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RESEARCH ARTICLE

# Structured incremental measurement of directed and objective simulation experiences-pilot (SIM DOSE-P)

Michael C. Thomas, Georges Adunlin, Megan Z. Roberts, Jennifer W. Beall, Elizabeth W. Covington, Mary A. Worthington, Jeffrey A. Kyle

McWhorter School of Pharmacy, Samford University, Birmingham, Alabama, United States

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**Correspondence**
Michael C. Thomas
McWhorter School of Pharmacy
Samford University
800 Lakeshore Dr
Birmingham, Alabama 35229
United States
*mthoma13@samford.edu*

## Abstract

**Objective:** To describe performance, anxiety, confidence, and time effects across multiple individual simulation experiences in an acute care environment among volunteer Pharm.D. students. **Methods:** This pilot study used five different cases spanning five weeks. Participants were not aware of case content until each simulation began but topics had been taught in the curriculum. Performance on a SOAP note, self-reported anxiety and confidence, and time to complete each activity were measured. A focus group provided qualitative feedback. **Results:** Fifteen participants completed the study. Mean performance scores across all cases were variable without a predictable pattern. Global measures of anxiety and confidence numerically improved. The average time to complete simulation activities was similar across the first three cases but decreased for the remaining two cases. Participant comments supported the overall design as meaningful and encouraged self-directed learning. **Conclusion:** The design of repeated individual simulation experiences improves anxiety and confidence scores and promotes self-directed learning.

## Introduction

Graduates from Doctor of Pharmacy (Pharm.D.) degree programmes are expected to be competent when entering practice (Vlasses *et al.,* 2013). Entrustable professional activities (EPAs) are a minimum standard that includes the following domains: patient care, interprofessional team member, population health promoter, information master, practice manager, and self-developer (Haines *et al.,* 2017). Although EPAs may be explored through didactic experiences, competence requires practice and application more likely to occur during advanced pharmacy practice experiences (APPEs). A significant portion of Pharm.D. curricula is dedicated to APPEs, which requires opportunities to perform patient-centred care in diverse practice settings (Accreditation Council for Pharmacy Education, 2016). Practice-based teaching is essential in the development of clinical problem solving and relies on various teaching approaches ranging from direct to facilitated instruction (Weitzel *et al.,* 2012). However, without simulation, this approach is broadly confined to the last year of the Pharm.D. curriculum.

A simulation is an educational tool that allows application-based activities to be practised in a safe and controlled environment (Vyas *et al.,* 2011). The most common reasons for using simulation in pharmacy education include patient assessment, communication abilities, patient counselling, and identification and assessment of drug-related problems (Vyas *et al.,* 2013). Theoretically, simulation should be incorporated before APPEs begin to allow for repeated practice and preparation before the final year. The Accreditation Council for Pharmacy Education (ACPE) supports using simulation as a substitute for part of an introductory

pharmacy practice experiences (IPPEs) requirement (Accreditation Council for Pharmacy Education, 2016). There are examples where simulation has been used in Pharm.D. programmes with positive results. Student perception is very positive (Seybert *et al.,* 2006; Fernandez *et al.,* 2007; Thomas *et al.,* 2018; Davis *et al.,* 2013). It is also an effective tool to teach and evaluate skill acquisition in a simulated clinical setting (Seybert *et al.,* 2007; Seybert *et al.,* 2008; Mieure *et al.,* 2010; Vyas *et al.,* 2010; Robinson *et al.,* 2011; Seybert *et al.,* 2011). The structured simulation could also be used as an assessment tool to ensure readiness to engage in direct patient care during the APPE year (Vyas *et al.,* 2012).

Although unrealistic for pharmacy students to be experts at the time of graduation, the very nature of healthcare demands professionals who are well prepared to optimise patient outcomes. Assuming individuals have the aptitude to engage and solve complex problems, moving from novice to expert is not one big step; rather, it is a continuum that requires repeated practice opportunities (Ericsson *et al.,* 2004; Persky *et al.,* 2017). Students may be better prepared to enter practice by combining repeated practice in a safe and controlled setting. Repeated practice is a best-practice feature of simulation leading to effective learning (Issenberg *et al.,* 2005; MacGaghie et al., 2010). However, the dose-response relationship between the amount of practice and the spacing of practice are current gaps in the literature (MacGaghie *et al.,* 2010). The overall goal for this investigation was to determine the effect of repeated practice opportunities on the clinical performance in a simulated hospital environment among volunteers from a single Pharm.D. programme in the United States. The specific objectives were to 1) Describe written performance across five simulation experiences using EPA patient care domains; 2) Report the effect of repeated practice on time required to complete patient care activities in a simulated environment; 3) Determine the impact of repeated clinical simulation experiences on student anxiety and confidence; 4) Report qualitative focus group feedback.

## Methods

Third professional-year Pharm.D. students from a single School of Pharmacy in the United States were invited to an information session during the fall of 2018. Volunteers signed informed consent, completed a demographic survey, and were provided with a unique participant identification number known only to the participant and one non-clinical researcher. Participants were incentivised with a $50 gift card upon completion of all requirements. As this research was not associated with a course, no course incentives were provided. This study was approved by the Institutional Review Board.

Each participant individually completed five simulation experiences in the spring of 2019, a number chosen based on the practicality of scheduling. Each simulation was up to one hour and scheduled during non-class times. The setting was a hospital environment with realistic equipment and a high-fidelity patient simulator (iStan, CAE Healthcare, Inc.) located on the university campus. The same case was used for all participants during a given week, but five unique cases were used in total. Each of the cases had a single primary problem (pneumonia, acute heart failure, pulmonary embolism, stroke, or asthma) and were designed and reviewed by two clinical faculty investigators. Students had been taught all included disease states in prior semesters, and the topics were amenable to inpatient scenarios. The primary and secondary problems and other case complexity guiding principles were decided by a consensus of the clinical investigators. Guiding principles were developed and applied to each case to ensure similar rigour (Figure 1). Each case was built in a simulated electronic health record (EHR Go, Archetype Innovations, LLC), which included information, such as laboratory values, vital signs, pertinent diagnostic images and interpretations (e.g., electrocardiogram, chest x-ray), physician notes, and orders. Each chart had a consult order requiring the pharmacy student to complete a medication and allergy history, evaluate pharmacotherapy related to the primary problem and provide any other needed pharmacotherapy recommendations.

One medical problem is clearly the most urgent needing to be addressed.
The most urgent medical problem requires treatment with pharmacotherapy.
Chronic medical problems should be included that require continuation of home therapy.
Two additional chronic medical problems should be included.
Home medications and allergy lists must be collected from the patient.
There must be at least one drug therapy dosing issue
- Dose optimization (i.e., insulin, levothyroxine)
- Renal dose adjustments
- Bridge therapy for anticoagulation
- IV to PO for antibiotics
- Switching between drug classes (due to allergy, etc.)
- Recognizing non-compliance is why the drug isn't working (i.e., don't need to increase the dose)

The patient in each scenario is coherent and conversant.
At least one error is planted related to drug therapy (incorrect home dose on admission orders, drug-drug interaction, drug-allergy issue, etc...).
Error related to drug therapy:
- Incorrect home dose on admission
- Drug-drug interaction
- Drug-allergy issue
- Drug-disease interaction (i.e., diuretic with hypokalemia/hyponatremia)
- Therapeutic duplication
- Untreated indication

Medical problems should be those already covered in previous pharmacotherapy courses (i.e., Pharmacotherapy I-III).
Cases may be in the ED or in an in-patient setting. If in an inpatient setting, no more than 3 hospital days are included.

**Figure 1: Case complexity guidelines**

Four stations were used for each simulation (Figure 2). In the first station (maximum 20 minutes), participants completed a brief anxiety and confidence survey designed by the investigative team (Qualtrics, LLC) and

evaluated patient data in the simulated electronic health record as described above. Global measures of anxiety and confidence were assessed using an electronic slider ranging from 1 (no anxiety; no confidence) to 10 (extremely anxious; extremely confident). Additional responses to the survey were based on a 4-point Likert scale. The second station (maximum 10 minutes) was a simulated inpatient hospital room with a high-fidelity manikin (iStan, CAE Healthcare, Inc.), where participants could interact with the patient, voiced by trained actors. A patient monitor displayed current vital signs, heart rhythm, and continuous plethysmography. Some simulators also had intravenous fluids running or were connected to oxygen, as clinically appropriate for the case. After interacting with the simulator, each participant proceeded to the third station (maximum 20 minutes), where they wrote a SOAP note based on their findings and evaluation, submitted through the learning management system (Canvas, Instructure, Inc.). Participants watched a pre-recorded ten-minute video debrief of the scenario in the fourth and final station (10 minutes). These videos reviewed the idealised approach to the case.

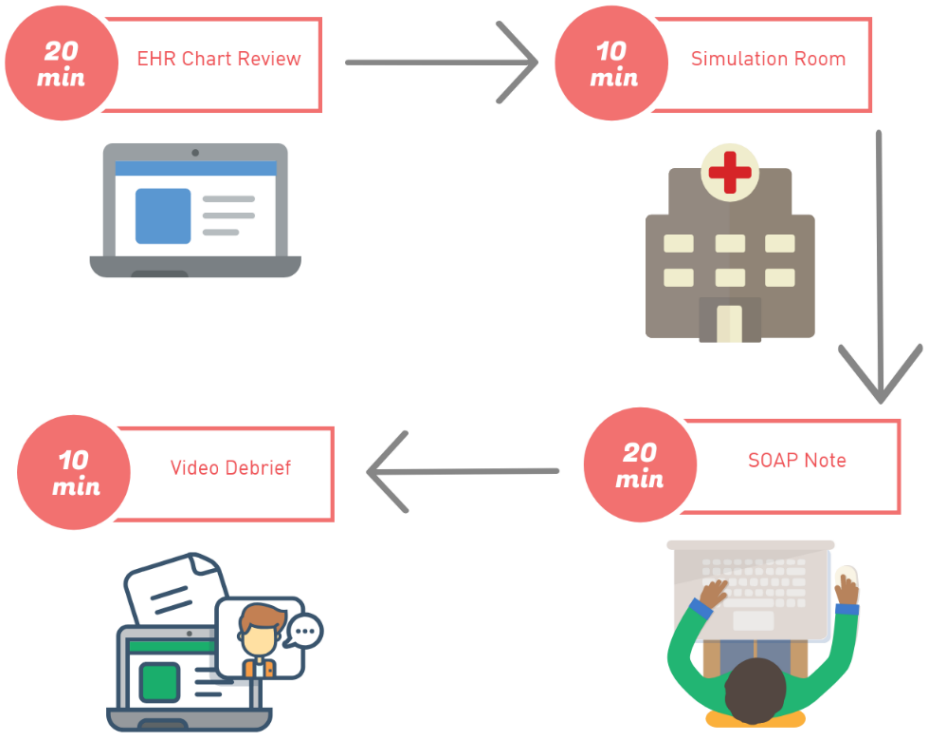


**Figure 2: Stations for each simulation experience with time allocated to each**

Aggregate time for the first three stations (electronic health record, patient encounter, and SOAP note) was determined to assess time efficiency. Timestamps from the electronic health record were used to calculate times for that station. The time in the patient encounter was recorded by the trained actor. The total time for the SOAP note was calculated as the difference in the recorded time participants entered the assignment in the learning management system and the time they submitted their answers. Timestamps were automatically logged based on student interaction with the learning management system.

Doctor of Pharmacy students were hired to serve as simulation coordinators. These fourth-year students coordinated participant movement on each simulation day. They also helped ensure no more than the allotted time was used for each station.

Each SOAP note was evaluated by two blinded clinical faculty investigators according to a rubric (Figure 3) developed and internally validated for this project (score range 0 to 12). The rubric has a 75% inter-rater agreement (kappa 0.6044, p=0.016). A kappa score between 0.41-0.60 is interpreted as moderate agreement (McHugh, 2012). Scores that varied by more than 10% were assessed by a third clinical faculty member.

**SIM DOSE Evaluation Rubric**

**Participant ID_____**

| | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| Collect information to identify a patient's medication-related problems and health-related needs | Subjective and objective information were not reported. | 1-25% of subjective and objective information were reported | 26-50% of subjective and objective information were reported | 51-75% of subjective and objective information were reported | 76-100% of subjective and objective information were reported |
| Analyze information to determine the effects of medication therapy, identify medication-related problems, and prioritize health-related needs | No medication- or health-related problems identified | 1-25% of problems identified OR most urgent problem NOT identified | 26-50% of problems identified, including most urgent problem | 51-75% of problems identified, including most urgent problem | 76-100% of problems identified, including most urgent problem |
| Establish patient-centered goals and create a care plan for a patient to include monitoring and follow-up. | No complete plan of care was developed for the patient, or plan included any elements that are life-threatening. | A complete plan was developed for 1-25% of problems identified OR no plan for most urgent problem | A complete plan was developed for 26-50% of problems identified, including most urgent problem | A complete plan was developed for 51-75% of problems identified, including most urgent problem | A complete plan was developed for 76-100% of problems identified, including most urgent problem |

**Figure 3: Evaluation rubric**

All participants were invited to participate in a focus group after the final simulation experience. Questions were adapted from a qualitative simulation-based medical education study (Sørenson *et al.,* 2015). A transcript of the responses was generated using the learning management system (Canvas Studio, Instructure, Inc.). Errors in the transcript were corrected, then themes from words and phrases were identified and frequencies recorded by two investigators.

Descriptive statistics were used to summarise the dataset using Stata version 13.1 (Stata Corporation, College Station, TX, USA). Categorical data were described as percentages, and continuous variables with normal distribution were presented as mean (standard deviation [SD]). Further statistical analysis was not reported due to the small sample size.

## Results

Fifteen students were enrolled in the study. Most participants (n=12) self-identified their gender as male and their race as white (n=10). Most participants had prior pharmacy work experience (n=11) and reported having a grade point average of 3.5 or greater (n=8). Additional baseline demographic characteristics that may affect knowledge are listed in Table I.

**Table I: Participant demographics (n = 15)**

| Characteristics | Number (%) |
|---|---|
| **Gender** | |
| Female | 12 (80) |
| Male | 3 (20) |
| **Age group** | |
| Less than 26 years old | 12 (80) |
| 26 years or older | 3 (20) |
| **Race/ethnicity** | |
| Asian | 2 (13.3) |
| Black | 3 (20) |
| White | 10 (66.7) |
| **Highest level of education before pharmacy school** | |
| Some college coursework | 8 (53.3) |
| Associate's degree | 1 (6.7) |
| Bachelor's degree | 6 (40) |
| **Current overall grade point average** | |
| 3.5 or greater | 8 (53.3) |
| 3.0 - 3.49 | 5 (33.3) |
| 2.5 - 2.99 | 1 (6.7) |
| Prefer not to answer | 1 (6.7) |
| **Previous work experience** | |
| Work experience in a pharmacy setting outside of the pharmacy curriculum | 11 (73.3) |
| Work experience in a healthcare profession outside of the profession of pharmacy | 3 (20) |
| Educational coursework or training in a healthcare profession outside of pharmacy | 4 (26.7) |
| **Previous experience in high-fidelity simulation** | |
| Elective courses | 3 (20) |
| Intermediate pharmacy practice experiences | 3 (20) |
| Other | 5 (33.3) |
| **Number of different previous high-fidelity simulation sessions** | |
| One session | 6 (40) |
| Two sessions | 3 (20) |
| Three sessions | 1 (6.7) |

The effects of the five simulation experiences on the measured endpoints are presented in Table II. The mean written performance score fluctuated throughout the simulated experience, but the lowest mean score was in the first case (5.07 ± 2.08).

**Table II: Study endpoints**

| | Case 1 | Case 2 | Case 3 | Case 4 | Case 5 |
|---|---|---|---|---|---|
| Performance Scores* | 5.07 (2.08) | 6.74 (1.60) | 5.97 (1.53) | 7.36 (1.48) | 6.06 (1.11) |
| Total Time (min)* | 41.13 (5.86) | 42.76 (4.74) | 41.36 (11.73) | 33.71 (8.63) | 37.52 (8.52) |
| Global Confidence Scores* | 5.50 (1.86) | 4.62 (1.36) | 5.80 (1.65) | 5.40 (1.54) | 6.40 (1.68) |
| Global Anxiety Scores* | 4.73 (2.08) | 6.18 (2.66) | 4.64 (2.66) | 3.33 (1.55) | 2.57 (1.15) |
| Answer choices | | Feeling more nervous and anxious than a typical school day† | | | |
| Not at all | 2 (13.3) | 5 (33.3) | 8 (53.3) | 7 (46.7) | 10 (66.7) |
| Somewhat | 6 (46.7) | 7 (46.7) | 6 (40) | 6 (40) | 4 (26.7) |
| Moderately | 6 (40.0) | 3 (20.0) | 1 (6.7) | 2 (13.3) | 1 (6.7) |
| Very much | - | - | - | - | - |
| Answer choices | | Feeling calm and can sit still easily† | | | |
| Not at all | 2 (13.3) | 1 (6.7) | 1 (6.7) | - | |
| Somewhat | 6 (40.0) | 8 (53.3) | 6 (40.0) | 6 (40.0) | 4 (28.6) |
| Moderately | 4 (26.7) | 5 (33.3) | 2 (13.3) | 4 (26.7) | 3 (21.4) |
| Very much | 3 (20.0) | 1 (6.7) | 6 (40.0) | 5 (33.3) | 7 (50.0) |
| Answer choices | | Feeling of heart beating fast† | | | |
| Not at all | 4 (26.7) | 4 (26.7) | 7 (46.7) | 7 (46.7) | 6 (42.9) |
| Somewhat | 8 (53.3) | 8 (53.3) | 5 (33.3) | 8 (53.3) | 6 (42.9) |
| Moderately | 1 (6.7) | 3 (20.0) | 3 (20) | - | 2 (14.3) |
| Very much | 2 (13.3) | - | - | - | - |
| Answer choices | | Excited about completion of today's simulation† | | | |
| Not at all | | 2 (13.3) | - | 1 (6.7) | 2 (13.3) |
| Somewhat | 6 (40.0) | 2 (13.3) | 5 (33.3) | 2 (13.3) | 2 (13.3) |
| Moderately | 4 (26.7) | 4 (26.7) | 5 (33.3) | 9 (60.0) | 5 (33.3) |
| Very much | 5 (33.3) | 7 (46.7) | 5 (33.3) | 3 (20.0) | 6 (40.0) |

| | Case 1 | Case 2 | Case 3 | Case 4 | Case 5 |
|---|---|---|---|---|---|
| Answer choices | | | Most excited about today's simulation† | | |
| Working with high fidelity manikins | - | - | - | - | - |
| Applying what I have learned | 3 (20.0) | 6 (40) | 3 (20.0) | 7 (46.7) | 5 (33.3) |
| Preparing for APPE rotations | 9 (60.0) | 8 (53.3) | 11 (73) | 7 (46.7) | 6 (40) |
| Practicing inpatient pharmacy skills | 3 (20.0) | 1 (6.67) | 1 (6) | 1 (6.7) | 4 (26.7) |
| Answer choices | | | Most anxious about today's simulation† | | |
| Feeling unprepared | 10 (66.7) | 7 (46.7) | 9 (60) | 7 (46.7) | 7 (46.7) |
| Time limit | 1 (6.67) | 8 (53.3) | 5 (33.3) | 5 (33.3) | 5 (33.3) |
| Being observed | 3 (20) | - | - | 1 (6.7) | 1 (6.7) |
| Working independently | 1 (6.7) | - | - | 1 (6.7) | 1 (6.7) |
| Other | - | - | 1 (6.7) | 1 (6.7) | 1 (6.7) |

*Data are expressed as mean (standard deviation)
†Responses from the anxiety and confidence survey are expressed as number (percent)

The global measure of self-reported anxiety increased between the first and second simulation from a mean baseline of 4.73 ± 2.08 to a peak of 6.18 ± 2.66. Then the anxiety level decreased after the second simulation until the last simulated experience to a mean level of 2.57 ± 1.15. Most participants felt calm and could sit still easily during the fifth simulation activity. However, most participants felt their hearts beating fast during the first, second, and fourth simulation activities. Across all simulation activities, participants indicated that the main reason for their anxiety was that they felt unprepared.

The global self-reported confidence level decreased between the first and second simulation from a mean baseline level of 5.50 ± 1.86, then continuously increased until the last simulated experience to a mean level of 6.40 ± 1.68. The participants indicated that they were very much excited about the second simulation activity. Preparing for APPE rotations was cited as the main reason for the participants' excitement about the simulation activities. The total simulation time decreased from a mean baseline level of 41.13 minutes ± 5.86 from the first simulation experience to a mean level of 37.52 minutes ± 8.52 on the last activity.

Twelve students participated in the focus group. There was a universal contribution, but each question was not answered by every participant. Participants felt the experience led to self-directed learning, which led to modifications of their approach to care, individual accountability, identification of learning gaps and revisiting concepts. Summary findings from the focus group and the frequency of each thematic comment or answer are shown in Table III.

**Table III: Representative comments from the focus group (N=12)**

| Questions | Representative Comments (number of participants) |
|---|---|
| What were your expectations concerning what you would learn during SIM DOSE-P? Were these expectations met? | **Expected it to be similar to lab (3)**<br>"I thought it was going to be like lab. That was the only thing I could compare it to."<br>**Expectations exceeded (3)**<br>"I don't think I expected it to be so real life inside the room" |
| There were four major components of SIM DOSE-P, i.e., 1) the review in the electronic health record (EHR-GO), 2) the "patient" interactions with the simulation mannequin, 3) the development of the SOAP note and 4) the debrief video. Which of these elements did you feel was most important for your learning in SIM DOSE-P? Is there any other element or aspect of the SIM DOSE-P experience that you felt was important to your learning? | **Debrief video (3)**<br>"So, the video at least the first couple times helped me kind of realise how I need to approach the case and so that informed the other parts of it as well."<br>**Individual effort (2)**<br>"I really like that I got to kind of see what I know and what I need to work on, personally, instead of relying on the knowledge of my colleagues."<br>**Entire process (2)**<br>"I really like that we got to do it five times. It was the same set up, same process, different clinical information but it really helped establish 'this is what I need to do as a pharmacist'." |
| The schedule for SIM DOSE-P was 5 weeks long occurring at varying points from January to March. After how many simulations in the SIM DOSE-P schedule did you begin to feel competent? What influenced your feelings of competence? | **Number of simulations = 2 (1)**<br>"I think after the first one it was pretty easy to understand the process"<br>**Number of simulations = 3 (1)**<br>"During the first one, I feel like the person was pretty point-blank obvious what was going on. Whereas there was a couple of more…that were more in-depth"<br>**Either 2 or 3 simulations (verbal group affirmation)** |

| Questions | Representative Comments (number of participants) |
|---|---|
| | "I think after the first one it was pretty easy to understand the process but more like the disease state might be or the complexity of the patient that made me feel more uncomfortable" |
| Do you think that participating in SIM DOSE-P has influenced your performance in your other academic classes? | **Lab (2)**<br>"Sometimes…in lab you have that safety net, like was spoken of before, you have other people with you so if you forget something, someone's there to pick up the slack. That wasn't here for this, so it really helped to formulate that confidence."<br>**General confidence (3)**<br>"I think especially tying it back into the video, it was also a confidence builder. I got the end of the video and you're just like 'Man, I actually knew how to do that'." |
| If you were to tell a prepharmacy student about SIM DOSE-P, how would you describe the learning or types of learning that occurred in the experience? | **Self-directed learning (2)**<br>"You may not get as much out of it. I feel like if you're not going to drive yourself, to kind of put yourself in that mindset of simulation of you caring for a patient."<br>**Patient care process (4)**<br>"I feel like it gives you like a holistic approach…you're by yourself having to figure everything out on your own."<br>**Safe learning environment (1)**<br>"I think the biggest key point to stress to them is it's safe...you're not going to be punished for doing it if you get it wrong…you're just going to learn from it and move on." |
| To what degree did you find SIM DOSE-P realistic/authentic to what you expect to experience on a hospital based APPE? What made SIM DOSE-P unrealistic/unauthentic? | **Closest experience to date (3)**<br>"I felt more prepared for rotations in those 5 weeks than I've ever felt."<br>**Felt unprepared for communication in this setting (9)**<br>"You know, it's a more serious situation than just 'I have a runny nose.' 'I have a fever.' And so it was awkward." |
| Did you ever look up information after the simulation for your own learning? | **Yes (verbal group affirmation)**<br>"When you go and you have looked up the answer and then you go watch the video, it's like the small wins are bigger than you think it's going to get." |
| Do you feel you became more efficient over time? | **Yes (verbal group affirmation)**<br>"Going into the next one I was like I need to set these priorities to really just help structure the way I've thought about it." |

APPE = Advanced Pharmacy Practice Experiences
SIM DOSE-P = Structured Incremental Measurement of Directed Objective Simulation Experiences-Pilot
SOAP = Subjective, objective, assessment, plan

## Discussion

This study was the first to evaluate repeated practice in acute care simulation settings not associated with coursework. It was intentionally designed with multiple measures of learning, time efficiencies, and student perception of the experiences. Students were free to practice in a safe and controlled learning environment since this experience was not associated with a course grade, and participant blinding was maintained. Case content was not known to participants before each simulation, which increased the realism of what students should expect on clinical rotations and ultimately in practice and allowed for the authenticity of the experience. This design also led to self-directed learning because students could identify their own learning gaps in clinical prowess and other skills like data retrieval and communication. These elements were expressed by focus group participants.

This study demonstrated improved but inconsistent written performance across the five simulated cases. As participants gained experience, performance was expected to improve with each case iteration and eventually plateau, which did not occur. There are several possible reasons for this finding. First, the investigators attempted to control cases for complexity by using established criteria, but some content may be more difficult for students. Second, simulation schedules were not adjusted based on competing priorities such as tests or project deadlines. Similarly, efforts were not assessed, which could have been variable based on internal motivation. However, the cohort was generally high-performing, with 53% of students reporting a grade point average of 3.5 or higher. Third, to ensure blinding of all participants and accommodate variable time slots for participants, a pre-recorded video debrief was used to help students learn about elements they should have identified in the case as opposed to individual debriefs. Video debriefs

appeared to be a unique feature of our study and allowed participants to compare their performance against the content in the video debrief and make adjustments accordingly. However, because of this design, participants were not provided with individualised feedback via structured debriefing, a form of clinical teaching that helps ensure simulation participants get to the right thinking and right action through a facilitated discussion with active reflection (Dreifuerst, 2015). During the focus group, most participants reported looking up information they may not have remembered when evaluating and making recommendations about the case. As evidenced in SOAP notes, video debriefs allowed participants to get to the right thinking and some elements of the right action.

The global measure of anxiety increased after case one but then consistently decreased. Although anxiety was expected to decrease with each iterative experience, it was not surprising it increased prior to the second simulation. Before case two, each participant had gained some experience and time to reflect on their performance, which likely influenced their anxiety score. The source of anxiety for most was feeling unprepared and time constraints (Table II). Levels of anxiety can influence performance, as shown in a nursing student simulation, where the classic inverted-U relationship was found but skewed to the left such that lower levels of anxiety resulted in better performance (Al-Gareeb *et al.,* 2019). However, the examination of Table II does not suggest an inverted-U relationship between the global measures of self-reported anxiety and performance in our participants.

Student-reported confidence was mainly unchanged across all cases. It was reassuring that confidence was highest before the last case, though self-reported global confidence scores were still in the mid-range (mean 6.40 ± 1.68). Practice through simulation is an effective way to ensure student readiness for patient care. The relationship between confidence and performance should be well aligned with knowledge and skills to be ideal practitioners; too little confidence results in a lack of appropriate action to impact care, while overconfidence can result in harm because of incorrect thinking (Wongwiwatthananukit, Newton & Popovich, 2002). There was general agreement between mean performance scores and self-reported confidence, indicating participants had adequate ability to assess their self-confidence (Table II).

Despite time being the most commonly cited source of anxiety, participants generally used less time as cases progressed. Some potential efficiencies were gained by participants as they gathered and evaluated clinical information, visited the simulated patient, and wrote their SOAP notes without adversely affecting performance. Focus group participants indicated they learned from each experience and modified their approach, which increased efficiency (Table III). The time blocks were also reassuring, should this model be adopted at other institutions or incorporated into course design, because it could demonstrate the ability to simulate complex acute care cases using a standardised approach when time is limited.

The ultimate "dose" of simulation needed for individual programmes must be balanced against available resources, desired outcomes, and overall curricular design. Participants in the focus group reported needing at least two or three simulations before they become comfortable with the process and develop an approach to patient care in this setting. Indeed, repeated experiences are necessary for students to gain confidence, reduce anxiety, and test their overall ability. The design of this investigation led to self-directed learning and natural inquiry based on simulation experiences. Although the durability of the knowledge and skills were not measured in this study, the fact students volunteered and engaged in natural professional development was exciting.

There are no published reports similar to the design of this project. However, several investigators have utilised multiple-simulation experiences in acute care settings (Vyas *et al.,* 2010; Seybert *et al.,* 2011).

Vyas and colleagues used three acute care simulation scenarios to supplement introductory pharmacy practice experiences for 28 students. Each scenario was completed by a team of two to four students, and their main outcome measures were changed in self-reported confidence and individual scores on knowledge-based quizzes before and after each simulation. The results showed improvement in the proportion of students, with an increase in ten measures of confidence (comparing before simulation and after completing the simulation series) and improvement in individual quiz scores for the three simulation scenarios. The strength of this paper was the comprehensive nature of confidence measurement. Each measure focused on pharmacy-specific tasks, such as using drug information resources, identifying medication-related problems, communicating, and working-up patients in limited time.

Seybert and colleagues reported their experience with 13 pharmacy students who were enrolled in an acute care elective. In groups of four to five, students completed weekly simulation scenarios focusing on acute-care topics, such as anticoagulation, sedation, or shock. Students were provided with formative feedback through debrief sessions after the weekly simulation experience. They were also assessed

through individual pre and post-simulation quiz scores on the weekly topic, which consistently improved post-simulation. Another individual assessment point was the completion of a midterm and final simulation activity assessed using a rubric consisting of the following domains: introduction to the patient, data collection or interpretation, pharmacotherapy plan, and verbal communication. Average scores were statistically similar at both midpoint and final evaluation. A strength of this report was the use of a simulation to measure individual performance twice during the term using a rubric.

In both studies described above, knowledge-based performance was assessed pre and post-simulation, thus only reflecting the effect of a single focused simulation. Additionally, much of the simulation experiences were in groups as opposed to individual efforts, contrary to our report, which entailed individual student efforts, used scenarios not known by participants before starting the simulation, and assessed performance with a rubric focused on reliable, professional activity elements of performance expected in clinical practice.

### *Strengths and limitations*

This study has several strengths. First, participation was completely voluntary and not associated with academic credit. Second, it was an individual experience sustained over five weeks, and written performance was assessed using an internally validated rubric based on EPAs. Third, it contained realistic elements modelled after pharmacy practice in hospital settings, including the timing of case content, the use of an electronic health record, and a simulated patient hospital room with trained actors. Fourth, it utilised a standard approach to ensure similar case complexity. Lastly, it used blinded assessment of SOAP notes.

This study also has several limitations. First, the number of participants who completed the study was relatively small and may not represent all pharmacy students in the final year of the didactic curriculum. While their participation provided valuable information, our power to detect differences through statistical measures was hampered. Second, despite controlling for case complexity, performance on cases may be influenced by the timing of topics in the didactic curriculum and individual student academic prowess. Lastly, clinical performance was measured with a written note, which is only a single, albeit important, element.

## Conclusion

Weekly acute care simulation experiences did not demonstrate consistent improvement in individual written note-performance over the five cases. There were some between case trends in measures of anxiety, confidence, and time required to complete all elements of the simulation experience. Although a definitive recommendation on the "dose" of acute care simulations cannot be made, there are benefits with repeated exposure, which must be balanced against resources and desired outcomes.

## Conflict of Interest

The authors declare no conflict of interest.

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