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CLINICAL INVESTIGATION

Assessment of Web-Based Training Modules on Learning Facilitation for Advanced Pharmacy Practice Experiences in Pediatrics

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OBJECTIVES To assess the effectiveness of web-based training (WBT) modules to enhance and facilitate student pharmacists' learning and their ability to provide pharmaceutical care to children during a pediatric advanced pharmacy practice experience (APPE).

METHODS Pediatric-specific WBT modules were developed for completion by APPE students during a 4-week rotation. Pediatric modules covered developmental pharmacology; antimicrobial use and monitoring; fluids, electrolytes, and dehydration; and drug information. Students were responsible for completing all modules within the first week of the APPE. Preassessments and postassessments consisted of 8 to 10 multiple-choice questions, with scores ranging from 0 to 100 points. Data were analyzed using descriptive statistics and paired *t* tests.

RESULTS Statistically significant improvements in postassessment scores were achieved for 3 of the 4 modules. Significant improvements were not observed in the antimicrobial use and monitoring module. Most student pharmacists either somewhat or strongly agreed that the modules improved their understanding of pharmaceutical care for children.

CONCLUSIONS WBT modules, taken during an APPE rotation, may expand and improve student pharmacists' understanding of pharmaceutical care in pediatric patients.

INDEX TERMS education, experiential education, pediatrics, pharmacy, students, Web-based training

ABBREVIATIONS APPE, advanced pharmacy practice experience; WBT, web-based training

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INTRODUCTION

In 2008, children comprised approximately one quarter of the US population, and 13% of them received a medication taken on a regular basis for a duration of at least 3 months.[1,2] All pharmacists should have a baseline understanding of the unique physiology and of the organ and system ontogeny that occur across the pediatric continuum, and how these affect medication safety and effectiveness in pediatric patients of all ages. These differences place this patient population at increased risk for medication errors and adverse drug effects.[3] Despite these factors, the doctor of pharmacy curricula generally devote minimal hours to the diseases that occur and the drug therapies used in the pediatric population.[4] In 1999, Low et al.[4] surveyed the 55 entry-level doctor of pharmacy programs in the United States. Of the 37 programs that responded, the mean ± SD number of hours devoted to specific pediatric topics was 16.7 ± 11.6 (range, 2.8-52.8 hours). Only 18% of programs offered an elective course in pediatric pharmacotherapy.[4]

In a 2005 opinion paper, the American College of Clinical Pharmacy Pediatric Practice and Re-

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search Network stated that the ideal pediatric curriculum within an entry-level doctor of pharmacy program should consist of 25 to 30 hours of didactic instruction in pediatric-specific topics, the availability of an elective course in pediatric pharmacotherapy, and one required advanced pharmacy practice experience (APPE) in pediatrics that is "facilitated by a pediatric specialist."[5] In light of these recommendations, many doctor of pharmacy programs likely fall short in their efforts to adequately educate graduates in basic knowledge and understanding in the pharmaceutical care of the pediatric patient. Two entry-level doctor of pharmacy programs are accredited in the state of Indiana. Like many schools or colleges of pharmacy, neither program meets the recommendations of the pediatric practice and research network of the American College of Clinical Pharmacy. Purdue University College of Pharmacy and Butler University College of Pharmacy & Health Sciences offer 14 and 9 hours of pediatric didactic instruction in the core curriculum, respectively. Both schools offer didactic sessions on introduction to pediatric practice, developmental pharmacology, and pediatric fluid and electrolyte therapy. Neither school offers a pediatric-specific drug information lecture in the core curriculum. A pediatric-specific pharmacokinetics lecture (focusing on vancomycin and aminoglycosides) is not provided at Purdue University, but it is at Butler University. Each program offers a 3–credit-hour pediatric pharmacotherapy elective, which includes additional pediatric topics not addressed in the core curriculum. Both colleges offer an elective APPE rotation with a pediatric specialist. However, completion of the pediatric pharmacotherapy elective is not a prerequisite to taking the pediatric elective APPE rotation. Faculty from these two colleges who are specialists in pediatrics developed pediatric-specific web-based training (WBT) modules to help facilitate student learning during a pediatric APPE at a single experiential education site.

The objective of this collaborative effort was to assess the effectiveness of WBT modules in enhancing and facilitating the ability of student pharmacists to learn and provide pharmaceutical care to children during a pediatric APPE.

METHODS

Four pediatric-specific WBT modules along with preassessments and postassessments were developed by the pediatric pharmacy faculty members responsible for both didactic and experiential pediatric education at Purdue University and Butler University. These modules reinforced and/or supplemented pediatric-focused material that was included in didactic pharmacy curriculum. Preassessments and postassessments were also developed by faculty members responsible for both didactic and experiential pediatric education at Purdue University and Butler University.

The 4 WBT modules focused on developmental pharmacology; antimicrobial use and monitoring (with a focus on vancomycin and aminoglycoside dosing and monitoring); fluids, electrolytes, and dehydration; and drug information. Each was intended to refresh and/or supplement concepts taught in the didactic portion of professional curriculum at the respective institutions. Although one additional module was also available as a refresher for basic pediatric information, no assessment was done. All students assigned to the respective faculty members' APPEs during the 2009–2010 academic year completed the WBT modules within the first 5 days of the rotation. Students were required to complete preassessments and postassessments for each module, and were scored on a scale of 0 to 100. The preassessments and postassessments contained the same questions. Each assessment had 10 multiple-choice questions, with the exception of fluid, electrolytes, and dehydration, which had 8 multiple-choice questions. Students received a score upon completion of each preassessment but did not receive feedback on the correct answers to the questions until the postassessment. Order of completion and time between assessment completion and review of the module material were not prescribed, thus students could have completed postassessments immediately following or some time after viewing the WBT module. Web-based modules and assessments were administered via each university's web-based learning management system (i.e., Blackboard Learning System, Blackboard, Washington, DC; Purdue uses Vista Enterprise License (Release Vista 8.0.5); and Butler uses Blackboard Learn 9.1).

With approval by the Institutional Review Board of Indiana University–Purdue University at Indianapolis, students were asked to voluntarily participate in an online survey to assess the students' perception of the WBT learning experience at the completion of APPE. The survey, consisting of 9 questions, was administered via SurveyMonkey (Palo Alto, CA; see Appendix 1). The survey link was distributed to the students in the month following rotation completion.

Preassessment and postassessment scores were analyzed using descriptive statistics appropriate for continuous data. Paired-samples t test was used to compare preassessment and postassessment scores. Independent-samples t tests or Mann-Whitney U tests were used to compare the preassessment scores

Table 1. Premodule and Postmodule Assessment Scores*

	Premodule (n=20)	Postmodule (n=20)	p value
Developmental pharmacology	60 ± 15.9	83 ± 10.8	<0.001
Antimicrobial use and monitoring	77.5 ± 16.5	83 ± 14.9	0.164
Fluids, electrolytes, and dehydration	48 ± 14.4	59.5 ± 13.9	<0.005
Drug information	63.5 ± 18.7	96.5 ± 6.7	<0.001

** Data are reported as mean ± SD.*

between students of the two universities and students completing APPE in the first or second half of the academic year, and for comparing the mean changes in preassessment and postassessment scores between students of the two universities. Survey results were analyzed using descriptive statistics appropriate for ordinal data. Values of $p<0.05$ were considered to be statistically significant. Statistical analyses were conducted using Statistical Package for Social Sciences version 16.0 (SPSS Inc, Chicago, IL).

RESULTS

A total of 20 students (13 from Butler University and 7 from Purdue University) were assigned by the Office of Experiential Education to pediatric-specialist faculty preceptors for an elective pediatric APPE. All students completed the preassessment, WBT training, and postassessments. Significant improvements in preassessment and postmodule assessment scores occurred for all modules except antimicrobial use and monitoring, which had the highest mean preassessment score (Table 1). Mean premodule assessment scores did not differ among students taking the pediatric APPE in the first vs. the second half of the academic year (Table 2). Likewise, the mean premodule assessment scores and improvements in module assessment scores between students from the two universities did not differ (Table 3). Eleven students (55%) completed the voluntary survey after completion of the APPE. Eight of these students (73%) somewhat or strongly agreed that the WBT was repetitive or refreshed the material addressed within the core didactic pediatric curriculum at their respective university (Table 4). Most respondents (90%) identified the antimicrobial use and monitoring, and the fluids, electrolytes, and dehydration modules as the most effective at enhancing APPE.

DISCUSSION

Neonates, infants, children, and adolescents are a complex patient population that is at high risk of harm from medication misadventures and adverse drug events. Adequate knowledge and understanding of physiologic and medication differences between pediatrics and other populations are important in the education of doctor of pharmacy students because they ensure the students are appropriately prepared to practice at a generalist level. Many colleges of pharmacy, including our own, dedicate only a small portion of the curriculum to this population and do not require experiential education in this patient care area. This potentially leaves APPE students and new

Table 2. Mean Premodule Assessment Scores for Students Completing the Rotation in the First vs. the Second Half of the Academic Year*

	First Half Preassessment (n=7)	Second Half Preassessment (n=13)	p value
Developmental pharmacology	62.9 ± 11.1	58.5 ± 18.2	0.569
Antimicrobial use and monitoring	70 ± 21.6	81.5 ± 12.1	0.140
Fluids, electrolytes, and dehydration	55.7 ± 9.8	43.9 ± 15	0.077
Drug information	58.6 ± 10.7	68.2 ± 21.8	0.485

** Data are reported as mean ± SD.*

Table 3. Preassessment Scores and Improvements Between the Two Universities

	Preassessment Scores*†			Improvements From Preassessment to Postassessment‡		
	BU (n=13)	PU (n=7)	p value	BU (n=13)	PU (n=7)	p value
Developmental pharmacology	59.2 ± 14.4	61.4 ± 19.5	0.777	23.8 (−10 to 60)	21.4 (0 to 60)	0.794
Antimicrobial use and monitoring	77.7 ± 14.8	77.1 ± 20.6	0.946	2.3 (−30 to 40)	11.4 (−10 to 40)	0.264
Fluids, electrolytes, and dehydration	50 ± 12.9	44.3 ± 17.2	0.411	5.4 (−10 to 10)	22.9 (−10 to 50)	0.019
Drug information	61.5 ± 13.4	67.1 ± 26.9	0.699	33.8 (10 to 60)	11.5 (0 to 70)	0.757

BU, Butler University; PU, Purdue University.
** Core out of 100 possible points.*
† Data are reported as mean ± SD.
‡ Data are reported as mean (range).

graduates without the knowledge and comfort level needed to care for this population.

WBT modules aimed to reinforce and supplement the pediatric pharmacy curriculum. The modular format of learning through technology and direct access to the preceptor for questions would likely appeal to the current generation of students.[6,7] This is a novel approach to enhance students' learning, and to our knowledge has not been previously described for pediatric APPE. Additionally, the use of WBT to review previously taught curricular content not only optimized APPE educational time, but allowed incorporation of these topics into advanced topic discussion.

After reviewing the WBT content, students' postassessments improved significantly over preassessments for all modules except the antimicrobial use and monitoring module. This module had the highest mean preassessment score of all of the modules, which may explain the lack of a significant difference. Additionally, much of the material contained within this module is addressed, albeit from an adult perspective, in other areas of the pharmacy curriculum at both colleges.

Table 4. Student Pharmacist (n=11) Perception on Effectiveness of Web-Based Training Modules*

	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
Improved understanding of pediatric pharmaceutical care	3 (27.3)	6 (54.5)	2 (18.2)	0 (0)	0 (0)
Increased level of comfort in providing pediatric pharmaceutical care during APPE	2 (18.2)	8 (72.7)	0 (0)	1 (9.1)	0 (0)
Enhanced pediatric APPE	4 (36.4)	7 (63.6)	0 (0)	0 (0)	0 (0)
Supplemented the didactic pediatric pharmacy curriculum at the university	6 (54.5)	3 (27.3)	1 (9.1)	1 (9.1)	0 (0)
Repetitive or refreshed didactic pediatric pharmacy curriculum at the university	5 (45.5)	3 (27.3)	3 (27.3)	0 (0)	0 (0)

APPE, advanced pharmacy practice experience.
** Data are number of responses (%).*

Although, preassessments and postassessments used the same questions and the improvement could reflect a degree of memorization, students were not provided with correct answers following the preassessment, only following the postassessment.

Despite significant improvement in preassessment and postassessment scores, the scores for fluids, electrolytes, and dehydration continued to be below acceptable for what is required to provide care for pediatric patients. Although not statistically significant, the mean preassessment scores of students in the second half of the academic year were lower than those students in the first half of the academic year, likely secondary to time since the student had received didactic education on this topic. The mean score for students of both universities was 50% or below for the fluid, electrolytes, and dehydration module. A statistically significant difference was noted in the improvement of the preassessment to postassessment score in students from Purdue University. This might reflect the lack of routine use of this knowledge in APPEs leading up to the pediatric APPE. These results support the need to require additional reinforcement via discussions between students and preceptors as well as additions and/or changes to the current module to clarify content. An additional consideration would be to increase the time devoted to the didactic instruction of pediatric fluids, electrolytes, and dehydration within the core curriculum.

Assessment of students' perception of learning was important to ensure that WBT modules were providing the intended education in a manner that was conducive to learning for the current generation of students. The electronic survey response rate was reasonable at 55%, but given our small population size, a larger response would have been desirable.[8] Students were not asked to participate in this survey until they had received final evaluations and had proceeded to their next APPE experience. This may have contributed to the fact that only 55% of the invited students participated. Most survey respondents either somewhat or strongly agreed that the modules helped to improve their understanding of drug therapy in the care in pediatric patients (81.8%); increased their comfort level in providing pharmaceutical care to pediatric patients (90.9%); and enhanced their pediatric APPE (100%). Neutral or negative responses concerning facilitation of pharmaceutical care may have been due to several factors. First, the modules do not expose students to actual patients. Second, students were exposed to the care of patients in challenging specialties because the precepted rotations were in pediatric critical care, nephrology, and infectious diseases. Some students also expressed neutral or negative responses concerning supplementation or refreshment of pediatric didactic curriculum. This may be secondary to students attending two different colleges, and thus being exposed to different core curricula. Also, these students may not have felt they needed reinforcement of these aspects of the curriculum, but the authors continued to feel reinforcement and repetition are important to these core concepts in pediatrics. Several students suggested additional topics that could be added to the WBT modules to enhance the experience further; however, most of these suggestions, such as pain and sedation, antifungal therapy, critical care, and nephrology overviews, are topics that would be discussed with the pediatric specialist faculty preceptor because these are more in-depth, complex concepts in pediatric care. More general pediatric topics could be incorporated with the currently offered WBT to further enhance the basic pediatric pharmacotherapy knowledge base for the APPE student and new graduate.

CONCLUSIONS

WBT modules may expand and improve students' understanding of care for pediatric patients during APPE, and when possible should be incorporated into the APPE as an additional learning technique. WBT modules also represent a novel and collaborative method of providing APPE education in institutions where faculty from multiple colleges practice. Faculty can also collaborate with nonfaculty APPE preceptors to incorporate WBT modules into the APPE instructional methodologies.

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Appendix 1. Assessment of web-based training modules on learning facilitation for advanced pharmacy practice experience in pediatrics

Answer choices for questions 1-3 and 6-7: 1=Strongly agree; 2=Somewhat agree; 3=Neutral; 4=Somewhat disagree; and 5=Strongly disagree.

1. The WBT modules improved my understanding of pharmaceutical care of pediatric patients.
2. The WBT modules increased my level of comfort in providing pharmaceutical care to pediatric patients on APPE.
3. The WBT modules enhanced my pediatric APPE.
4. Please rank the following WBT modules in order of effectiveness at enhancing your pediatric APPE (5 – highest; 1 – lowest)
   ___ Introduction to Pediatrics
   ___ Developmental Pharmacology
   ___ Fluids, Electrolytes, and Dehydration
   ___ Antibiotic Pharmacokinetics
   ___ Pediatric Drug Information
5. I felt that the following WBT modules would have enhanced my APPE (please suggest topics):
6. The WBT modules supplemented the didactic pediatric pharmacy curriculum at my university.
7. The WBT modules were repetitive of the didactic pediatric pharmacy curriculum at my university.
8. I attend:
   a. Butler University
   b. Purdue University
9. I completed my pediatric APPE during rotation month number: ___