RESEARCH ARTICLE

Rapid integration and student outcomes of virtual, case-based, patient scenarios in advanced pharmacy practice experiences

Jason W. Lancaster[1,2] (iD), Baily Thomas[1] (iD), Rachel Mahoney[1,2] (iD), Macayla Bartucca[1] (iD), Adam Woolley[1] (iD)

[1] School of Pharmacy & Pharmaceutical Sciences, Northeastern University, Boston, Massachussets, United States
[2] Department of Pharmacy, Beth Israel Lahey Health, Lahey Hospital & Medical Center, Burlington, Massachussets, United States

Abstract

Background: Many healthcare and educational institutions have continued to utilise technology-driven learning well before 2020. However, there is limited published literature that rigorously evaluates student outcomes in virtually-delivered advanced pharmacy practice experience (APPE) rotations. This article reports student competency and comfort from eighteen 4th professional year Doctor of Pharmacy students from May 2020 to December 2020. **Methods:** Students completed 40 virtual, case-based, clinical reasoning cases during each 6-week APPE. A validated expert-generated anonymous survey was administered to students on two separate occasions. Student competency was assessed using expert-generated case-based clinical questions, and comfort was assessed using a 5-point Likert scale. **Results:** Competency scores demonstrated statistically significant improvements in 40% (N=6) of the domains and non-statistically significant improvements in the remaining 60% (N=9). Student comfort improved in 93.33% of the domains but was not statistically significant. **Conclusion:** Future directions include exploring the impact of virtual cases in combination with on-ground rotations and comparing student knowledge after graduation.

Introduction

Since the COVID-19 pandemic, significant changes to the delivery of education, among many other areas of people's daily lives, have occurred, including the increased use of technology and virtual platforms. In addition to the health, social, and financial impact, healthcare institutions and educational organisations globally have rethought how to continue providing high-quality care and education in a rapidly changing environment. Organisations have worked diligently to navigate the many challenges, including those faced by healthcare students and trainees, many of whom have encountered altered training experiences that may not meet all previously decided learning outcomes and expectations. In 2020, following the guidance of the Association of American Medical Colleges (AAMC), many U.S. hospitals and healthcare settings cancelled a portion of in-person clerkships, causing healthcare

students to become increasingly displaced from experiential training sites (2020). In March 2020, the Accreditation Council for Pharmacy Education (ACPE) issued a letter to pharmacy deans suggesting creative ways to adjust experiential learning requirements for pharmacy students, including, but not limited to, implementing telehealth experiences, virtual journal clubs or presentations, and simulations (ACPE, 2020). With a rapid worldwide transition to virtual teaching and learning, many universities and practice sites had to focus on how to provide high-quality virtual, didactic, and experiential education to graduate competent health professionals, with limited guidance provided by the profession (ACPE, 2015; Gallegos *et al.,* 2021). Since 2020, many institutions are maintaining, in some fashion, components of virtual teaching that may not have been in place previously.

Advanced Pharmacy Practice Experiences (APPEs) are a form of experiential pharmacy education that occurs

during the last year of pharmacy school and prepares graduates to enter practice as competent pharmacists (ACPE, 2015). This training is essential to integrate, reinforce, and advance student knowledge, attitudes, and practices developed in the pre-APPE pharmacy curriculum (ACPE, 2015). APPEs conventionally occur at assigned, required or elective practice sites and emphasise patient-care services across the continuum of healthcare (ACPE, 2015). Pharmacy students are among the healthcare students globally who were initially displaced from APPE practice sites due to the COVID-19 pandemic, necessitating innovative ways to simulate patient care and support the development of clinical competencies (Gallegos *et al.,* 2021). Virtual patient technology has been used globally in medical education, including pharmacy curricula, to reinforce and enhance learning objectives, skills, comfortability, and attitudes, primarily within didactic teaching (Cavaco *et al.,* 2012; Al-Dahir *et al.,* 2014; Menendez *et al.,* 2015; Barnett *et al.,* 2016; Curley, McDonald & Aspden, 2016; Lichvar *et al.,* 2016; Zlotos *et al.,* 2016; Baumann-Birkbeck *et al.,* 2017; Taglieri *et al.,* 2017; Borja-Hart, Spivey & George, 2019; Kononowicz *et al.,* 2019; Buckley *et al.,* 2020; da Silva *et al.,* 2020; Fidler, 2020; Thompson, White & Chapman, 2020). Additionally, several publications have reported their findings after the implementation of virtual learning within APPE educational opportunities (Sehgal *et al.,* 2019; Schellhase & Miller, 2020; Johnson *et al.,* 2021; Montepara *et al.,* 2021; Maravent *et al.,* 2022; Sakr *et al.,* 2022). While several publications have evaluated the requirements for delivering and reporting student satisfaction within virtual experiences, none have assessed student competency associated with virtual learning and educational outcomes from students engaged in a virtual APPE.

The primary objective of this study was to explore whether the utilisation of standardised, online case-based platforms improve pharmacy students' learning. Additional studied outcomes focused on students' reported comfort with disease-state management and perceived benefits of geriatrics and internal medicine competencies implemented during a 6-week virtual experiential education setting. The hypothesis was that students who took part in online virtual patient cases during APPE rotations would demonstrate measurable improvements in their reported comfort in managing patients with various disease states and in case-based assessment questions in the care of geriatric and internal medicine patients.

Methods

Design

During the period from May 2020 to December 2020, fourth professional year Doctor of Pharmacy students transitioned from entirely in-person APPE rotations to a virtual rotation experience. In both cases, a minimum of 20 hours per week were completed under the direct supervision of a preceptor, including patient care discussions and presentations in addition to shared topic discussions and other educational activities, e.g. medical grand rounds. However, due to limitations in engaging with medical teams and participation in in-person patient care rounding activities, the authors implemented the use of 40 standardised expert-developed case-based clinical scenarios to supplement student learning as part of a virtual 6-week health-systems/geriatrics or internal medicine APPE rotation. These cases covered various topics, including commonly observed cardiology, infectious disease, and respiratory disease states, and were available for a fee from two national organisations. A total of two hours per day and four days per week were spent reviewing these clinical cases under the direct guidance and facilitation of one of three rotation preceptors.

Ethical considerations

This institution review board (IRB)-exempt study sought to evaluate student competency, attitudes, and comfortability across disease states while using virtual patient cases. Student responses were collected using an anonymous, electronic, validated survey designed by the investigators and distributed to eighteen fourth-year Doctor of Pharmacy students, once at the beginning of the rotation, prior to the use of virtual case-based clinical cases, and again after the completion of all clinical cases. Student baseline characteristics were not collected per the IRB offices exemption requirement.

Assessment

Competency was assessed using validated expert-generated clinical questions included in each virtual case (Leipzig *et al.,* 2009; Sehgal *et al.,* 2019; American College of Physicians, 2022). A total of 15 practice areas or domains were assessed as part of these cases, ranging from cardiovascular and infectious to electrolyte, metabolic, and neurologic diseases. Each domain was presented using a series of electronic case vignettes coupled with assessment questions, detailed answer explanations, and accompanying literature. Student comfort and attitudes were assessed using a 5-point Likert rating scale from strongly disagree/extremely uncomfortable (1 point) to strongly agree/extremely comfortable (5 points). Each of the virtual cases, case

questions, and assessments were copyright-protected, and permission for reprinting has not been granted.

Data analysis

Pre- and post-survey items were analysed using IBM SPSS Statistics for Macintosh, Version 27.0. Descriptive statistics, paired t-tests, and Fisher's exact tests were used where appropriate, and worst-case imputation was used for any student lost to follow-up. Statistical significance was determined by $p \leq 0.05$.

Results

A total of 18 students completed the pre-survey (100% response rate), and 17 students completed the post-survey (94% response rate). Beyond all students being in their fourth professional year of the Doctor of Pharmacy degree program, baseline characteristics were not captured in accordance with institutional review board requirements for survey approval.

Competency

Compiled competency scores were statistically increased post-rotation compared to pre-rotation in 6 of the 15 domains, including several core domains such as the management of electrolyte abnormalities and falls. Eight competency domains showed improvement greater than 10% (range increase 10 to 30%) between pre-rotation and post-rotation assessments, with three additional domains demonstrating improvements greater than 40% (Table I). Additionally, four of the seven competency domains with a pre-rotation correct response rate of less than 50% demonstrated at least a doubling in correctness post-rotation.

Table I: Student competency with by disease-state pre- and post-participation in a virtual Inpatient General Medicine APPE

	Pre-APPE N (%)	Post-APPE N (%)	*p* value
Age-related conditions	13 (72.2)	16 (94.1)	0.31
Atrial Fibrillation	11 (61.1)	12 (70.6)	0.58
Community-acquired pneumonia	6 (33.3)	16 (94.1)	<0.01
Delirium	7 (38.9)	17 (100)	<0.01
Dementia	0 (0)	3 (23.5)	0.47
Depression	7 (38.9)	11 (64.7)	<0.05
Electrolyte abnormalities	7 (38.9)	11 (64.7)	<0.05
Falls	3 (16.7)	9 (52.9)	<0.01
Gastrointestinal bleeding	9 (50)	14 (82.4)	0.04
Hypertension	12 (66.7)	15 (88.2)	0.58
Hypo-/Hyperglycemia	13 (72.2)	13 (76.5)	1.00
Potentially inappropriate medications	13 (72.2)	15 (88.2)	0.71
Urinary incontinence	6 (33.3)	8 (47.1)	0.56
Urinary-tract infection	9 (50)	10 (58.8)	0.83
Venous thromboembolism	3 (16.7)	6 (35.3)	0.09

Comfort

Aggregate mean comfortability was statistically higher (p <0.001) in pharmacy students following completion of the virtual cases (M=3.7, SD=0.1) compared to before the rotation (M=3.1, SD=0.4). Students' mean comfortability scores in six of the domains, including atrial fibrillation, delirium, dementia and related behaviours, electrolyte abnormalities, falls, and venous thromboembolism, significantly increased from baseline to post-rotation (Table II). Ten domains, including community-acquired pneumonia, electrolyte abnormalities, gastrointestinal bleeds, venous thromboembolism, atrial fibrillation, urinary incontinence, dementia and related behaviours, delirium, falls, and age-related physiologic changes, showed improvement of more than 10% in comfortability (range increase 0.5 to 1.4). Other domains showed marked improvement, except for the hypertension domain, which showed a decrease in reported comfort.

Table II: Student perception of comfort with disease-state management before and after participation in a virtual Inpatient General Medicine APPE

	Pre-APPE Mean (SD)	Post-APPE Mean (SD)	*p* value	95% CI
Age-related conditions	3.0 (0.8)	3.67 (1.1)	0.59	1.4
Atrial Fibrillation	2.72 (0.8)	3.72 (1.3)	0.22	1.6
Community-acquired pneumonia	2.25 (0.9)	3.42 (1.2)	0.79	1.8
Delirium	2.5 (0.8)	3.5 (1.2)	0.15	1.8
Dementia	3.0 (0.9)	3.94 (1.2)	0.43	1.8
Depression	3.56 (0.7)	3.67 (1.2)	0.46	0.9
Electrolyte abnormalities	1.83 (0.6)	2.75 (1.2)	0.55	1.8
Falls	2.89 (0.8)	3.67 (1.2)	0.31	1.5
Gastrointestinal bleeding	2.67 (0.8)	3.17 (1.5)	0.94	1.6
Hypertension	4.17 (0.4)	3.83 (1.3)	0.01	0.7
Hypo-/Hyperglycemia	3.72 (0.6)	3.83 (1.2)	0.52	0.8
Potentially inappropriate medications	3.56 (0.8)	4.0 (1.1)	0.79	1.1
Urinary incontinence	3.0 (1.1)	3.61 (1.0)	0.32	1.5
Urinary-tract infection	3.39 (0.9)	3.67 (1.1)	0.52	1.0
Venous thromboembolism	3.08	4.08	0.66	1.9

SD=Standard Deviation

Discussion

Competency

While comfort is important to assess a student's ability to utilise knowledge in patient care, it is equally, if not more important, to assess competency to ensure that students have baseline knowledge that can be optimised to provide adequate and specific patient care recommendations upon graduation. Student assessments showed that overall competency scores increased across all domains, although pre-rotation baseline knowledge in several domains may be considered deficient in more than half of all disease-state domains (<50%). Interestingly, in almost all domains, students reported being least comfortable before starting their rotation; these were also the domains in which they were least competent, save for the management of age-related conditions.

Comfort

Students reported feeling more comfortable in their ability to manage and recommend treatment options for various disease states after completing the virtual APPE experience. Although there was a general improvement in most of the disease state areas, only one domain demonstrated statistically significant changes in the reported comfort level, and this was a negative correlation. When examining the pre- and post-rotation student survey responses for hypertension more closely,

it can be noted that the pre-survey reported comfort level was the highest of all domains, and the post-survey comfort level decreased only modestly, which may be attributed to initial student overconfidence in the general topic area.

Due to the pandemic disrupting traditional educational teaching, the switch to virtual or digital means of teaching, especially for clinical educational experiences such as APPEs, was essential to train pharmacy students. Our findings confirm that the use of online case-based scenarios, initially developed for medical education, could be applied to pharmacy education to generally improve comfort and competency in disease state management and could be implemented regardless of the nature of the learning experience with limited resources. Although the use of online virtual patient cases in APPE rotations has shown improvement in students' reported comfort and significant measurable gains in some domains, there are still concerns about whether this virtual experience can fully replace the traditional in-person APPE rotations.

Several published studies evaluated the use of virtual patient cases on student outcomes and/or perceptions within didactic coursework from the first through the third professional year across course disciplines. There are notable differences when comparing their approach to that of the present study. Indeed, in previous studies (Taglieri *et al.,* 2017; Thompson, White & Chapman, 2020), students were randomly assigned to the use or

not of virtual patient cases, whereas all the participants in the present study engaged with the virtual patient case materials. Furthermore, the expected time of engagement with the virtual patient cases varied considerably in the published literature. Estimates of students requiring less than 30 minutes for the completion of virtual activities were previously reported (Douglass et al., 2013; Curley, McDonald & Aspden, 2016; Buckley *et al.,* 2020). Other studies reported an average time of one to two hours for reviewing virtual patient case scenarios (Taglieri *et al.,* 2017; Borja-Hart, Spivey & George, 2019). Several studies, including the present one, reported a total engagement time with virtual scenarios exceeding ten hours per student (Johnson *et al.,* 2021). Unsurprisingly, among the cited studies, those that required students to spend the least amount of time to complete the virtual activities were didactic courses compared to those that required the most, which were experiential.

Two studies closely resembled the present one and were focused on pharmacy students during their fourth professional year (Al-Dahir *et al.,* 2014; Johnson *et al.,* 2021). The first one enrolled students in a mixture of APPE rotation experiences, including internal medicine and ambulatory care. Despite the much larger sample (N=119), each student only participated in a single virtual learning case over one disease state (e.g., atrial fibrillation) (Al-Dahir *et al.,* 2014), contrary to this study where all 18 students participated in 28 total sessions across 15 disease states. The second study (Johnson *et al.,* 2021) recruited a similar overall number of students (N=26) and used standardised virtual patient cases, but the authors did not quantify the time spent in this area of learning, nor did they employ a pre- and post-assessment strategy or have a method for evaluating competencies. Thus, it is believed that despite the available published literature, our study adds much to this growing body of evidence supporting the various use of virtual patient cases in pharmacy education.

A systematic review and meta-analysis conducted by the Digital Health Education Collaboration in 2019 found that, compared to traditional education, virtual patient simulations were favoured for skill improvement (Kononowicz *et al.,* 2019). When virtual patient simulations were blended with traditional learning techniques, improvements in skills and knowledge were higher compared to in-person learning only (Kononowicz *et al.,* 2019). Overall, the authors suggest that a virtual patient component could be beneficial as an addition to didactic pharmacy education, potentially even when students are on experiential rotations, as was found in our study.

Limitations

An advantage of evaluating competency is that it provides an objective rating that is not influenced by personal opinion and evaluates individual performance. However, competency does not directly demonstrate one's ability to use the information correctly. Thus, examining the assessments more closely brings to light some limitations, including the fact that several of the assessment questions were-lower level taxonomically, e.g. basic recall questions. Additionally, the benefits of using virtual cases and evaluating students' self-reported comfort levels comprise the potential to assess the reported ability to make patient recommendations about specific disease states and, more importantly, allow for competent healthcare students to practice their knowledge within no or severely limited risk scenarios.

However, the challenge remains that comfort is not an indicator of competency or knowledge. One major limitation to assessing comfortability via online case-based scenarios is that these case-based scenarios were completed as a group activity rather than individually. This type of scenario, while representative of real-world practice, has the potential to allow for student shadowing of responses and/or reporting of marked improvement in comfort despite an inability to integrate and apply what is known individually. Looking closely at the reported comfort level prior to rotations and its relationship with didactic knowledge, a clear pattern between comfort level at baseline and recent exposure to specific disease states could be noted. Lastly, another potential limitation of this study was the acuity of COVID-19 interventions put in place with regards to delivering an education to displaced students, leading to minimal funds and time to implement these cases. However, this represents a scenario many education settings and healthcare providers may find themselves in due to circumstances well-beyond their control.

Conclusion

Online case-based platforms applied to pharmacy students during a 6-week virtual experiential rotation significantly increased overall comfortability scores, but this increase was not statistically significant for most individual disease states. Competency scores increased overall, but individual disease states varied in significance. It is believed that this acute educational response to the COVID-19 pandemic could be utilised as a supplemental learning tool to enhance student comfort, competency, and attitudes during experiential pharmacy rotations, regardless of the setting or situation; it also has a place in future rotations

experiences. With such an acute situation, implementing virtual patient cases was the closest replacement to direct patient care providable at the time. Furthermore, based on the available evidence, these findings could demonstrate the benefits of using virtual patient learning, regardless of the nature and setting, and its use should be more widely considered across the continuum of pharmacy education. It would be recommended to include virtual patient cases in future APPE rotations that entail direct patient care activities to complement these activities and maintain consistency in the disease states to which students are exposed. These virtual cases would reinforce previous knowledge and foster comfort in a low-risk environment.

Conflict of interest

The authors declare no conflict of interest.

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