Campus, Aurora, Colorado

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**Objective.** To describe how a pharmacotherapy capstone course was used for student learning and programmatic curricular assessment.

**Design.** A pharmacotherapy capstone course was included in the University of Colorado curriculum for 13 years from 2002 through 2014. This 9-credit hour course was the last course prior to Advanced Pharmacy Practice Experiences (APPEs). Students were held accountable for prior learning using complex patient cases and other activities that are seen in APPEs. Application of knowledge, skills, and critical thinking were integrated in this course using exclusively active learning methodologies. Students were expected to actively participate and learn independently, from peers and through self-assessment.

**Assessment.** Evidence of student learning was demonstrated based on student performance on written and verbal evaluations analyzed from 2012 to 2014. Survey and self-evaluation data indicated that students learned within the course. Increases in student confidence in critical thinking, problem-solving, decision making, and lifelong learning were also seen during APPEs. Student performance in this course prompted changes to prerequisite courses and guided development of a renewed curriculum.

**Conclusion.** The University of Colorado pharmacotherapy capstone course prepared students for the rigor of APPEs, provided insight that facilitated improvements in prerequisite courses, and was a nexus for the development of a renewed curriculum, which includes a new clinical capstone course.

**Keywords:** capstone course, education, pharmacy, curricular assessment, curriculum

## INTRODUCTION

Capstone courses have been included in various professional curricula.<sup>1-4</sup> A key similarity among different models is to use the capstone course or learning experience to engage students in active and student-centered learning. Capstone courses within schools of pharmacy have been published in the literature.<sup>5-10</sup> Capstone courses used as culminating experiences focusing on patient care or preparation for Advanced Pharmacy Practice Experiences (APPEs) have been shown to positively impact students' confidence and knowledge, and to provide a tool for curricular assessment.<sup>5,6</sup> The pharmacotherapy capstone course at the University of Colorado Skaggs School of Pharmacy and Pharmaceutical Sciences was

designed for both of these purposes. The pharmacotherapy capstone course called Comprehensive Patient Care was designed for the school of pharmacy's first entry-level doctor of pharmacy curriculum for its class of 2003. Within this curriculum, this required 9-credit hour pharmacotherapy capstone course ran for 13 years, and was replaced by a similar course, the clinical capstone course, as a component of a renewed curriculum in 2015. This article describes the original pharmacotherapy capstone course, including data analysis from 2012 to 2014. This course was purposefully designed with a very high credit hour allocation to facilitate the intent of being a capstone course that focused on revisiting pharmacotherapy topics that were taught in preceding courses. This course was the primary course during the spring semester of the third professional year and was the last course prior to students proceeding into APPEs in the fourth year.

The overall initial intent of the course was to reinforce and apply pharmacotherapy content and topics,

**Corresponding Author:** Joseph J. Saseen, Skaggs School of Pharmacy and Pharmaceutical Sciences, University of Colorado, Anschutz Medical Campus, 12850 E. Montview Blvd., (C238), Aurora, CO 80045. Tel: 303-724-2656. E-mail: joseph.saseen@ucdenver.edu

evidence-based medicine (EBM) applications, and drug information skills that were covered in prior courses. The course was focused on comprehensive patient care using actual clinical scenarios that required students to apply and integrate previous coursework. It was designed to cultivate students' ability to apply knowledge and improve their ability to be independent. This course emphasized individual student accountability in preparation, discussion and critical application of knowledge using a student-directed learning model for evaluating and discussing clinical cases.

## DESIGN

The pharmacotherapy capstone course, conducted from 2002 through 2014, included activities for integration and application of essential knowledge, skills and abilities. The overall structure was maintained throughout all 13 years of the course's duration with some changes included along the way. This article describes the course's structure

for the final six years. This course had eight outcomes and 12 course-specific objectives (Table 1). Course outcomes were selected from our professional curriculum ability-based outcomes.<sup>11</sup> These outcomes were introduced in prerequisite courses allowing the pharmacotherapy capstone course to be a culminating experience.

Several guiding philosophies served as the foundation of the course pedagogy, and were explained to students as core principles that determined the course design and structure. The course was also a student and curricular assessment tool. Individual student performance was used to generate formative feedback and summative feedback for the students. Students received direction on how to improve immediately prior to starting APPEs. From a pedagogical perspective, overall student performance in achieving several of our curricular outcomes was useful for curriculum assessment. Prerequisite courses in preceding semesters that focused on topics included in the course were continually modified to improve student

Table 1. Structure, Principles, Outcomes, and Objectives Included in the Pharmacotherapy Capstone Course

Structure and Principles	Reintroduce therapeutic topics that have been previously taught in the curriculum using plausible, integrated, and complex patient cases; Use active learning methodologies exclusively; Provide learning experiences and evaluations that mirror real-life clinical scenario; Enable and expect students to learn independently and from peers, and to routinely self-assess performance; Expect students to conduct themselves in a professional manner, including conduct that is consistent with what is expected throughout APPEs and for a practicing pharmacist.
Curricular Outcomes	Collect appropriate patient data to make an assessment; Conduct a patient-centered assessment; Design, implement, evaluate and adjust a patient-centered pharmacy care plan; Retrieve, evaluate, and utilize basic science, professional, and lay information in a critical and scientific manner that enhances the practice of pharmacy; Exhibit the highest standards of professional and ethical behavior; Maintain professional competency and professional stewardship; Apply basic and clinical scientific principles and methods to identify and solve problems; Communicate effectively using multiple strategies to improve health outcomes.
Course Specific Objectives	Evaluate a complex patient case independently and communicate relevant findings to peers and health care providers within a clinically appropriate timeframe; Prioritize medical problems by developing problem lists; Triage patients for further work-up or medical care; Apply data gathering, problem solving and decision making skills to complex patient cases; Develop succinct and accurate recommendations for pharmacotherapy and self-care; Provide appropriate rationale for patient assessments and pharmacotherapy recommendations; Communicate necessary patient education for pharmacotherapy recommendations; Incorporate evidence from the literature into decision making about patient care; Communicate clinical information and recommendations in written and verbal formats for both health care providers and patients; Answer impromptu drug information and disease specific questions; Participate in active learning activities that involve professional/ethical issues; Integrate knowledge of pharmacotherapy, health-systems, pathophysiology, pharmacology, and other related sciences into the application of patient care.

learning. Moreover, assessment of the course was instrumental in the design of our renewed curriculum.

This 9-credit hour course occurred within the spring semester of the third professional (P3) year and was organized into three 5-week blocks. Within each block, the first four weeks included two long cases (with three discussion sessions each), two participation evaluations, two or three short cases, an EBM session, and practice evaluations. In the third block, students were required to present a patient from their introductory pharmacy practice experience (IPPE). One written evaluation and two verbal evaluations were conducted during the last week of each block. Approximately 160 students were enrolled in the course each semester and were assigned to one of 12 smaller student groups for each block. Groups changed for each block to allow students to become accustomed to working with different peers. Students met for course sessions in small groups (about 8 hours/week) and in larger combined groups (about 4 hours/week). This course did not include didactic lectures. Additional time was scheduled to complete preparatory and follow-up work for the course sessions.

The purpose of long cases was to provide students with an opportunity for longitudinal continuity of care and for them to experience ambulatory and inpatient scenarios for the same “patient” over time. Each block included two different long cases with a variety of common medical problems incorporated into three distinct case sessions per long case. For example, one long case depicted a patient who initially presented in an ambulatory setting as a patient with multiple major cardiovascular risk factors (eg, hypertension, dyslipidemia) during the first case session. In the second case session, the patient was hospitalized for an acute coronary event. In the third and final case session, the patient presented in the ambulatory setting with complications from drug therapy and new onset gouty arthritis. This long case example highlights a patient’s transition through the health care system and the progression of common medical problems. Cases were not repeated annually. They were either updated or replaced by a new case in subsequent years.

Case information was provided in the form of a medical record document. Students evaluated the patient information and completed a written worksheet that required them to synthesize a patient’s specific information and create a prioritized medical problem list. For each medium and high priority medical problem identified, students created an assessment of the condition, an assessment of the current therapy, identified reasonable therapy choices for the problem, and completed a compare-and-contrast matrix for each treatment. Students then created complete care plans for each medium and high priority

problem, which included a recommendation, rationale with supportive evidence, monitoring and appropriate patient education. This approach to evaluate patient cases was practiced in previous courses in a limited capacity and primarily for one discrete and independent medical problem. In contrast, long cases were patients with integrated complex problems commonly seen in APPE settings. Updated patient information was provided to students before each long case session, requiring them to use the above preparatory process before each long case session discussion.

After completing individual preparation, students actively engaged within an assigned small group during each 2-hour long case session (three per long case patient). Groups received instructions and were led by a facilitator to ensure discussions occurred in a systematic manner. The facilitator ensured that discussions were active and appropriate by providing direction and clear time frames for aspects of the discussion. All facilitators used the same instruction guide, but did not provide answers to students. The facilitator’s role and level of input decreased as students proceeded through the course (Table 2). By the end of the course, students had small group discussions of complex patients without direct facilitation.

There were eight short cases throughout this course. These cases were used to expose students to patients with additional integrated complex problems. Students prepared by using the same preparatory process used for long cases. There were several pedagogical differences between the long cases and short cases. During short case discussions, a faculty member led the interactive case discussion among a larger group of approximately 40-80 students. In short cases, a faculty member showed students how to evaluate a complex patient case. Short cases were an opportunity for students to self-reflect on how they might evaluate a patient case compared to a faculty member. Short cases also only depicted the patient at one point (a snapshot) in their life; there were no additional scenarios or different clinical settings discussed. However, therapeutic problems included in short cases were designed to be equally complex as long cases.

The course had three sessions on evidence-based medicine (EBM). These sessions were designed to revisit important concepts of literature evaluation and to help students appropriately apply evidence to specific patients. The first two EBM sessions were journal article reviews of a primary literature article (randomized controlled trial) that was related to topics included in the respective block. Each student reviewed and completed a summary/critique document prior to the EBM journal article session as his/her individual preparatory work. During the EBM journal article session, a faculty member led a discussion

Table 2. Description of the Facilitation Models Used in the Different Course Blocks

	<b>Facilitators</b>	<b>Role of the Facilitator</b>
Block 1 (weeks 1-5)	24 full-time clinical faculty	<p>Complete Facilitation</p> <p>Present for entire discussion and provide significant direction and clear timelines; Lead the group to discuss the case using the correct process (eg, critical and appropriate assessments are discussed, multiple treatment options are considered and debated, evidence is applied and incorporated into plans); answers not provided;</p> <p>Provide students with sufficient and apparent redirection toward correct discussions; Ensure discussions are professional and that all students are involved; Complete one participation evaluation per long case for each student.</p>
Block 2 (weeks 6-10)	24 total full-time clinical faculty, adjunct faculty, Colorado Residency Teaching Certificate Program participants	<p>Moderate Facilitation</p> <p>Present for entire discussion and provide some direction and clear timelines; Enable the group to discuss the case using the correct process and for the group to transition to discussing the case independently. Answers not provided; Provide students less redirection toward correct discussions; Complete one participation evaluation per long case for each student.</p>
Block 3 (weeks 11-15)	6 full-time clinical faculty	<p>Peripheral Facilitation</p> <p>Present only for a portion of the discussion but provide clear timelines; Allow the group to discuss the case independently using the correct process; no redirection provided.</p>

of the journal article using the same summary/critique document that students used. These sessions occurred twice, each with half of the class (80 students).

The third EBM session was called EBM Rounds. For this session, students were paired with another student and were assigned a case vignette with patient specific questions. Student pairs answered the questions collaboratively before the session using literature references as their preparatory work. During the actual EBM Rounds session, student pairs presented answers to other students within assigned groups and to a faculty facilitator.

The IPPE patient presentations provided an opportunity for students to integrate their IPPE experiences into the classroom, to critically evaluate a patient using the course processes, and to facilitate peer and faculty feedback. Students presented a patient encounter from IPPEs that occurred during the same semester. Students identified an appropriate IPPE patient case to demonstrate critical thinking, problem-solving, and decision-making skills by finding an IPPE case with medical problem requiring treatment with drug therapy that was either 1) a less common medical problem or 2) a well-known medical problem but present in the patient in a challenging way. Presentations were conducted in small groups with one faculty facilitator. Each student had 5 minutes to present an IPPE case and another 5 minutes to answer questions during a Q&A session. Students used the same format as long and short cases to prepare and present their case. They were not permitted to use handouts or slides but were encouraged to use a white board.

This was a pass-fail course with 10 graded evaluations. Students who received a passing score for eight or more of the evaluations received a final passing course grade. Students who received a passing score for five or fewer evaluations received a final failing course grade. Students who received a passing score for six or seven evaluations were required to complete a reassessment evaluation to receive a final passing course grade.

There were three written evaluations (one in each block) that received an overall pass or fail evaluation score. Each question included in the written evaluations received a pass or fail based on pre-specified criteria and students needed to pass 60% to 70% of the questions to pass the evaluations. Topics for written evaluations came from all aspects of the given block, including long and short cases and EBM sessions. Written evaluations consisted of exclusively short answer questions, including creation of assessments and/or plans, summaries of clinical evidence and focused therapeutic questions.

There were three verbal case evaluations and three verbal question evaluations (one of each in each block). Similar to the written evaluations, these received an overall pass or fail evaluation score. Each verbal case evaluation response received a pass or fail based on pre-specified criteria. The faculty determines the overall pass grade for these evaluations. For verbal question evaluations, each question received a pass or fail based on pre-specified criteria and students needed to pass 60% to 70% of the questions to receive an overall pass grade.

Both verbal evaluations per block occurred within one coordinated and simultaneous examination session that started with a 50-minute preparation period. During this preparation period, students received one of three test cases (in the same medical record format as long and short cases), a blank worksheet similar to those used in long and short cases, and a computer with access to electronic references through the university library. During this period, students individually evaluated the patient case, formulated an assessment and plan for two of the patient's high priority medical problems, and completed the worksheet.

For the verbal case examination, students presented one of the problems they prepared in 5 minutes. Presentations included an introduction, history of present illness, past medical history, current medications, drug allergies, a prioritized problem list, and a complete assessment and plan for one of the specified problems. Students presented in front of one faculty member and alongside two other students, with each student presenting a different patient case. Students were graded based on both content and communication.

For the verbal question examination, each student was asked 10 verbal questions. Four questions were related to the patient case and six were related to other topics discussed in the corresponding block. To maintain consistency, the faculty evaluator did not prompt or rephrase the questions, but repeated the question when asked. Students were graded based on content only. As with the verbal case examination, students answered questions alongside two other students, but each student was asked different questions.

To assess student participation, the faculty facilitator completed a participation assessment on each student for each of the long cases within blocks 1 and 2 (four total). These assessments collectively reflected student participation within all three of the respective long case sessions. Students were assessed on their level of engagement, quality of contributions, listening and respect for others, professionalism, attendance and self-evaluation skills. Students completed the same assessment as a self-evaluation upon completion of each of the first four long cases. Faculty and students discussed facilitator- and self-evaluations in person during a brief meeting after the conclusion of each long case. Modified participation assessments were used to assess students for the EBM Rounds session and for the IPPE patient presentation session. In total, each student had six participation evaluations completed by a facilitator throughout the pharmacotherapy capstone course: one for each of the first four long cases, one for the EBM Rounds session, and one for the IPPE Patient Presentation session. These six evaluations constituted the Overall Participation Evaluation grade. Students who passed all six of these evaluations earned a pass for the Overall Participation Evaluation.

Students who passed only six or seven of the 10 course evaluations were required to pass the reassessment evaluation to earn an overall course grade of pass and proceed to APPEs. Reassessment evaluations were conducted during finals week of the spring semester, after completion of the block 3 evaluations. The structure of reassessment evaluations was similar to the verbal case and verbal questions evaluations. However, the reassessment examination was considered one total examination for reassessment purposes. Topics for the content of this reassessment examination were individualized for each student and selected based on each student's demonstrated subject matter deficiencies in the course.

## EVALUATION AND ASSESSMENT

Evidence of student learning within the pharmacotherapy capstone course was assessed and demonstrated in multiple ways based on data from the 2012, 2013 and 2014 academic years. Overall course grades consistently demonstrated success in all three blocks. The majority of students (86%) received a passing grade in at least eight of the 10 evaluations, and passed the course without the need for a reassessment examination (Figure 1). Since inception, approximately 15% of students annually required completion of the reassessment examination, though this decreased to 9% in 2014. The majority of students passed this reassessment examination; with a range of zero to three students per year failing the reassessment examination. Only three students failed the course without the option of a reassessment examination in the 2012 and 2013 years combined, and none in 2014.

Written and verbal evaluations were analyzed and the data demonstrated that students learned from this course. Improvement and stabilization of passing grades on these evaluations were seen throughout the course from block 1 through block 3. This showed evidence of learning. The mean percentage of questions answered correctly on the written examination questions increased from block 1 to block 3 (Figure 2). Improvement in student performance was seen with a progressive decrease in facilitation from block 1 to block 3. This indicated that students were learning and gaining independence in critical thinking abilities, preparing complete and accurate assessments and plans, and applying evidence. Evidence from verbal question evaluations also indicated stability in student performance over time (Figure 3). Students consistently responded correctly to high-level questions requiring them to critically think and apply evidence and knowledge to a patient case, rationalize the treatment plan, and compare and contrast treatment options. An examination passing grade was typically set at 60% to 70% (ie, passing 6 or 7 of 10 verbal questions) and

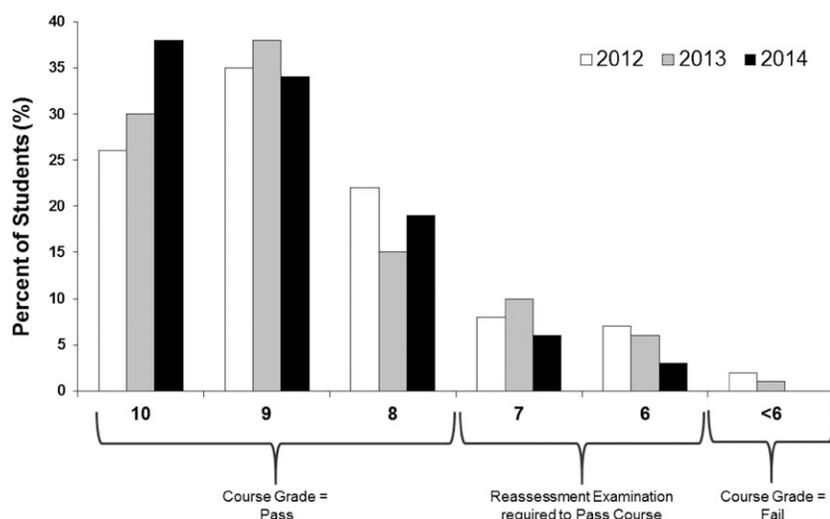


Figure 1. Number of Passing Scores for Evaluations (out of 10 Total)

although the content changed, students performed at this level consistently in each semester. Students also practiced using verbal communication skills, which allowed them to quickly and appropriately respond to high-level questions simulating those commonly encountered during APPEs. Scores for verbal case evaluations were stable over the different blocks, with only slight variations in passing scores (Figure 4).

Most students performed well in block 1, partially due to the material presented in the long cases coming from common ambulatory disorders (eg, hypertension, dyslipidemia), where students may have more familiarity. Moving to blocks 2 and 3, some students struggled with

more challenging problems (eg, atrial fibrillation, acute pain, inpatient hyperglycemia, critically ill patient cases); pass rates for the verbal case evaluations fluctuated more than in block 1. The stabilization in pass rate on the verbal case evaluations came with less facilitation, indicating the students were able to successfully adjust to learning and applying information independently over the course of the semester.

Evidence for improved student learning and effectiveness came directly from the self-evaluations describing their perceptions about long case discussions. Students commented on how they highly valued the pharmacotherapy capstone course and the different learning

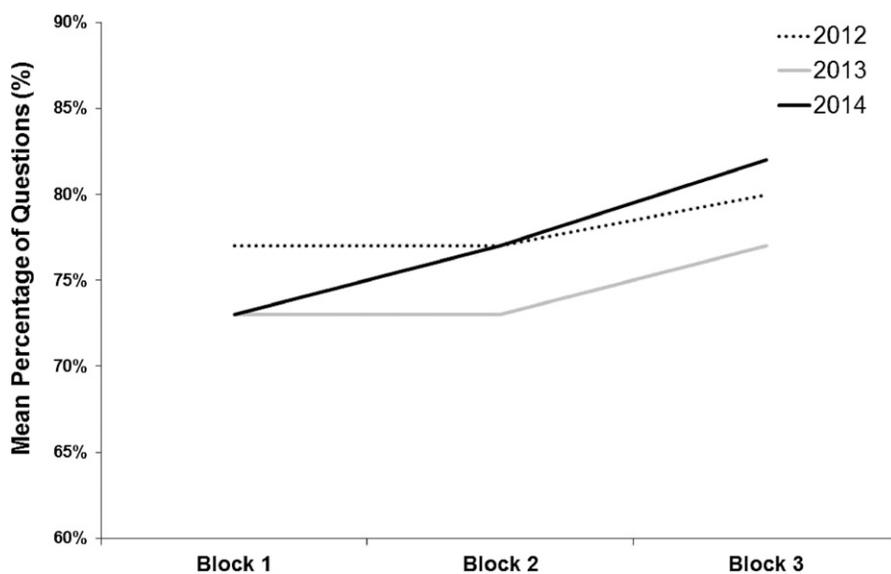


Figure 2. Written Examination Questions Answered Correctly

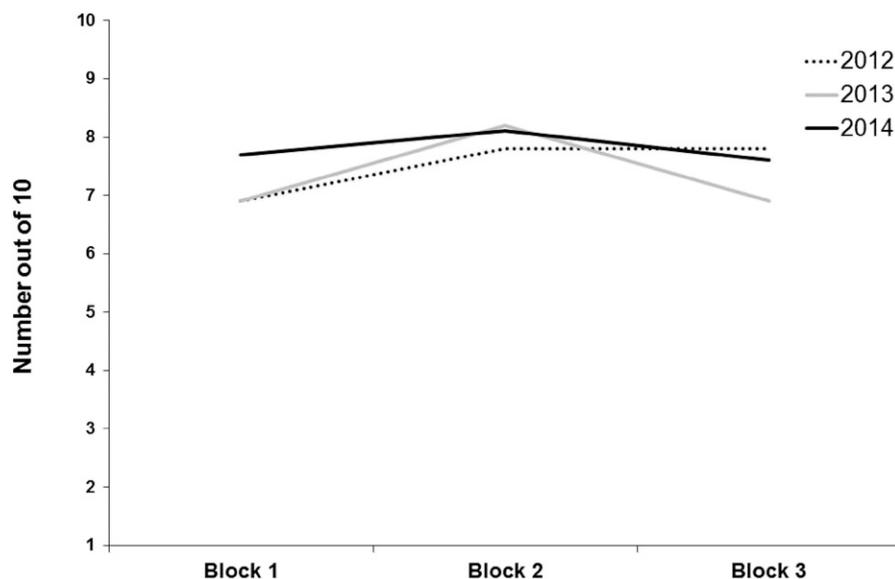


Figure 3. Mean Number of Verbal Evaluation Questions Answered Correctly

methods incorporated throughout. End-of-course student evaluations were consistently positive regarding the learning strategies and effectiveness (Table 3). The majority of students evaluated course learning strategies or materials with a 4 or 5 out of 5 points on the Likert scale. Although the pharmacotherapy capstone course was the first (and last) for the students to completely focus on self-directed and active learning strategies, both were rated highly. Importantly, 97% of students agreed that this course was relevant to the practice of pharmacy by rating this question with a 4 or 5, the highest ranking for all questions. Some students (nine in 2013, 11 in 2014) were

not required to complete course evaluations because they were appointed members of the class student focus group and gave real-time feedback mid-semester. Feedback from the focus groups expressed an even higher level of appreciation for the learning strategies and materials than indicated in annual course evaluations. Consistently, students provided written feedback that they felt the pharmacotherapy capstone course was the most valuable course in the curriculum. They also identified that this course was very challenging.

During the fourth professional year, after completion of five APPEs, students from 2013 were surveyed

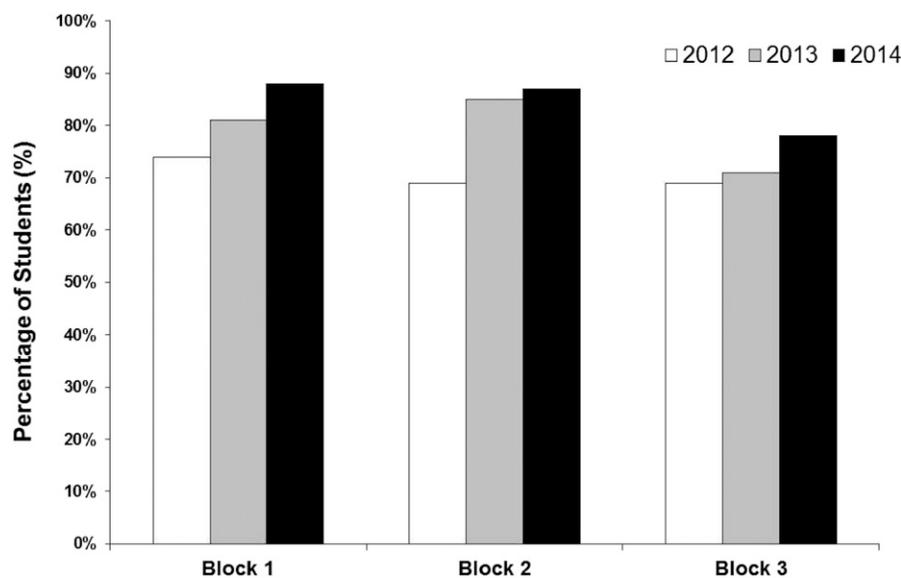


Figure 4. Verbal Case Evaluations Receiving a Passing Score

Table 3. Student Attitudes and Beliefs Regarding the Pharmacotherapy Capstone Course from End of Course Evaluations

Question	Response (mean value) <sup>a</sup>	
	2013 (n=146/155) <sup>b</sup>	2014 (n=146/157) <sup>b</sup>
The course was designed in a manner to meet course outcomes.	4.6	4.4
Self-directed learning strategies (pre-readings, self-study modules, etc.) helped to meet course outcomes.	4.5	4.4
Active learning strategies (non-lecture related) used in the classroom helped to meet course outcomes.	4.5	4.3
Practice activities helped to meet course outcomes.	4.4	4.2
A variety of learning strategies were offered to stimulate my learning.	4.3	4.2
This course complemented what I learned in other courses.	4.6	4.4
This course was made relevant to the practice of pharmacy.	4.7	4.5
Assessments and evaluations provided sufficient feedback to improve future performance.	4.3	4.2
Assessments and evaluation tools (eg, rubrics) used in the course accurately reflected my performance.	4.3	4.2

<sup>a</sup>Likert scale: 1=Never, 2=Some of the time, 3=Half of the time, 4=Most of the time, 5=Always

<sup>b</sup>Response rates were 100% but excluded nine students in 2013 and 11 students in 2014 who were not required to complete evaluations because they were appointed to the student focus group and provided input there

regarding the effect the pharmacotherapy capstone course had on their confidence in their ability to critically think, problem-solve, make decisions, and pursue lifelong learning (Table 4). Most students strongly agreed or agreed that they were more confident in their abilities after completing the course.

Faculty perceptions of the pharmacotherapy capstone course were positive. There were 27 full-time faculty members involved in this course at any level. These faculty members completed a survey regarding perceptions (Table 5). Mean responses to all questions were at 4.0 or above on a 5-point Likert scale. This faculty survey also identified areas within the curriculum where faculty members felt student performance in the pharmacotherapy capstone course prompted changes to prerequisite courses. Changes were made in several professional skills development courses, along with didactic pharmacotherapy courses. Faculty members also believed that insight from the pharmacotherapy capstone course helped guide the development of a renewed curriculum at the University of Colorado, which was implemented in 2012. They

also believed that this course was the most important and valuable course prior to APPEs that ensure student learning. Specific comments described how multiple faculty members worked diligently to introduce the pharmacotherapy capstone course methodology and learning strategies earlier in the renewed curriculum to help students be more successful and prepared for the P3 year and beyond.

## DISCUSSION

The University of Colorado pharmacotherapy capstone course was comprehensive. The course structure used a multipronged approach of holding students accountable for prior learning by reintroducing previously taught topics and requiring them to apply knowledge using plausible, integrated, and complex simulated patient cases. This course focused on further developing student abilities and expected students who had learning deficits to self-evaluate and further develop their knowledge and competencies required for APPE rotations and eventual professional practice. By providing learning experiences (including evaluations) that mirrored real-life clinical

Table 4. Student Attitudes and Beliefs Regarding the Pharmacotherapy Capstone Course as P4 Students After Completion of Five APPEs for Students Who Completed the Course in 2013 (n=152 of 157<sup>a</sup>)

After completing the Pharmacotherapy Capstone Course. . .	Response (mean value) <sup>b</sup>
I am more confident in my ability to critically think	4.3
I am more confident in my ability to problem-solve	4.3
I am more confident in my ability to make decisions	4.3
I am more confident in my ability to pursue lifelong learning	4.2

<sup>a</sup>97% response rate

<sup>b</sup>Likert Scale: 1=Never, 2=Some of the time, 3=Half of the time, 4=Most of the time, 5=Always

Table 5. Faculty Perceptions of the Pharmacotherapy Capstone Course in 2013 (n=26 of 27<sup>a</sup>)

<b>The Pharmacotherapy Capstone course</b>	<b>Response (mean value)<sup>b</sup></b>
Provides learning experiences and evaluations that mirror real-life clinical scenarios (eg, cases, application of evidence, patient presentations)	4.6
Uses active learning methodologies exclusively	4.0
Reintroduces therapeutic topics that have been previously taught in the curriculum using plausible, integrated, and complex patient cases	4.7
Does <u>not</u> introduce new therapeutic topics	4.1
Requires that student conduct and performance are consistent with what is expected throughout P4 APPE rotations and that of a practicing pharmacist	4.1
Provides evidence/data to assess global student performance related to pharmacotherapy prior to APPEs	4.4
Provides evidence/data that is/was used to modify preceding courses in the old/current curriculum	4.3

<sup>a</sup>96% response rate

<sup>b</sup>Likert Scale: 1=Strongly disagree, 2=Disagree, 3=Neither agree nor disagree, 4=Agree, 5=Strongly agree,

scenarios and activities found in clinical settings, and expecting students to learn independently and from peers, we prepared students for APPEs in a comprehensive and effective manner. The philosophies of this course were consistent with all four of the Accreditation Council for Pharmacy Education (ACPE) categories of standards for Doctor of Pharmacy degree programs, especially standard 3 (approach to practice and care).<sup>12</sup> Moreover, the course helped targeted problem solving, which is included in domain 3 of the Center for Advancement of Pharmacy Education 2013 Educational Outcomes.<sup>13</sup>

Students learn and improve their critical thinking skills with courses that include explicit and focused education targeting these skills.<sup>14,15</sup> Five basic approaches to decision-making and problem-solving approaches in pharmacy education have been identified: clinical, ethical, managerial, economic, and legal.<sup>15</sup> The clinical approach was one focus of the pharmacotherapy capstone course, but ethical and economic approaches were also included. Our course structure was challenging for some students, appropriate with a 9-credit hour course. For example, based on feedback from student focus groups, students who preferred traditional lecture-based courses were not always comfortable with our active learning model, and this has been documented in other schools using flipped classroom models for pharmacotherapy content.<sup>16</sup>

The term “capstone course” has been used within educational programs for decades. The traditional use of a capstone course in higher education is a seminar course or culminating educational experience that requires completion of a project. There are several publications describing different capstone courses in pharmacy curriculum.<sup>5-10</sup> While most of these capstone courses had a very specific focus (eg, research, documentation), two had a more broad

clinical focus, similar to our course.<sup>5,6</sup> Lee and colleagues focused on advanced patient care skills and demonstrated improvements in several measures of effectiveness.<sup>5</sup> However, their course was not intended to be used as a curriculum assessment tool. Hirsh and colleagues provided a comprehensive capstone course with the primary purpose to better prepare students for APPEs.<sup>6</sup> This 4-credit hour, case-based course was successful as a curricular assessment tool. However, it was primarily instructor-directed with faculty presenting topics. This is different from our student-directed model. To the best of our knowledge, no other pharmacy school has a capstone course comparable to our pharmacotherapy capstone course, with a dual purpose of student development and curricular assessment.

Most schools of pharmacy utilize curriculum assessment plans to provide a structured method of monitoring and delivering continuous quality improvement within their programs.<sup>17,18</sup> Schools of pharmacy have successfully evaluated ability-based curricula using performance-based assessments that are included across several courses.<sup>19</sup> Our pharmacotherapy capstone course was unique because it provided an opportunity for curricular assessment of pharmacotherapy within one ideally placed course. The design of our pharmacotherapy capstone course enabled collective assessments of all students’ performance that, in part, reflected prior learning. Therefore, the pedagogy of this course afforded the opportunity to use the pharmacotherapy capstone course as a programmatic curricular assessment tool and identify overall strengths and weaknesses of prerequisite courses. Course directors were chairs of both the school’s curriculum committee and assessment committee. Therefore, findings from the pharmacotherapy capstone course were shared with both of these committees on an ongoing basis. This facilitated continuous improvement of prerequisite

courses. By modifying learning strategies and adding components to courses that were mostly in the second (P2) and third (P3) professional year fall semesters, this approach allowed us to increase student preparedness for the pharmacotherapy capstone course. These changes included the following:

**Andragogical changes** - Modifications to pharmacotherapy courses in the P2 fall, P2 spring and P3 fall semesters were implemented to ease the transition of students from dependent to independent and self-directed learners. The changes were also intended to introduce more immediate application of knowledge and skills so that students were more patient-centered, consistent with the pharmacotherapy capstone course expectations. Active learning exercises (think-pair share, flipped classrooms) were added to the traditional didactic pharmacotherapy courses.

**Instructional changes** - The systematic approach to evaluating patient cases and the emphasis of applying knowledge and using clinical evidence to justify recommendations was first introduced in the pharmacotherapy capstone course in 2002. After the first year, it was clear that these instructional components needed to be introduced in prerequisite courses to better prepare students for the pharmacotherapy capstone course. From 2004 to 2009, several activities were introduced into three course series (ie, professional skills development, therapeutics, and drug information) as a result of this capstone course. Examples included increased utilization of patient cases, literature identification activities, and exercises that required application of clinical guideline recommendations.

**Evaluations** - Evaluations in the pharmacotherapy capstone course were drastically different than the traditional multiple-choice questions used in prerequisite courses. Therefore, the P2 fall, P2 spring and P3 fall professional skills development course series changed to an assessment structure that eliminated multiple choice questions and relied exclusively on short answer questions, patient counselling exercises and verbal evaluations. Also, prerequisite pharmacotherapy courses were changed from being 100% multiple choice questions to including 20% to 25% short answer questions.

The renewed curriculum at the University of Colorado began with the class of 2016 and was designed with seven visions in mind. Four of these visions (outcome driven, assessment driven, student directed learning methodologies, and integration of experiential training) were included because of the success of our pharmacotherapy capstone course. The renewed curriculum is organized using an escalated model that incrementally and optimally fosters learning. Influence of this pharmacotherapy capstone course is seen in several new courses. A patient-centered

communication series of two courses occurs in the first professional (P1) year. These courses are primarily responsible for the curricular outcome of “communicate effectively using multiple strategies to improve health outcomes” and “collect appropriate patient data to make an assessment.” The pharmacotherapy capstone course identified that students’ ability to communicate effectively needed more focused direction and attention earlier in the curriculum.

The pharmacotherapy series in the renewed curriculum consists of 10 courses, two self-care courses in the P1 fall and P1 spring semesters, seven pharmacotherapy courses in the P1 spring through P3 fall semesters, and one clinical capstone course in the P3 spring semester. These pharmacotherapy courses are responsible for the curricular outcomes of “conduct a patient-centered assessment” and “design, implement, evaluate and adjust a patient-centered pharmacy care plan” – the same outcomes that were in the pharmacotherapy capstone course. Active learning strategies and traditional didactic lectures are primary learning strategies within these prerequisite pharmacotherapy courses. This is in contrast to the previous curriculum where didactic lectures were used in the pharmacotherapy courses and active learning strategies were used in the professional skills development courses. Importantly, case discussions are core components and use the pharmacotherapy capstone course long case structure. Pharmacotherapy course assessments have purposeful escalation. Assessments incrementally transition throughout the curriculum from mostly traditional multiple-choice questions with fewer performance-based questions (short answer, verbal cases, verbal questions, clinical skill demonstration) in the P1 year to where most evaluations are performance-based questions in the P3 year.

The pharmacotherapy capstone course was the first course at the University of Colorado to integrate IPPE experiences with another course. This integration with IPPE patient presentations was successful and allowed students to apply the process used in the pharmacotherapy capstone course. It provided an opportunity for students to practice this skill in a clinical environment. This success provided justification for the new model of IPPE in the renewed curriculum where required IPPE activities are now determined by courses occurring in the same semester. The concept enacted here was conceived in the pharmacotherapy capstone course; what students learn within other courses is practiced and further developed in IPPE sites concurrently to capitalize on the IPPE component of our program.

Students entered the pharmacotherapy capstone course with different baseline abilities to clinically apply knowledge. Faculty observed that students with the most robust prior clinical experiences typically performed

better in the pharmacotherapy capstone course. As a result, in the renewed curriculum, all students have a full-time six week IPPE course (called the Advanced IPPE) prior to the renewed clinical capstone course. The Advanced IPPE course takes place in a patient care clinical site during the first six weeks of the P3 spring semester and is a standardized way to provide a foundational clinical experience to allow all students to perform at a very high level in the new clinical capstone course.

There is a new 6-credit hour clinical capstone course over the last nine weeks of the P3 spring semester in the renewed curriculum. Instead of running over a full 15-week semester, it is conducted over the last nine weeks of this semester and immediately follows the Advanced IPPE. It is an evolved version of the pharmacotherapy capstone course described in this article. However, the same guiding philosophies are maintained in the course structure consisting of two blocks in contrast to the three that are described in this pharmacotherapy capstone course. The preceding pharmacotherapy and communication courses, along with the Advanced IPPE in the renewed curriculum provide the framework to prepare students for the expectations of the clinical capstone course in the renewed curriculum. This renewed framework also allows for expanded IPPE experiences.

Course directors have conducted scholarly evaluations of this pharmacotherapy capstone course.<sup>20,21</sup> These scholarly evaluations have been done to provide data that we have used to modify our current curriculum and develop our renewed curriculum. We evaluated student performance on assessments from long case discussion sessions (student-directed) compared with short case discussion sessions (instructor-directed). We concluded that students learned comparably from both case formats and justified our capstone model.<sup>20</sup> We have also compared student self-assessments during long cases to faculty assessments and demonstrated overall correlation. These data are useful in rationalizing expanded use of student self-assessments.<sup>21</sup>

The pharmacotherapy capstone course at the University of Colorado is generalizable and could be implemented in other pharmacy programs. Strategic placement just prior to APPEs would be essential to achieve the intended purpose of this course to prepare students for advanced clinical experiences. Moreover, full clinical faculty engagement with the contribution of several clinical faculty members facilitated our success and would be needed in other programs. Facilitation could be augmented by pharmacy residents and voluntary faculty, but would need to be directed by full-time faculty members to ensure alignment with student capabilities and program needs. Our course was built to be a 9-credit

course. Other programs could successfully implement a similar capstone course if provided similar resources. The amount of resources needed was directly associated with the number of students, so smaller pharmacy programs may need fewer resources. It is possible that other programs could use a smaller credit hour allocation. However, adaptations of our comprehensive and integrated model would likely still require a large credit hour allocation (ie, minimum of five credit hours) to maintain the germane guiding philosophies. Our pharmacotherapy capstone course model required the use of several different style classrooms and educational technologies, including a robust learning management system. On the Anschutz Medical Campus, we infrequently utilized large 200-seat classrooms for this course. Most often, our needs were met by small (10-16 seat) multipurpose classrooms for long case discussions and medium (60-75 seat) classrooms for short case discussions. Additionally, a mixture of the Pharmaceutical Care Learning Center (with approximately 80 computers linked to the Health Sciences Center Library) and small multipurpose classrooms were used for verbal evaluations.

The implementation of this pharmacotherapy capstone course and its evaluation had several limitations. This was a 9-credit hour course that was graded on a pass/fail scale. The high credit hour allocation required a large devotion of faculty time for implementation and organization. Six faculty members shared course-directing responsibilities, which may be considered excessive. Moreover, the number of other faculty involved in the numerous case discussions and other active learning sessions might be considered excessive by some programs. Due to the pass/fail style of grading, there was more negative impact on grade point average for students who performed poorly and failed the course than positive impact for students who excelled. The evaluation conducted to assess the performance of this course was limited to performance within course grades and survey data assessing perceptions. Though we gathered data from both students and faculty, our methodology cannot directly link the pharmacotherapy capstone course to student performance or competency on APPEs. Lastly, curriculum from other accredited schools of pharmacy were not assessed, so it was difficult to make robust comparisons of our course to other capstone courses used in pharmacy education.

## SUMMARY

Our pharmacotherapy capstone course had spanned 13 years, achieved overall success, and had several innovative components. Student and faculty perceptions indicated this was the most valuable course in the

curriculum despite it being very challenging. Moreover, we demonstrated the ability to maintain the course structure while providing insight on student performance as a culminating experience. Our pharmacotherapy capstone course was innovative from three perspectives: overall course structure, use as a curriculum assessment tool, and influencing curriculum renewal. This was a demanding course to deliver from a workload perspective, but was appropriate with a 9-credit hour course that was also used for curricular assessment purposes. This course aligned with a changing culture of how students learn by using self-directed and independent learning strategies, and it has contributed to the overall effectiveness of our curriculum.

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