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INSTRUCTIONAL DESIGN AND ASSESSMENT

Interactive Web-based Learning Modules Prior to General Medicine Advanced Pharmacy Practice Experiences

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Objective. To implement and evaluate interactive web-based learning modules prior to advanced pharmacy practice experiences (APPEs) on inpatient general medicine.

Design. Three clinical web-based learning modules were developed for use prior to APPEs in 4 health care systems. The aim of the interactive modules was to strengthen baseline clinical knowledge before the APPE to enable the application of learned material through the delivery of patient care.

Assessment. For the primary endpoint, postassessment scores increased overall and for each individual module compared to preassessment scores. Postassessment scores were similar among the health care systems. The survey demonstrated positive student perceptions of this learning experience.

Conclusion. Prior to inpatient general medicine APPEs, web-based learning enabled the standardization and assessment of baseline student knowledge across 4 health care systems.

Keywords: web-based learning, active learning, experiential education

INTRODUCTION

Advanced pharmacy practice experiences are designed to provide opportunities for practical application of material learned during the preAPPE phase of the curriculum. To take advantage of the limited time on any given experience, preparation prior to and outside of APPE hours is often necessary and expected. Current Accreditation Council for Pharmacy Education (ACPE) Standards mandate a total of 1440 experiential hours be completed during the APPE year, with at least 400 hours within a hospital or other health care system.^{1,2} This causes APPE durations to vary, compelling creative time management on the part of both preceptor and student to accomplish assigned learning objectives. An additional challenge may arise when precepting multiple students who have varying comprehension of pertinent disease states. Although the ACPE Standards highlight the importance of student knowledge for common disease states, varied student comprehension may require more review of basic material to get students on the same

page.^{1,2} Appropriately preparing students to interpret patient information and to synthesize therapeutic recommendations align with the Center for the Advancement of Pharmacy Education's (CAPE) Educational Outcomes for the provision of patient-centered care (2.1) and problem solving (3.1).³ Methods to secure similar student baseline knowledge may allow for advanced discussion and experiences, thus leading to a higher level of comprehension and potentially enhancing patient care delivery.

Student preparation for commonly encountered clinical situations is essential for the delivery of patient care. However, the specific elements of patient care depend on the specific clinical site. Disease states that students are prepared for is left open to interpretation by ACPE Standards and likely vary among APPE practice sites as a function of the type of clinical practice. Government agencies may help guide clinical practice and reimbursement based on what is considered commonly encountered situations, such as use of venous thromboembolism prophylaxis in hospitalized surgical patients, as specified by The Joint Commission.⁴ Institutional scope of practice can also facilitate scenarios frequently encountered by pharmacists and students, including management and adjustment of antibiotics or anticoagulants. Lastly, specific acute and chronic disease states are often reasons for hospital

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admission. The Healthcare Cost and Utilization Project reported on the most frequent conditions requiring hospitalization in 2011, highlighting pneumonia among the most common reason for hospitalization.⁵

To maximize efficiency in pharmacy education, while simultaneously providing an appropriate student experience, faculty and nonfaculty preceptors must employ creative teaching methods. This can include the use of different levels of learners, team-based precepting, and outside preparation.⁶⁻¹² Use of web-based learning is one mechanism available to standardize knowledge of key clinical disease states across multiple learning experiences. Web-based learning also provides the ability to assess knowledge prior to the APPE. The objective of this study was to implement a web-based learning module series and evaluate its ability to enhance baseline knowledge of commonly encountered disease states in APPEs on inpatient general medicine across 4 different health care systems.

DESIGN

Three clinical web-based learning modules were developed for use prior to inpatient general medicine APPEs. Experiential general medicine faculty members at Butler University College of Pharmacy and Health Sciences provided feedback on commonly encountered disease states at their practice site. Based on this feedback, therapeutic topics selected for the modules were inpatient anticoagulation, pneumonia, and antibiotic pharmacokinetics and pharmacodynamics. The web-based learning modules and assessment were developed by a second-year postgraduate pharmacy resident and reviewed by an inpatient faculty member serving as the content expert. Additionally, the content was made available to all experiential general medicine faculty preceptors for review.

The web-based learning modules were developed as PowerPoint slides and recorded as a synchronized narrative audio through Panopto (Panopto Inc., Pittsburgh, PA). The didactic component of the modules was delivered via video. Modules were designed so students would view 5 to 9 minutes of didactic instruction followed by interactive patient cases to enable application of learned material. Students were provided individualized feedback during the interactive cases with explanations of correct and incorrect answers. After completing the interactive patient case, students advanced to the next segment of educational video, and the cycle continued with alternating audiovisual instruction and interactive patient cases. Each clinical web-based learning module was 15 to 20 minutes in length and contained 3 to 4 instructional videos along with 2 to 3 patient case assessments.

Separate from the patient cases within the modules, a preassessment and postassessment were developed and were composed of 15 identical multiple-choice questions, 5 questions from each clinical module topic. The questions focused on patient cases and aimed at a higher learning level using Bloom's Taxonomy.¹³

In addition to the clinical web-based learning modules, an orientation module was developed for each of the 4 APPE health care systems. Content included information on parking, directions to the pharmacy, drug information resources, and pertinent system policies and procedures. The orientation module was developed and recorded by pharmacy residents at each health care system.

Eligible study participants included all fourth-year professional pharmacy students enrolled in an inpatient general medicine APPE facilitated by a Butler University faculty member from July 2013 through April 2014. Figure 1 illustrates the study timeline. Students were contacted for voluntary study enrollment 10 days prior to the APPE. After providing informed consent, students completed the preassessment and then began participating in the web-based learning modules. After completing all modules, students completed the postassessment. The learning management system Moodle (Moodle Pty Ltd., Perth, Australia) was used to facilitate the informed consent, web-based learning modules, and assessment questions. Students were asked to complete all components by day 2 of the APPE so the clinical experience would not impact performance on the assessments. Students were excluded if they had participated in the web-based learning modules in a previous APPE or did not complete all study components by the requested time, with the exception of the perception survey.

Students were asked to complete the perception survey at the conclusion of the APPE to determine the utility of the modules and the impact on student learning experiences. The perception survey asked for students' level of agreement, using a 4-point Likert scale (strongly agree, agree, disagree, strongly disagree), on 15 items regarding navigation, interactivity, content, and applicability of web-based learning. The perception survey was e-mailed to students during the final week of the APPE and completed anonymously through SurveyMonkey (SurveyMonkey Inc., Palo Alto, CA). The study was deemed exempt by the Butler University Institutional Review Board.

EVALUATION AND ASSESSMENT

The primary endpoint of this study was the change in preassessment and postassessment scores for each individual web-based learning module and for the combined

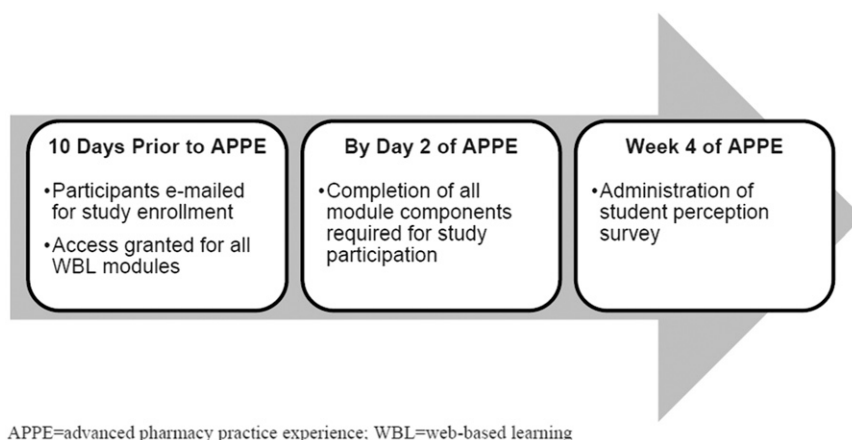


Figure 1. Study Timeline

score of all 3 modules. Secondary endpoints included assessment scores in relation to academic year, postassessment scores by health care system, and the perception survey. The primary endpoint was analyzed via a paired *t* test or a Wilcoxon signed rank sum as appropriate. The comparison of assessment scores for the first part of the academic year (July through December) vs the second part (January through April) were analyzed with a Mann-Whitney U test. Postassessment scores by health care system were evaluated using the Kruskal-Wallis test. The student perception survey results were reported utilizing descriptive statistics. Statistical analysis was performed using SPSS v21 (SPSS Inc., Chicago, IL) with significance defined as $p < 0.05$.

Between July 2013 through April 2014, 58 students were eligible for the study. This represents 54% of the

2014 graduating pharmacy class. Eighteen students were excluded for the following reasons: 3 never logged into the web-based learning website, 5 only completed the preassessment, 8 completed the preassessment and viewed some of the modules, and 2 finished all study components but not within the requested time. The remaining 40 students (69%) completed all study components on time and were included in the analysis. Participants were located at 4 different health care systems within the metropolitan area. Average student time commitment for the study was 2.6 hours. Students spent 1.4 hours viewing the web-based learning modules and the remaining 1.3 hours participating in interactive patient cases and assessments.

Preassessment and postassessment scores for the individual and combined modules are shown in Figure 2.

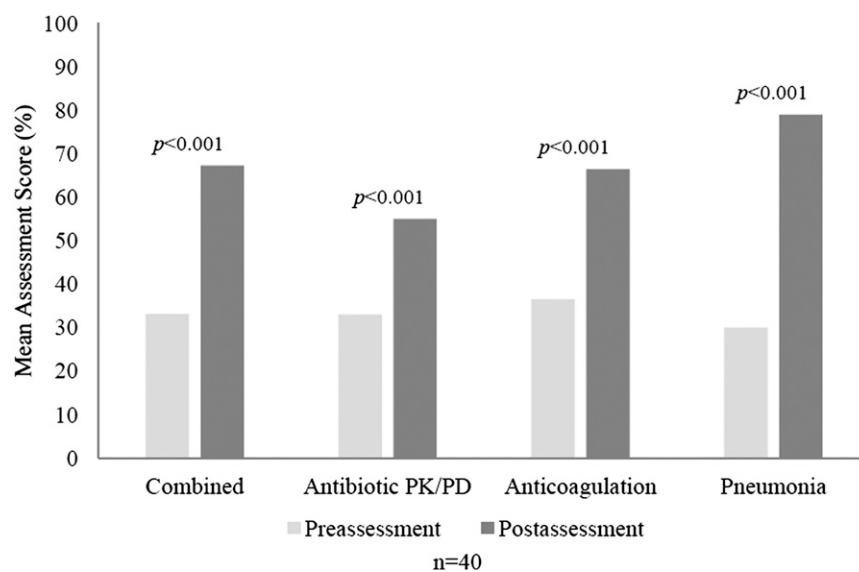


Figure 2. Preassessment and Postassessment Scores

Table 1. Assessment Scores in Relation to Academic Year

Assessment	First: Jul-Dec (n=24)	Second: Jan-Apr (n=16)	<i>p</i> value
Preassessment, % (SD)	30.3 (13.1)	38.3 (15.4)	0.073
Postassessment, % (SD)	63.6 (12.0)	71.7 (12.8)	0.056

For the primary endpoint, there was a significant improvement in postassessment scores overall and for each individual module. There was no difference in the preassessment or postassessment scores in the first half of the academic year compared to the second half (Table 1). The analysis by health care system is displayed in Table 2. The similar postassessment scores demonstrate a standardized baseline for all participants on topics covered within the web-based learning modules at the 4 health care systems ($p=0.67$).

The student perception survey results are displayed in Table 3. Of the 40 student participants, 36 responded to the survey (90%). Overall, students reported high rates of agreement with most survey items, finding participation in the web-based learning modules to be a positive learning experience. From the survey items on application, the students were able to utilize material from the modules and apply it directly to patient care throughout the APPE.

DISCUSSION

The ACPE Standards state pharmacy practice experiences should allow students to integrate and further advance the knowledge and skills developed in the curriculum.^{1,2} In clinical settings, students must be able to build on previously learned information and synthesize patient-specific therapeutic recommendations. A pilot study of our research demonstrated use of web-based learning modules in an inpatient general medicine APPE at one health care system.⁷ Student knowledge was enhanced through the use of web-based learning, with significant improvement in postintervention scores with 2 of 3 modules. The pilot analysis demonstrated the potential use of web-based learning in preparing students to apply and synthesize knowledge in the clinical setting. However, further investigation was necessary to delineate the efficacy of web-based learning for general medicine APPEs at multiple health care systems.

Providing experiences with comparable learning opportunities throughout diverse practice sites can be difficult. Web-based learning offers the possibility of standardizing learning opportunities across different health care systems, ensuring consistent educational outcomes. This consistency aligns with current ACPE Standards, which state that educational activities and expectations must be comparable regardless of the health care system.^{1,2} Ruehter and colleagues implemented web-based learning modules in introductory pharmacy practice experiences (IPPEs) at many sites.⁸ After utilizing the web-based learning modules, students' postintervention scores showed significant improvement in clinical knowledge, skill application, and confidence for the IPPE. Similar to results of our study, students in the Ruehter et al study reported positive perceptions of this educational intervention in preparing them for the clinical experiences.

To date, our analysis is the first to demonstrate positive outcomes with web-based learning use for APPEs at multiple health care systems.⁹⁻¹¹ Web-based learning reinforced and enhanced therapeutic knowledge prior to general medicine APPEs at 4 health care systems. Student postassessment scores were comparable among systems, demonstrating similar baseline knowledge on the selected topics prior to the APPE. The modules were able to not only increase students' knowledge and confidence, but also standardize preAPPE learning opportunities and baseline knowledge for students at different health care systems.

The ACPE Standards also emphasize that students must demonstrate APPE competencies through reliable and validated assessments.^{1,2} Web-based learning allows preceptors to reinforce therapeutic principles and assess student knowledge prior to APPEs. Allowing students to demonstrate competencies prior to the APPE should enable higher-level thinking in discussions with preceptors during the APPE and ultimately enhanced

Table 2. Postassessment Scores by Health Care System

Health Care System (# beds)	No. Faculty Preceptors	No. Student Participants	Postassessment % (SD)	<i>p</i> value
System 1 (800)	5	22	65.4 (11.5)	0.67
System 2 (900)	1	8	65.0 (11.5)	
System 3 (300)	1	7	72.4 (14.0)	
System 4 (325)	1	3	68.9 (19.1)	

Table 3. Student Perception of Web-based Learning Survey Results

Survey Statement	% Agree/Strongly Agree (n=36)
Navigation and Interaction	
The modules were easy to navigate	97
The display of information was appealing	97
The method of instruction was stimulating and informational	92
I enjoyed the interactive patient cases	92
Content	
Knowledge from the modules was applied during the APPE	100
The orientation module was useful	78
The modules enhanced my understanding of disease state concepts	100
Modules	
The PK/PD module improved my delivery of patient care	89
The pneumonia module improved my delivery of patient care	100
The anticoagulation module improved my delivery of patient care	100
Application	
The WBL modules enhanced my level comfort during the APPE	92
The WBL modules supplemented the APPE	97
The WBL modules should be utilized for future general medicine APPE	97
The WBL modules should be created for use before every APPE	73
Summary	
Overall, WBL was a positive learning experience	97

WBL = web-based learning

ability to apply learned material in the delivery of patient-centered care.

Vyas and colleagues evaluated standardized patient simulation cases to assess student competencies prior to beginning APPEs.¹² The results illustrated web-based learning improved assessment scores and better prepared students to perform technical skills. The authors concluded that web-based learning was able to teach and assess 10 of the 11 preAPPE core domains. While our study did not release assessment scores to preceptors, the web-based learning assessments and tools from this study could be beneficial instruments to assess readiness for APPEs. In other words, knowing students have participated in web-based learning prior to practice experience and being able to access results of built-in assessments promotes student accountability of material and enables preceptors to tailor instruction based on the students' clinical strengths and weaknesses.

In terms of study limitations, student performance on the preassessment and postassessment may reflect strategic memorization. To combat this potential limitation, neither the questions nor the answers for either assessment were provided to the students at any point in the study. In addition, student participation was voluntary, resulting in a participation rate of 69% and a sample size of 40. Another limitation was the inability to assess faculty perceptions of this learning experience. Because many faculty preceptors were active contributors to the development and review of the web-based learning modules, to avoid introducing bias,

they were not surveyed on their perceptions of the modules and student performance. In the future, preceptors using the web-based learning modules may be surveyed regarding module impact on student performance.

This study demonstrates the benefits of web-based learning in preparing students for inpatient general medicine APPEs across different health care systems. Web-based learning enhanced student knowledge and confidence prior to the practice experience to improve overall student performance. The postassessment scores were similar at health care systems exhibiting comparable baseline knowledge for the selected topics among students before the APPE. Additionally, the web-based learning assessments employed in this study could be used by preceptors to measure student preparation and baseline knowledge prior to APPEs.

CONCLUSION

The use of web-based learning prior to inpatient general medicine APPEs improves baseline knowledge in all disease state modules among students across 4 health care systems. Students report positive perceptions of the learning method.

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