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Experiences in Teaching and Learning

Using simplistic simulations to enhance learning in a nephrology pharmacotherapeutics module

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ABSTRACT

Background and purpose: The purpose of this study was to evaluate the effect of a simplistic simulation exercise in a nephrology module on pharmacy students' learning in a three-year concentrated curriculum.
Educational activity and setting: Second year pharmacy students participated in a two-part simulation on electrolyte imbalances and dialysis in a nephrology pharmacotherapeutics module. Students completed a seven-item anonymous survey at the end of the simulation on a five-point Likert scale to examine the effect of the simulation and their attitudes to the exercise. Additionally, exam scores were assessed at the end of the module to measure learning.
Findings: A total of 65 students completed the activity. Seventy-eight percent of students agreed that the simulation was a valuable learning experience and 76.9% reported that the simulations gave them real-world knowledge. Exam scores in the group who performed the simulations were higher on the assessment compared to those without the experience ($p < 0.01$)
Discussion and summary: Participation in the simulation had positive effects on students' attitudes, learning, and exam scores. This experience was a successful active-learning method for enhancing learning in pharmacy education.

Background and purpose

Simulation has emerged as an active-learning strategy in recent years and has gained more popularity in the pharmacy curriculum. Elements in simulation can vary in complexity from the inclusion of low-tech simulators, such as replica models, to high fidelity simulations, such as full-body programmable manikins.[1] Partial task trainers in which models are used, and peer-to-peer learning where collaboration between students facilitate the development of skills, are simplistic methods in simulation that help enhance competency while mirroring reality.[1] As an educational tool, simulation has been regarded as a method to achieve competency-based learning in a controlled environment.[2,3] Literature using simulation in pharmacy education has primarily focused on using advanced simulations to optimize learning outcomes and to allow for the integration of clinical skills into the curriculum.[4–6] This article focuses on using simplistic simulations in a nephrology module in a large classroom setting and their effects on students' attitudes and learning.

Educational activity and setting

Two simplistic simulation activities were performed as part of a nephrology pharmacotherapeutics module for a class of sixty-five

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students during their second-year of pharmacy school in a concentrated three-year curriculum. The purpose of the simulations was to integrate lecture material in a real-world setting to facilitate learning and to master exam concepts. The first simulation was completed after 12 hours of therapeutic lectures on fluids and electrolytes, two hours of which covered potassium disorders, and two hours focused on phosphorous disorders. The second simulation activity was completed after a five-hour lecture on chronic kidney disease. These simulations were each allotted approximately 60 min to be completed over two separate days of course instruction.

The objectives of the first simulation were to demonstrate the principles of admixing and to review the management of hyperkalemia and hypophosphatemia. The activity focused on fluids and electrolyte disorders where students first viewed a five-minute video on parenteral compounding and sterile technique before the activity. This video was a review about the concepts of sterility which the students received during their first didactic year of pharmacy school. Using the principles from the fluids and electrolytes lecture, a patient case on hyperkalemia with cardiac conduction abnormalities was presented where students identified the etiology and treatment options. Students were then asked to calculate and create an intravenous solution of 1 g calcium gluconate, the drug-of-choice to manage hyperkalemia with electrocardiogram changes. After injecting calcium gluconate in a 250 mL intravenous dextrose 5% bag and calculating the infusion rate, students were introduced to the second part of the case where the patient concomitantly had low phosphorus levels upon laboratory follow-up. Students were asked how they would react if the doctor in the case decided to administer 30 mmol of sodium phosphate into the same bag as the calcium gluconate. The *King Guide to Parenteral Admixtures* on Lexicomp® and *Trissel's Stability of Compounded Formulations* on Micromedex® were used to determine the nature of the reaction between the two compounds. Students were instructed to inject sodium phosphate into the calcium gluconate bag to witness a precipitation reaction.

The objectives of the second simulation were to familiarize students with diffusion principles across a semipermeable membrane during dialysis and to understand the types of substances needed to maintain homeostasis in the body. Students were asked to create a dialysis machine and replicate the properties of diffusion using a procedure modified from Science Take-Out.[7] Copyright clearance was granted for the activity. Serpent skin tubing was used to mimic dialysis tubing and one end was tied in a knot. Students mixed red blood cells (red glitter), glucose, protein, and salt into a urea solution (water with yellow dye) to mimic artificial blood. The artificial blood mixture was then poured into the tubing. The tubing was placed in a hot water bath that represented the dialysate fluid of the hemodialysis machine. After 10 min, the dialysate fluid was analyzed with a pH indicator strip and a Siemens Multistix® reagent strip to determine the diffusion of urea, protein, glucose, salt, and red blood cells across the semi-permeable dialysis membrane. If salt was present in the dialysate fluid, the pH paper turned from light green to dark green. If protein was present, the Siemens Multistix® reagent strip turned from light green to dark green or blue at the protein calibration. If glucose was present, the Siemens Multistix® reagent strip turned from blue to green or brown at the glucose calibration. The diffusion of urea and red blood cells across the semi-permeable membrane was determined visually in the dialysate. Students then completed a chart about which substances diffused from the dialysis membrane into the dialysate, and whether these substances should be added back into the dialysate to maintain homeostasis.

Students formed groups of five or six each to complete the two-part simulation series. Both activities were completed in a large lecture hall where the students could rearrange their chairs into teams. During the group activity, a recorder and a presenter for each team were selected by the instructor. However, each member of the group was expected to participate in the manipulations for hands-on experience. Once the simulations were complete, students discussed the results within their groups for 10–15 min, and then groups were randomly selected to present their findings to the class. The whole-class discussion focused on the therapeutic principles and its application in a real-world setting.

Evaluation of the simulations included an anonymous seven-item post-survey inquiring the students about their experiences with the activity. Responses were based on a Likert-type scale with "1" being "strongly disagree" to "5" being "strongly agree." Independent *t*-tests where the differences between two means comparing the group that disagreed and strongly disagreed to the statement to the group that agreed and strongly agreed was completed. Students were also asked to provide written comments about their thoughts on the experiences and recommend suggestions for improvement. Additionally, exam scores from the nephrology module in which objectives from the simulation exercises were incorporated were compared to the prior pharmacy class who completed the modular exam without the simulations. There were eight questions on a 70-item test that assessed the objectives outlined in the simulations. The exam questions from both years were standardized and there were no changes with the content. Each of the eight exam question responses were analyzed using chi-square tests, and overall exam results were analyzed with a student *t*-tests using a two-sided 95% confidence interval. Demographics data was analyzed with chi-square and student *t*-tests. Data reporting, descriptive and statistical analyses were conducted using SPSS® and Minitab®. The study was approved through the investigational review board.

Findings

Student demographics are shown in Table 1, and there were no statistically significant differences between the two class cohorts ($p > 0.05$). Overall, students who were exposed to the simulations expressed high levels of satisfaction with this type of learning experience (Table 2). Fifty-one (78.4%) students agreed that it was a valuable learning experience that actively engaged their learning ($p < 0.01$). Additionally, 76.9% responded positively that the simulations gave them real-world knowledge ($p < 0.01$), and 63.1% reported that the activity facilitated their learning of test material ($p < 0.01$). There were eight exam questions that tested the objectives outlined in the simulations that were standardized between the two class cohorts (Table 3). The students who were exposed to the simulations performed better on all eight exam questions pertaining to these therapeutic concepts ($p < 0.05$). The class ($n = 65$) who completed the simulation activities achieved a mean score of 83.3 ± 8.3% on the overall exam of 70 questions