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Evaluating Student Pharmacists' Knowledge Retention through Use of Electronic Health Records versus Concurrent Engagement in Simulated Experiences

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Abstract

This research aimed to evaluate if incorporating standardized patients (SPs), or combining SPs with interprofessional student groups, alongside a simulated electronic health record (EHR) system, enhanced knowledge retention and student attitudes among learners. A prospective cohort design was employed to examine three groups of entry-level pharmacy students participating in skills lab sessions during 2018, 2019, and 2021. The main goal was to assess retention of case content one month later across the groups. Progressive enhancements were made to the simulation each year. In 2018, participants worked solely with the simulated EHR platform to handle the case. The 2019 version built on this by including an objective structured clinical examination (OSCE) involving SPs. In 2021, physician assistant students were added to create interprofessional teams. Comparisons also included performance on the cases and learner feedback. From 260 eligible individuals, 238 were analyzed for the primary outcome. Findings revealed notable gains in one-month knowledge retention when interprofessional collaboration and SPs were integrated. Average retention scores were 63.8% for the 2018 cohort, 71.7% for 2019, and 76.1% for 2021. Learner attitudes also showed marked positive changes. Incorporating SPs and interprofessional teamwork into skills labs featuring a simulated EHR led to substantial improvements in knowledge retention and student satisfaction.

Keywords: Simulation, Objective structured clinical examination, Interprofessional education, Electronic health record, Knowledge retention

Introduction

Studies show that simulation-based training boosts learners' self-assurance, analytical abilities, and practical skills in healthcare training [1]. Such approaches help deepen understanding and prepare students for real-world patient encounters. Various methods can heighten the authenticity of these educational scenarios, such as advanced technological tools, scripted case scenarios with actor-patients, and mannequins ranging from basic to advanced models.

Typically, investigations in education have examined isolated simulation methods to gauge their impact on long-term recall. Regarding sustained learning, interactions with SPs and basic mannequins have proven effective for enhancing recall in pharmacy students [2, 3]. Simulated EHR systems have similarly shown advantages for learning outcomes and attitudes [4-6]. Yet, as far as we know, no prior work in pharmacy or interprofessional training has integrated a simulated EHR with live actor-patients or cross-professional learners to foster a genuine collaborative care setting. Therefore, this investigation sought to explore if enhancing EHR-based cases with SP encounters, or SP encounters combined with interprofessional participation, would better support recall, case handling, and learner contentment on the subject matter. The focus was endocrine therapy cases, evaluated in first-professional-year PharmD students.

Materials and Methods

The investigation used a prospective cohort approach involving three sets of first-year pharmacy students from skills courses in spring semesters of 2018, 2019, and 2021. Starting in fall 2017, the PharmD curriculum incorporated a simulated EHR across multiple years to build skills and readiness for advanced practice [7]; it was particularly emphasized in skills labs. Funding came from an institutional grant, with ethical approval granted via expedited process by the university's review board.

This multi-phase exercise was designed for the skills lab aligned with the endocrine module, occurring in the spring of the initial professional year. Faculty developed two scenarios embedded in the EHR: one involving a male with type 2 diabetes seeking urgent care for urinary tract infection signs, and another featuring a female with type 2 diabetes and hypothyroidism managing medications upon discovering pregnancy. Accompanying questions were created, which students completed and submitted as part of their lab grade. Identical scenarios and questions were retained across years, though delivery varied. Analysis focused solely on the initial scenario.

Participation included enrolled first-year pharmacy students from the specified years or physician assistant students in 2021 **(Figure 1)**. The 2020 cohort was excluded due to pandemic-related disruptions that canceled the planned interprofessional OSCE. All groups received EHR access to cases two days before the session, with questions distributed on the lab day. For the initial version in spring 2018, pharmacy students independently reviewed EHR data and addressed questions during a 90-minute lab slot.
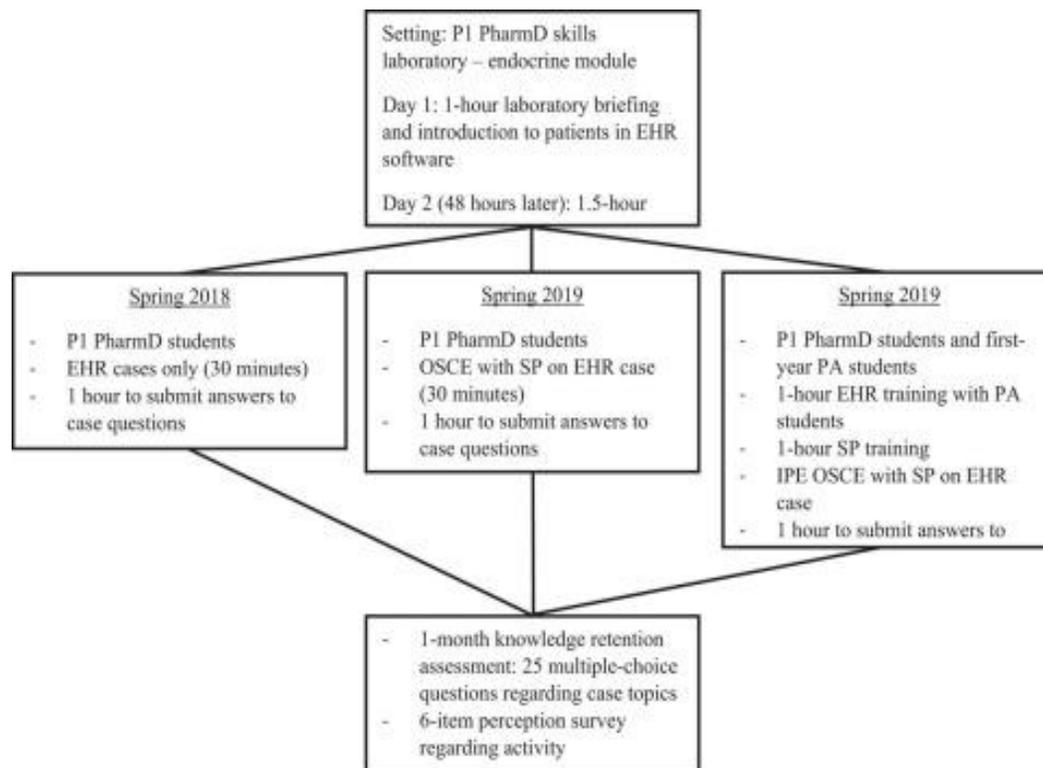

Figure 1. Illustration of a study assessing student pharmacists' knowledge retention when using electronic health records compared to concurrently engaging in simulated experiences.

Figure Legend: Day 2 – After receiving the activity briefing, student pharmacists from each year reviewed an endocrine pharmacotherapy patient case within the simulated electronic health record (EHR). Spring 2018 – First-year (P1) PharmD students only reviewed the EHR case and submitted their responses for grading. Spring 2019 – P1 PharmD students reviewed the EHR case for 30 minutes and interacted with a standardized patient (SP), then submitted their case assignment responses. Spring 2021 – P1 PharmD students were paired with first-year physician assistant (PA) students to complete the same activities as in 2019, though only the PharmD students were required to submit case answers for grading. Following each activity, PharmD students

completed a one-month knowledge retention assessment and a perception survey regarding the activity. Abbreviations: P1 PharmD = first-year Doctor of Pharmacy; EHR = electronic health record; OSCE = objective structured clinical examination; PA = physician assistant; SP = standardized patients; IPE = interprofessional education.

In the second iteration (Spring 2019), student pharmacists worked in pairs, conducting a 10-minute interview with an SP, followed by 15 minutes to develop a management plan, and 5 minutes to counsel the patient on the plan and any medication changes. Students then had one hour to complete both the SP case questions and a second patient case available only in the EHR. SPs in this iteration acted according to the patient described in the EHR, receiving a one-hour training session with pharmacy faculty immediately before the event and reviewing the scenario script a week in advance; all SPs were compensated through grant funding and had prior experience as SPs. The SP interaction aimed to allow students to collect additional patient information and communicate the care plan effectively.

In Spring 2021, an interprofessional component was added. PharmD students were randomly paired with first-year PA students in 1:1 or 2:1 groups and completed the SP interaction as described above. Since the endocrine module aligned in both the pharmacy and PA curricula, this interprofessional activity was incorporated naturally. PA students conducted the physical examination and collaborated with PharmD students to develop a care plan. After the SP interaction, PharmD students had the remainder of the 1.5-hour lab session to complete both the SP case questions and the EHR-only case.

Grant funding also supported the EHR web application for the PA program. PA students received EHR training one week before the activity, and EHR case information was posted two days prior, along with student group assignments. Students were encouraged to review and discuss both patient cases with their partners before the lab session.

One month post-activity, all student pharmacists completed a 25-question multiple-choice knowledge retention test covering guidelines and medication treatment for the endocrine disorders presented in the cases; questions were not patient-specific. Following the test, students completed a six-item survey (five-point Likert scale) assessing perceptions of the learning methods. The survey and test were administered during a 50-minute pre-laboratory class at semester's end. Participation in the case activity was universal across cohorts, and test results did not contribute to laboratory grades.

The primary objective was to compare one-month knowledge retention scores across the three cohorts. Secondary outcomes included patient case scores and student perception survey results. Statistical analyses were performed using JMP Pro 14 (SAS Institute Inc), with $p < 0.05$ indicating significance. Continuous variables were analyzed via ANOVA, and ordinal variables via the Kruskal-Wallis test.

Results and Discussion

Among 260 enrolled P1 students across the three cohorts, 257 (98.8%) participated in the case activity, and 238 (91.5%) completed the one-month knowledge retention test and perception survey. Baseline characteristics were generally similar between cohorts, except for pharmacy work experience, which varied significantly: 76.0% (2018), 57.0% (2019), and 69.1% (2021) (p=0.04). No significant differences were observed in final course grades, work experience type, or age **(Table 1).**

Table 1. Demographic and academic profile of student pharmacists across study cohorts

Variable	2018: EHR Only (n=96)	2019: SPs + EHR (n=93)	2021: IPE + SPs + EHR (n=68)
Prior pharmacy employment, n (%)	73 (76.0)	53 (57.0)	47 (69.1)
Employment setting, n (% of those with experience)			
– Community pharmacy	54 (74.0)	40 (75.5)	36 (76.6)
– Hospital pharmacy	14 (19.2)	11 (20.8)	8 (17.0)
– Other settings	5 (6.8)	2 (3.7)	3 (6.4)
Age, mean (SD), years	24.0 (4.3)	24.3 (5.0)	24.7 (5.5)
Final course score, mean (SD), %	90.6 (4.92)	94.5 (4.64)	95.1 (2.94)

Abbreviations: EHR = electronic health record; SPs = standardized patients; IPE = interprofessional education.

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For the primary outcome measuring one-month knowledge retention, the incorporation of standardized patients and student physician assistants in the 2021 cohort resulted in a statistically significant increase in test scores compared with both the standardized patient–only approach used in 2019 and the electronic health record–only model used in 2018; mean scores were 76.1% for 2021, 71.7% for 2019, and 63.8% for 2018 (p<.01; **Table 2).**

Table 2. One-month knowledge retention and patient case performance across study groups

Outcome	2018: EHR Only	2019: SPs + EHR	2021: IPE + SPs + EHR	p value
Knowledge retention assessment				
Number of participants	n=83	n=87	n=68	
Mean score (SD), %	63.8 (9.3)	71.7 (11.5)	76.1 (8.1)	<.01
Patient case performance				
Number of participants	n=96	n=93	n=68	
Mean score (SD), %	81.1 (14.0)	84.4 (8.7)	85.4 (12.5)	.05

Abbreviations: EHR = electronic health record; SPs = standardized patients; IPE = interprofessional education.

Although the increases in case performance did not reach statistical significance, a progressive upward trend was observed across cohorts, with average scores rising from 81.1% in spring 2018 to 84.4% in spring 2019 and 85.4% in spring 2021 (p = .05). Findings from the student perception survey indicated that the majority of student pharmacists agreed or strongly agreed that simulated learning activities had a positive impact on their learning experience. Moreover, perceptions improved significantly with each successive cohort—first following the introduction of standardized patients and later with the combined use of standardized patients and interprofessional team-based care—as demonstrated by responses to four of the six survey items **(Table 3).** While no statistical comparison was performed, student physician assistants who participated in the spring 2021 cohort likewise reported high satisfaction levels with the activity **(Table 3).**

Table 3. Student perceptions of the simulated learning experience across cohorts

Survey statement[a]	2018 (n = 83) Mean (SD)	2019 (n = 87) Mean (SD)	2021 (n = 68) Mean (SD)	2021 PAs (n = 53)[b] Mean (SD)	p value
This activity enhanced my understanding of my responsibilities within a clinical practice setting	3.98 (0.82)	4.15 (0.80)	4.35 (0.72)	4.20 (0.88)	.02
I am able to effectively gather essential information directly from a patient	4.27 (0.70)	4.32 (0.60)	4.46 (0.73)	4.48 (0.65)	.07
Engaging in patient discussions helps me develop more meaningful and appropriate therapy recommendations	4.23 (0.70)	4.28 (0.63)	4.52 (0.66)	4.55 (0.69)	.01
Simulated clinical experiences should be incorporated more frequently throughout the curriculum	4.14 (0.83)	4.08 (0.69)	4.34 (0.80)	4.28 (0.72)	.03
This experience enabled me to make recommendations that account for individual patient preferences	3.99 (0.83)	4.20 (0.67)	4.42 (0.70)	4.36 (0.72)	<.01
I believe this activity represented an effective use of both human and technological resources	4.06 (0.92)	4.16 (0.83)	4.32 (0.87)	4.18 (0.90)	.11

Abbreviations: PA = student physician assistants.
[a] Survey scale: 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree.
[b] Responses from student physician assistants were not included in the statistical analysis.

This prospective cohort study demonstrated improved student knowledge retention and perceptions when simulated learning activities incorporated standardized patients (SPs) alone or SPs combined with interprofessional team-based care. Within activities containing these elements, a statistically significant enhancement in one-month knowledge retention was observed (p<.01), along with a trend toward higher case scores (p=.05). Furthermore, findings from student perception surveys showed that expanding the use of simulation with SPs and integrating an interprofessional component positively influenced most survey measures **(Table 3).** Collectively, these results emphasize that employing multiple simulated learning strategies may strengthen student learning outcomes and promote sustained knowledge retention.

Several factors may account for the observed improvements in knowledge retention across different degrees of simulated realism. The methods for gathering and evaluating patient information used during the initial phase of the study were familiar to students across all cohorts, as our institution routinely applies this approach in case-based learning. Previous literature indicates that simulation technologies involving virtual patient cases and electronic health records (EHRs) enhance student satisfaction, perceived readiness for practice, and performance [8–10]. For example, Smith and colleagues reported that student pharmacists who used a simulated EHR felt significantly more prepared for clinical practice (p<.01) [8]; however, that study did not identify improvements in performance when advanced pharmacy practice experience grades were compared. In contrast, Bernaitis and colleagues found increased student satisfaction and significant gains in final examination scores following the use of simulated technology [9]. Consistent with our findings, their investigation did not reveal differences on short-term assessments but demonstrated significant improvements on end-of-semester examinations (p<.01) [9]. That work focused on final-year pharmacy students engaging with computer-based oncology cases developed using DecisionSim [9]. Overall, our results reinforce existing evidence that simulation technology is advantageous throughout the pharmacy didactic curriculum, benefiting students from the first professional year through the final year.

The educational value of SPs has also been well documented, particularly regarding skill-based coursework and knowledge retention among student pharmacists. Prior studies have shown that SPs enhance learning outcomes for first-year pharmacy students acquiring skills related to inhaler use and insulin administration techniques [2, 3]. Similar to the present study, incorporating SPs not only strengthened students' practical skills and counseling abilities but also supported retention of subject-specific knowledge at one month [3]. In addition, research by Simko and colleagues demonstrated a significant increase in both nursing and pharmacy students' perceptions of the importance of interdisciplinary roles and shared knowledge after participation in an interprofessional education experience [10]. Maerten-Rivera and colleagues evaluated pharmacy and physician assistant students' confidence in applying the Pharmacists' Patient Care Process to patient cases, as well as their perceptions of interprofessional collaboration [11]. Their findings showed a significant rise in confidence related to performing the Pharmacists' Patient Care Process, although attitudes toward interprofessional collaboration did not significantly change. Notably, both groups reported high interprofessional perception scores before and after the activity [11].

Finally, Mitzel and colleagues paired pharmacy and physician assistant students in their final didactic year to engage in an interprofessional objective structured clinical examination (OSCE) focused on reviewing inpatient medication orders [12]. That study aimed to evaluate the OSCE's influence on perceptions of interprofessional education and to assess whether simulated patient outcomes improved through interprofessional collaboration. The results confirmed higher accuracy in patient care recommendations among the interprofessional group, along with enhanced perceptions of the value of interprofessional patient care [12].

Despite the substantial body of literature addressing classroom technology, standardized patients (SPs), and interprofessional education independently, the intentional integration of these components—which, in this study, produced a more authentic case scenario and required greater student preparation—has been infrequently examined. Based on our observations, effective preparation for interactions with SPs required students to develop questions ahead of time and to be prepared to ask appropriate follow-up questions as the encounter evolved. Moreover, the inclusion of student physician assistants as an added element of realism may

have further shaped preparation, as student pharmacists were expected to function as the medication experts within the interprofessional team. Nevertheless, preparation alone is unlikely to fully explain the observed gains in knowledge retention, since increased preparation did not translate into statistically significant differences in case grades **(Table 2)**. Instead, the structure and immersive nature of the activities themselves may have created a more impactful and memorable learning experience, thereby enhancing knowledge retention. Although simulated EHRs, SPs, and interprofessional education have each been shown to improve learning outcomes and student satisfaction when used separately, to our knowledge, this investigation represents the first study in pharmacy education to deliberately combine all three strategies.

Several limitations should be acknowledged. Replicating this interprofessional team-based care model across other didactic curricula or therapeutic areas may be challenging, as the sequencing of disease state instruction does not always align across different professional programs. In addition, the study period included a one-year interruption (spring 2020) related to the transition to remote and virtual learning during the COVID-19 pandemic, which prevented in-person interactions between students and SPs. Furthermore, because certain indicators of academic performance—such as grade point averages and Pharmacy College Admission Test scores—were unavailable, academic achievement cannot be excluded as a potential confounding factor. Future research should further evaluate the influence of this educational model on long-term knowledge retention and performance during clinical rotations.

Conclusion

Incorporating SPs and interprofessional team-based care into a pharmacy skills laboratory supported by a simulated EHR web application resulted in a significant improvement in student knowledge retention. These enhancements also showed a tendency toward improved immediate case performance and were associated with more favorable perceptions of both the simulated learning environment and interprofessional education. Although routine inclusion of interdisciplinary learners may not always be practical, the findings support the value of introducing team-based care early within the pharmacy curriculum.

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