

RESEARCH ARTICLE

A capstone clinical case examination as an assessment of student readiness for ambulatory care advanced pharmacy practice experiences

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Abstract

Background: A clinical case exam (CCE) is given to third-year pharmacy students prior to embarking on fourth-year Advanced Pharmacy Practice Experiences (APPEs). This study assessed the efficacy of the CCE as a measure of students' readiness for ambulatory care APPEs. **Methods:** This retrospective study examined the correlation between students' CCE scores and their ambulatory care APPE evaluation scores across four cohorts (Classes of 2018-2021). Students take a capstone course in their final didactic semester that includes a CCE focused on common APPE encounters, followed by an ambulatory care APPE during one of seven rotation blocks. Pearson's correlation coefficients were calculated to evaluate the relationship between CCE scores and APPE performance, along with subgroup analyses for each cohort and rotation block. **Results:** A total of 295 students were included. Student CCE scores were positively correlated with ambulatory care APPE scores ($r = 0.5180$, $p < 0.001$). Positive correlations were observed for each cohort and for students with ambulatory care APPEs in the first five rotation blocks, while nonsignificant correlations were found for the last two rotation blocks. **Conclusion:** There was a positive correlation between CCE scores and ambulatory care APPE performance, but it was not significant for students near the end of their APPE year. CCEs can effectively measure readiness for ambulatory care APPEs.

Introduction

Pharmacy educators are tasked with ensuring each student pharmacist is adequately trained and competent to provide patient-centred care upon graduation, an attribute referred to by pharmacy educators as being "practice-ready". There are many aspects in the Doctor of Pharmacy (Pharm.D.) curriculum that prepare students for the end goal of being practice-ready, one of which is the experiential education component, inclusive of Introductory Pharmacy Practice Experiential (IPPE) and Advanced Pharmacy Practice Experiential (APPE) rotations. The Accreditation Council for Pharmacy Education (ACPE) provides guidance to pharmacy schools on the various aspects of providing a Pharm.D. education. One of the standards (Standard 12) is focused on the Pre-APPE curriculum, inclusive of all didactic instruction and IPPE

rotations, which should prepare students to be "APPE-ready" prior to the last year of the curriculum (Accreditation Council for Pharmacy Education, 2015). This means that students should demonstrate competence in various areas, including the foundational knowledge, skills, and attitudes needed to succeed in APPE rotations. Although ACPE provides this guidance for all colleges and schools of pharmacy, there is no singular way to meet these standards. All colleges are tasked with ensuring that their students are APPE-ready prior to the last year of the curriculum, but how a college specifically assesses APPE-readiness can vary (VanLangen *et al.*, 2020).

At this college of pharmacy, a capstone course entitled "Applied Pharmaceutical Care (APC)" is placed in the last didactic semester in the third-year (P3) of the Pharm.D. curriculum, with the purpose of ensuring that students are "APPE-ready" before entering their

fourth-year (P4) APPE rotations. The capstone course is intended to serve as a comprehensive course that assesses the student's competency in the primary areas of the first three years of the curriculum. The benefits of utilising a capstone course in the didactic curriculum to improve and assess students' APPE-readiness have been previously discussed (Guirguis et al., 2020; Minshew et al., 2020; Beatty et al., 2024). Through this course, students must demonstrate clinical competence in the four areas of ambulatory care, acute medicine, community pharmacy, and drug information. Each area includes various activities such as quizzes, case discussions, and presentations, ultimately ending with a Clinical Case Examination (CCE). Each CCE involves students reviewing a patient case and assessing the case to present to a pharmacy practice faculty member. Each CCE is structured to mimic what might be expected of students during an APPE rotation in that particular area, so each CCE is structured differently. Students must achieve a passing score of 70% on each CCE to be deemed APPE-ready and advance to P4 APPE rotations. APPE rotations at this institution are six weeks in duration, and each student must complete six rotations in seven different rotation time blocks, with one off-block. Students are assessed by the primary preceptor on APPE rotations using a standardised rubric, but the overall rotation is a non-graded, credit/no-credit structure. Although the rotation is credit/no-credit, the rubric is helpful in providing students with more meaningful formal feedback on various areas of their performance on the rotation.

This study aims to evaluate the potential use of the ambulatory care CCE as a measure of third-year students' readiness for fourth-year ambulatory care APPE rotations, as assessed by the correlation between CCE scores and APPE evaluation scores. The ambulatory care CCE was specifically selected as it was the first CCE created in this course and has been the most consistent, whereas other areas (i.e. acute medicine, community pharmacy, etc.) have varied over the years due to changes in instructional faculty and workloads. The objective of this study was to identify if the ambulatory care CCE was an effective measure of ambulatory care APPE readiness, with intent of adding to the existing literature that discusses ways of assessing APPE readiness.

Methods

The APC capstone course is a three-credit course that was restructured to the current model in the Spring 2017 semester. The ambulatory care section of the

course consists of three 3-hour class sessions, held once weekly and taught by a single faculty member with expertise in ambulatory care. The section starts with an overview of the ambulatory care field of pharmacy. Although ambulatory care is a broad field of pharmacy and pharmacists in this field must understand many different conditions, the section of this course focused on the most common conditions encountered in general ambulatory care practices, including hypertension, diabetes, dyslipidemia, heart failure, thromboembolic disorders, chronic obstructive pulmonary disease, and asthma. Each of these topics is initially taught in the second-year therapeutics course series. During the APC class sessions, students are provided with various comprehensive practice patient cases revolving around these conditions. Students utilise the class time to assess the comprehensive practice cases, working individually and in small groups. Students assess the cases using the Pharmacists Patient Care Process framework that is taught and reinforced throughout the curriculum and are expected to present their findings in Subjective, Objective, Assessment, and Plan (SOAP) format (Joint Commission of Pharmacy Practitioners, 2014). Although these common disease topics have been previously taught in the curriculum, these practice cases are comprehensive and incorporate many aspects of the conditions into the case. After assessing the case, students then debrief with the faculty member in classroom discussion. While these are debriefed as a whole class, the faculty member was always available to debrief further with students individually or in small groups after class as needed. In addition to the in-class practice cases, students are also given quizzes and homework case assignments. All the activities in the first 3 weeks lead to the ambulatory care CCE.

The ambulatory care CCE is an individual exam structured to include a formal written "assessment and plan" chart note and a verbal SOAP case presentation. The "assessment and plan" chart note mimics what clinicians would be expected to write in the electronic medical record after a patient visit, which includes the patient-specific assessment of the conditions, interpretation of findings, and plan for implementation and follow-up. The faculty member creates six different cases each year to be used to ensure students are not able to communicate details about the cases to each other. The cases were also reviewed by additional faculty with expertise in ambulatory care pharmacy prior to implementation of the CCE. The cases were created to be at a difficulty level that the faculty believed an entry-level APPE student should be able to manage effectively. Each student receives a patient case that is inclusive of 2

uncontrolled chronic disease states from the previously listed 7 topics. Each patient case has multiple other comorbidities, but the student is assigned to assess two specific chronic diseases per case. These cases include the usual findings clinicians encounter in an electronic medical record in an outpatient clinic, such as past medical histories, laboratory values, and vitals. Additionally, a short description of the patient interview for the visit is provided, including relevant and irrelevant information for the case. Some examples of information included in the patient interview section are the patient’s description of their medication adherence, how they explain their diet and exercise routines, and what the patient did over the weekend. This section was added in writing to replace the need for having a simulated patient actor. The student has up to 45 minutes to review the case and complete the official assessment, and plan written documentation. During this time, students could use online drug information resources but were prohibited from using any form of communication, including shared online documents. After the 45 minutes, students were

moved into faculty offices in groups of 3, with each student having a different case. Groups of 3 students per faculty office were decided simply due to logistics in order to execute the CCE for the class size of 70-85 students with only 7 faculty graders. Figure 1 provides an outline of the CCE schedule. In the faculty office, each student had 10 minutes to present their SOAP to the group individually. The faculty member then graded the verbal SOAP presentation. All CCEs are graded on a standardised rubric, and all faculty are provided with a detailed answer key for each portion of the SOAP presentation. Students are evaluated primarily on the pharmacotherapy aspects of their SOAP presentation, but verbal and non-verbal communication skills are also included on the rubric. The assessment and plan written documentation was graded by the lead faculty member afterwards. The schedule was created to accommodate up to 84 students with only seven faculty graders and can be adapted based on student and faculty needs. The students' scores on the written (60 points) and verbal rubrics (65 points) were added to represent the total exam score (115 points).

Time	1:00	1:05	1:10	1:15	1:20	1:25	1:30	1:35	1:40	1:45	1:50	1:55	2:00	2:05	2:10	2:15	2:20	2:25	2:30	2:35	2:40	2:45	2:50	2:55	3:00	3:05	3:10	3:15	3:20	3:25	3:30	3:35	3:40	3:45	3:50	3:55	4:00									
Session 1 (Students #1-21)	Case Work-Up & Documentation (21 Students in Classroom 1)									Transition	Verbal SOAP (3 students per faculty office, Cases 1, 2, & 3)																																			
Session 2 (Students #22-42)										Case Work-Up & Documentation (21 Students in Classroom 2)						Transition	Verbal SOAP (3 students per faculty office, Cases 1, 2, & 3)																													
Session 3 (Students #43-63)																Case Work-Up & Documentation (21 Students in Classroom 1)						Transition	Verbal SOAP (3 students per faculty office, Cases 4, 5, & 6)																							
Session 4 (Students #64-84)																						Case Work-Up & Documentation (21 Students in Classroom 2)						Transition	Verbal SOAP (3 students per faculty office, Cases 4, 5, & 6)																	

Figure 1: Clinical case examination schedule

The fourth-year curriculum involves six 6-week APPE rotations, which include one mandatory rotation in an ambulatory care setting. Students may opt to take additional elective rotations in the area of ambulatory care but must complete their mandatory ambulatory care rotation prior to these electives. There are seven APPE rotation blocks, with APPE Block 1 starting in May immediately after the P3 spring semester and ending with APPE Block 7 the following March prior to graduation. While APPE rotations are designated as “credit/no-credit” courses and do not carry a traditional grade, each student is assessed by their

preceptor using this individual college’s standardised evaluation form. Students receive informal feedback throughout the rotation from preceptors but also receive the standardised evaluation form at the midpoint and the end of the rotation. The evaluation rubric includes six subsections: (1) Professionalism, Attitude & Behaviour, Ethics & Responsibilities; (2) Communication Abilities; (3) Drug Information & Literature Research; (4) Health & Wellness; (5) Clinical Application; and (6) Medication Use Process. There are multiple topics within each of the six areas that preceptors evaluate the student on. There are four

options for preceptors to rate students for each topic: excellent, average/satisfactory, below average/needs improvement, or unsatisfactory/remediation required. Each of these four ratings correlates to a score of 100%, 75%, 50%, and 25%, respectively. Scores of each of the six areas are averaged, resulting in a final evaluation score. The students can view their scores and feedback for each item on the rubric, subsections, and final evaluation score, though the final transcript lists “credit” or “no-credit”.

This study was approved by the University’s Institutional Review Board and involved a retrospective analysis of performance of all students from the Classes of 2018, 2019, 2020, and 2021. Student performance data that was analysed included the students’ scores on the ambulatory care CCE and the evaluation form scores of their APPE ambulatory care rotation. This data was retrospectively retrieved from the college’s online learning management systems and de-identified and coded for analysis. If a student completed additional elective APPE ambulatory care rotations, only the score from the first APPE ambulatory care rotation was used. The primary outcome was the correlation between individual students’ P3 APC ambulatory care CCE scores and P4 mandatory ambulatory care APPE evaluation scores. Secondary analyses aimed to assess the correlation based on student cohorts, the timing of the students’ APPE rotation block, and the use of faculty vs non-faculty preceptors. Lastly, the correlation between CCE scores and each subarea of the APPE evaluation rubric was assessed. The secondary analyses were chosen to assess further if there were any variances in the applicability of the CCE as an APPE-readiness assessment for these sub-groups.

Statistical analysis was conducted using STATA V15 (College Station, TX) (Snedecor & Cochran, 1989). To examine the relationship between matched student scores on the P3 APC ambulatory care CCE and their

performance on subsequent P4 APPE ambulatory care rotations, Pearson’s correlation coefficients were calculated. Statistical significance was defined as a p -value of < 0.05 .

Results

A total of 308 students completed the P3 year APC ambulatory care clinical case exam over the 4 year study period and advanced to APPE rotations. Upon data analysis, a total of 13 students had an incomplete APPE evaluation rubric by their preceptor, leading to a total of 295 students being included in the analysis. Over the 4 years, the total average APC ambulatory care CCE score was 83.5%, and the total average APPE ambulatory care evaluation score was 87.4%. Average scores per year were consistent between the 4 years.

For the primary outcome, there was a statistically significant correlation between a student’s ambulatory care CCE score and their APPE rotation evaluation score ($r = 0.5180$, $p < 0.001$). A significant correlation was also found for each cohort year, as noted in Table I. When assessed by timing of the APPE rotation, a significant correlation was found during the first five rotation blocks (APPE rotations from May through December). However, for the last two rotation blocks (APPE rotations in January through March), the correlation was non-significant. Table II depicts the correlation scores for each APPE rotation block. A sub-analysis was conducted for students who were precepted by a faculty member for their APPE ambulatory care rotation as well as for students who a non-faculty preceptor precepted, and significant correlations were found for both subgroups (Table III). Lastly, significant correlations were found between CCE scores and each of the six subsections of the APPE evaluation rubric (Table IV).

Table I: Correlation between ambulatory care Clinical Case Exam (CCE) and Advanced Pharmacy Practice Experiences (APPE) evaluation scores - By cohort year

Cohort year	Pearson’s correlation coefficient (r)	P-value
2018 (N=74)	0.4430	$p < 0.001$
2019 (N=74)	0.4238	$p < 0.001$
2020 (N=67)	0.6157	$p < 0.001$
2021 (N=80)	0.6727	$p < 0.001$
Total (N=295)	0.5180	$p < 0.001$

Table II: Correlation between ambulatory care Clinical Case Exam (CCE) and Advanced Pharmacy Practice Experiences (APPE) evaluation scores - Total (primary outcome) and by APPE block (secondary outcomes)

	Pearson's correlation coefficient (r)	P-value
Total (N = 295)	0.5180	$p < 0.001$
Block 1, May-June (N = 59)	0.4800	$p < 0.001$
Block 2, July-Aug. (N = 67)	0.5407	$p < 0.001$
Block 3, Aug.-Sept. (N = 45)	0.6441	$p < 0.001$
Block 4, Sept.-Nov. (N = 26)	0.6477	$p < 0.001$
Block 5, Nov.-Dec. (N = 33)	0.5756	$p < 0.001$
Block 6, Jan.-Feb. (N = 36)	0.2312	$p = 0.175$
Block 7, Feb.-March (N = 29)	0.1906	$p = 0.3221$

Table III: Non faculty & faculty preceptors

	Pearson's correlation coefficient (r)	P-value
Total (N = 295)	0.5180	$p < 0.001$
Faculty preceptors (N = 185)	0.5122	$p < 0.001$
Non-faculty preceptors (N = 110)	0.5087	$p < 0.001$

Table IV: Correlation between Ambulatory Care Clinical Case Exam (CCE) Score & Ambulatory Care Advanced Pharmacy Practice Experiences (APPE) Eval Subsection-Scores

APPE evaluation subsection	Pearson's correlation coefficient (r)	P-value
Professionalism, attitude & behaviour, ethics & responsibility	0.4602	$p < 0.001$
General communication	0.4918	$p < 0.001$
Drug Information & literature research	0.4424	$p < 0.001$
Health & wellness	0.4926	$p < 0.001$
Clinical application	0.4279	$p < 0.001$
Medication use process/pharmacy operations	0.3580	$p < 0.001$

Discussion

The results of this study demonstrated that the APC ambulatory care CCE has a significant correlation with APPE ambulatory care evaluation scores, leading to the conclusion that this CCE can serve as an effective predictor of the degree of student's ambulatory care APPE readiness. This may be largely because the exam was created with the intention of mimicking cases commonly encountered during an APPE rotation. Many pharmacy programmes have incorporated case-based examinations throughout the Pharm.D. curriculum, as well as in other healthcare education programmes (Gillette *et al.*, 2017; Terry *et al.*, 2017; Croft *et al.*, 2019; Curtis *et al.*, 2019). The utilisation of clinical case exams has the benefit of simulating the healthcare environment while still being able to control and tailor the environment to best suit the goals of the assessment.

The structure of case-based examinations can vary and include different components.

This study adds to the evidence supporting utilising clinical case exams as a method for assessing student readiness prior to embarking on experiential rotations. Literature review found three additional studies that aimed to study the correlation between clinical case exams and APPE performance (Mészáros *et al.*, 2009; McLaughlin *et al.*, 2015; Frankart *et al.*, 2022). One study assessed the use of a three-part exam: a closed-book exam, an open-book exam, and an objective structured clinical exam. The study reported a strong correlation between performance on this exam and general APPE performance ($r = 0.60$) (Mészáros *et al.*, 2009). These results are similar to the findings being presented in the current study. The second study found only a weak correlation between a third-year objective structured clinical examination (OSCE) and APPE ambulatory care

rotation performance ($r = 0.25$) (McLaughlin *et al.*, 2015). This study used an OSCE, while the current study utilised a clinical case exam. One factor to consider is that each institution may format a case exam very differently, which may be a reason why results in published studies vary. OSCEs typically include standardised patients and an assessment of patient communication skills, while the CCE does not include any patient communication assessment. The third study utilised “*Rx Reviews*,” which was a classroom-based activity in which students reviewed electronic medical records in a manner that simulated pre-rounding in ambulatory care and acute medicine settings. The study reported that student performance on these reviews was correlated with performance on ambulatory care and acute medicine APPE rotations (Frankart *et al.*, 2022). In addition to these studies, there are also many other studies published regarding assessing the APPE-readiness of students as this is an important area in pharmacy education. One study assessed multiple models for predictors of APPE readiness and found that primarily knowledge-based measures showed modest correlation with APPE midpoint scores (Nyman *et al.*, 2020). Another study aimed to identify predictors of APPE readiness and identified that overall poor academic performance and unprofessional behaviour on IPPEs were associated with APPE failure or poor performance (Call *et al.*, 2020). Both of these studies demonstrated that a knowledge assessment correlates with students’ APPE performance, similar to the finding in the current study that CCE performance correlated with students’ performance on APPE ambulatory care rotations. Aside from studies aiming to identify predictors of APPE readiness, another study at another institution reported that students found a capstone course beneficial in aiding APPE preparation (Hirsch & Parihar, 2014).

During the secondary analysis on this study, no significant correlation was found for students who completed APPE rotations in the last two blocks. A proposed reason as to why these blocks did not find significant correlation is that there was a larger amount of time between the student taking the clinical case exam in their third-year spring semester and completing their APPE ambulatory care rotation towards the end of their fourth year (roughly 10-12 months). As students progress through their APPE year, they would have likely learned more through their previous APPE rotations and have grown significantly since completing their exam. Because of this, the third-year exam score may not be an accurate predictor of the students’ APPE readiness towards the end of their APPE year.

Overall, these findings indicate that the APC ambulatory care clinical case exam is an appropriate and effective tool to measure a third-year student’s degree of readiness to complete APPE ambulatory care rotations.

A strength of this study was that a total of 4 years of student data was assessed. Over the 4 years, the clinical case exam structure and preparation have remained consistent and have been deemed based on student performance and student and faculty feedback. Students also frequently report in their APPE year that the APC clinical case exam was a helpful aide in preparing them for their APPE rotations. Although this feedback is anecdotal and cannot be quantified, it has been received from students in verbal comments to faculty preceptors and in writing on post-rotation reflection questions.

The APPE preceptor evaluation tool was used as it is believed that the APPE preceptor has the most accurate assessment of the students’ performance, as they are an expert in this specific field of pharmacy and had spent a significant amount of time with their students during the six-week APPE rotation. A published study that surveyed schools and colleges of pharmacy reported that using preceptor evaluations was the most common method used for validating APPE readiness (VanLangen *et al.*, 2020). Additionally, as noted in Table IV, it was found that the students’ CCE scores carried significant correlations to each of the six subsections. This was an interesting finding, as the CCE was not designed to measure students’ performance on each of the six subsections of the APPE evaluation. Most notably, the CCE does not assess students in the areas of health and wellness or in medication use process/pharmacy operations. A proposed reason for this finding is that preceptors may tend to evaluate students more broadly, and students’ performance in more commonly assessed areas, such as clinical application or communication, may carry over into the other subsections. Additionally, it may be possible that students who performed well on the CCE were overall more prepared in other aspects of pharmacy.

While this study assessed the use of the CCE as a predictor or assessor of APPE-readiness, these findings suggest that the CCE may have the potential to serve as a tool to identify students who need additional assistance or practice prior to APPE rotations. The minimum passing score for the CCE was set at 70%, as this has been the standard pass point in most courses in the curriculum at this institution. If the CCE were to be used to identify students who need additional attention prior to APPE rotations, the minimum passing score or another cut point would need to be decided upon to identify students who are deemed APPE ready but may benefit from additional practice.

There are notable limitations to this study that should be addressed. Each year, the faculty creates six different cases. When creating multiple cases for the same exam, the faculty member needs to ensure that each case is similar in difficulty level. Having the variety of cases

provides the students with a more realistic experience, as they are not told exactly what their case will encompass, just as would happen in an ambulatory care clinic. While this was an appropriate utilisation of the rubric score, there are some limitations to using this score. The college has held preceptor development sessions and worked with preceptors on how to utilise the APPE evaluation rubric appropriately, but it is highly possible that each preceptor may have different expectations and standards for their rotation. This inter-rater reliability could not be assessed, so it must be noted that this could be a potential confounding variable. However, it was found that the group of students precepted by a faculty preceptor had a similarly strong, significant correlation as students who were precepted by a non-faculty preceptor.

There are many ideas to improve upon this APC course to incorporate additional ways to improve and assess students' readiness for APPE rotations. This clinical case exam includes a patient case on paper and does not include a patient actor or experiential component. This was decided upon as the logistics of including an actor or completing this at a rotation site for all students would not be feasible. Studies published by other programmes have reported on utilising patient actors in their clinical exams or OSCE's, or in having students assessed in a specific IPPE programme (Ragan *et al.*, 2013; Gilliam *et al.*, 2017). The college plans to reassess this and revisit the idea of incorporating this element into a future curriculum. Another area of interest in improving the APC process is the incorporation of Entrustable Professional Activities (EPA's) in the assessment (Haines *et al.*, 2016). Other colleges have reported utilising the EPA's in capstone courses (VanLangen *et al.*, 2019). The college is assessing ways to incorporate assessing students on EPA's both in the APC didactic course and on APPE rotations in the future.

Conclusion

Based on the findings of this study, an ambulatory care clinical case exam in the third-year of the Pharm.D. curriculum was found to be an effective measure of the level of a student's readiness for early APPE ambulatory care rotations. The CCE can be used to ensure students are prepared and competent prior to embarking on APPE ambulatory care rotations. Further studies may be conducted to assess the CCE's effectiveness at measuring APPE-readiness in other practice areas, as well as the use of a CCE to identify students who need additional preparation prior to APPE rotation.

Conflict of interest

The authors declare no conflict of interest.

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