Bulletin of Health,
Science and Technology
BHST
ISSN 0858-7531
Volume 13, Number 2, 2015 : 31-38

EVALUATION OF SIMULATION INTRAVENOUS ADMIXTURE TRAINING FOR STUDENTS ENROLLED IN AN INTRODUCTORY PHARMACY PRACTICE EXPERIENCE

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Abstract: The purpose of this study was to evaluate the effect of the addition of simulation intravenous admixture laboratory training sessions for the first year Doctor of Pharmacy (PharmD) students prior to participating in the Introductory Pharmacy Practice Experience (IPPE) at the hospital. Students completed six hours of structured training sessions in the principles of aseptic technique and intravenous (IV) admixture preparation, including simulation of hospital procedures. At the end of the IPPE hospital rotation, students completed the survey related to their perceptions towards the simulation training of IV admixture/hospital experience prior to the IPPE, the IV simulation sessions, and the degree to which the sessions helped to increase their confidence in performing activities encountered during hospital rotation. Students reported very positively that the IV training sessions benefited them in multiple areas. The simulation training should become an effective approach to integrate into the coursework for the IPPE hospital experiential rotation.

Keywords: Intravenous admixture, Sterile compounding, Simulation, Introductory Pharmacy Practice Experience, IPPE

INTRODUCTION

Quality of a pharmacy student to be successful while enrolled in the Introductory Pharmacy Practice Experience (IPPE) courses requires his/her critical thinking and application of knowledge and skills with confidence, a capability to reason, and an ability to contextualize a given situation. In many cases students lack confidence in the ability to perform tasks during rotation and share these thoughts in reflection statements and debriefing sessions.

PharmD students often enter pharmacy practice rotations in the first professional year (PY1) with limited or no prior pharmacy experience. Mar, et al. reported 18.2% of pharmacy students (N=206) had experience in a hospital inpatient setting prior to matriculation.

Research demonstrated by Ratka, et al. showed 9.2% of second-year students (N=75) had experience with sterile compounding procedures prior to enrollment in their first sterile compounding laboratory course. Other articles describe sterile IV compounding simulation in the third year (PY3) of curriculum and the evaluation of sterile compounding skills in preparation of student entry to advanced rotations or entry level practice. Eukel, et al. describes curricular design of a PY3 IPPE using simulation in a pharmaceutical care laboratory course that included assessment of skills in sterile compounding activities for a simulated patient using a rubric. Research by Cretton-Scott, et al. involved the assessment of two cohorts of PY3 students participating in IPPE simulation IV exercises who completed a simulation sterile compounding laboratory course as a PY1 student. It was concluded that providing opportunities for advanced pharmacy students to review sterile compounding before entering pharmacy practice would allow them to refine their skills. Nevertheless, research on integrating the simulation training of aseptic technique and IV admixture preparation as a part of coursework prior to PY1 IPPE hospital rotation is non-existent.

At the University of Hawaii at Hilo Daniel K. Inouye College of Pharmacy (DKICP), the early years of the IPPE hospital rotation included some IV training provided by one hospital pharmacist preceptor as students began their hospital rotation. This preceptor was included in the full time pharmacy staffing of this 275 bed community hospital providing everyday pharmacy services in addition to student responsibilities. As a result, IV admixture training for students at the hospital was inconsistent, valuable experiential time was not well utilized and the preceptor had to repeat foundation steps up to 45 times per academic year for all the students who were scheduled. The only foundation intravenous experience the PY1 student had at the DKICP was a two-hour lab linked with the PY1 pharmaceutics course. Due to non-synchronous scheduling of the IPPE hospital rotation and the pharmaceutics labs, many students actually had the lab after the IPPE hospital rotation.

Sterile preparation of IV admixture must comply with the United States Pharmacopeia 797 (USP 797) standards for quality and is most commonly practiced in the hospital practice setting. In accordance with the Accreditation Council for Pharmacy Education (ACPE) Standards guideline 14.5, structured simulation (SIM) may be used to meet introductory pharmacy practice experience goals and objectives. In the 2011-2012 academic year, the existing PY1 IPPE hospital rotation coursework at the DKICP was adjusted to include a SIM IV simulation training program to provide students with the fundamentals of compounding sterile products and to practice techniques and refine skills utilizing safe practices in a simulated environment. The ultimate goal was to provide consistent foundation training for the students prior to the IPPE hospital rotation so they could apply and transfer their simulation training skills to the actual IV admixture activities component of IPPE hospital

rotation, to utilize the limited time given in this hospital rotation, and to lessen the training time needed from the hospital preceptor.

The purpose of this study was to evaluate the effects of integrating simulation IV admixture training sessions (SIM IV) prior to PY1 hospital rotation regarding assessing individual areas of IV lab simulation training, training overall, students' perception of the benefit of the simulation training, and a hospital preceptor's perception regarding student performance with IV admixture activities. Secondary objectives were to determine percentages of students with prior hospital and/or sterile product preparation experience and to examine if this prior experience impacted the effectiveness of the training.

MATERIALS AND METHODS

This cross-sectional survey study was conducted to assess the study objectives. The study was reviewed and deemed exempt by the University of Hawaii Human Studies Program Institution Review Board. Student participation was voluntary and students could opt out of the survey only, but not the SIM IV training exercise.

Prior to IPPE hospital rotation, students completed structured training sessions in the principles of aseptic technique and IV admixture preparation, including simulation of hospital procedures. The entire PY1 class of 90 students was divided equally into six training groups of up to 16 students. Training for each group was purposely set to coincide with the start of each groups' associated hospital rotation blocks that were scheduled throughout the academic year. This was done to improve recall of activities and generate student confidence with techniques. The SIM IV training was coordinated and taught by the same faculty instructor for all six groups. The one pharmacist preceptor at the local hospital remained the same. The simulation exercise was not graded but students were observed how they performed skills, provided feedback, and suggested changed to improve their competence and performance by an instructor. If students had adequately demonstrated proficiency in the SIM IV skill assessed, the instructor signed off upon successful completion of the skills portion of the coursework.

Description of Instruction

Concerns with IV admixture activities were identified by the clinical education coordinator (faculty pharmacist) when assessing PY1 hospital experiential rotations. In an effort to better prepare students for IV admixture activities and maximize experiences at the hospital rotation, additional training including simulation was added to the coursework for students to complete prior to the start of IPPE hospital rotation.

Each group's instruction was completed over two consecutive days and consisted of lecture, viewing selected portions of video from the American Society of Health-System Pharmacists (ASHP) Compounding Sterile Preparations USP 797 and ASHP Aseptic Compounding, with discussion and active learning sessions interspersed. Figure 1 describes the activities for the two days of training.

Day 1 Exercises- 3.5 hours

1. Introduction to compounding sterile preparations (USP 797 overview, roles and responsibilities, patient safety, current events, out-sourcing and in-sourcing, lecture, video, discussion)
2. Principles of aseptic technique and compounding environments (lecture, video, discussion)
3. Getting familiar with labeling and products used in IV admixture (lecture, video, discussion, hands-on exercises)
4. Introduction to and use of key IV admixture drug information resources (compare and contrast various resources, adult and pediatric)
5. Hand hygiene and garbing (hands-on exercises including use of glow germ system to enhance awareness of proper hand washing technique)
6. Cleaning, disinfecting, and preparing the laminar flow hood
7. Bench top compounding (vial and ampule, with additive to IV bag)
8. Homework assignment for day 2 IV admixture exercises (prescriptions with admixture research and calculations required)

Day 2 Exercises- Up to 3 hours

1. Review of principles and techniques from day 1
2. Review and discussion of homework; prepare IV label
3. Prepare IV admixture for 3 prescriptions (includes drug vial reconstitution, ampule, additive to IV bag, label)
4. Sign-off for satisfactory completion of training

Figure 1. Description of Instruction in Simulation IV Training Sessions (SIM IV)

Basic IV admixture training for each group started in the pharmaceutics lab on Day 1 with bench top activities and training kits. Smaller breakout groups then moved to the hospital simulation room to utilize the laminar airflow workbenches and supplies. During day 2 activities students worked in a simulated hospital environment with primary and secondary engineering controls and followed USP 797 standards. Students reviewed IV admixture prescriptions and drug information, performed calculations required for reconstitution and administration flow rates, prepared IV labels and selected items needed from supply shelves where look-alike products were stocked. Once garbed and working in the clean room environment, standards for ante area, buffer area, and segregated compounding area were upheld. Any breaks needed during the session required sterile compounding practice standards to be followed, including de-garbing when leaving the clean room lab, and hand hygiene and re-garbing before continuing IV admixture.

Students obtained sign off from the SIM IV instructor for each of the day 1 and day 2 exercises as they had adequately demonstrated proficiency in the SIM IV skills and successfully completed all tasks listed in Figure 1. Day 2 exercises culminated in over-all training sign off as students prepared IV admixtures from prescriptions and were evaluated and provided feedback individually by instructor direct observation. Rubrics based on USP 797 standards were used for evaluating the proficiency of admixture skills with ampules, vials, garbing/gloving, hand-washing, and general aseptic and safety techniques. Students were required to achieve proficiency of all IV admixture sterile compounding skills before obtaining final signing off by the instructor.

Data Collection

A survey was administered to students after completion of both the SIM IV and the IPPE hospital rotation. Students who did not want to participate in the survey could turn in a blank survey. Identity protection codes were developed to take the place of student names on surveys. Completed surveys were placed face down in the center of the table and shuffled prior to being collected to ensure anonymity. A Likert scale was used for survey statement responses. Two additional questions were used to assess the number of students who had prior hospital and sterile technique experience prior to the SIM IV and IPPE hospital rotation. The one hospital preceptor involved gave feedback regarding student performance with IV admixture activities while on rotation. The feedback was qualitative, obtained during conversation after rotations were completed.

Data Analysis

Likert scale scores were averaged to produce a mean score with standard deviation in three categories: (1) all students, (2) students with prior sterile preparation experience, (3) students without prior sterile preparation experience. Descriptive statistics were calculated and analyzed using IBM SPSS Version 22. Independent *t* test was performed to compare experienced and non-experienced students for each of the survey items. Level of significance for all analyses was set at an alpha ≤ 0.05.

RESULTS AND DISCUSSION

As with any new coursework it was important to evaluate the impact of this new additional instructional method, the perceived benefit to students and to the hospital preceptor. We believe our research study would help to determine if the additional hours of SIM IV training would add value, and if it should become a part of the IPPE curriculum. When students completed the SIM IV training and hospital rotation they were invited to participate in the survey to evaluate the IV training. The entire class of 90 students participated in the training and all students elected to participate in the survey. Demographics, hospital background and sterile compounding experience of the 90 students are illustrated in table 1.

Table 1. Student Demographics and Experience Characteristics

Characteristic	N=90	
Age	25 Average (Range 20-68)	
Gender	Female 48 (53.3%)	Male 42 (46.7%)
GPA	3.25 Average	
Prior hospital experience	Yes 24 (28%)	No 66 (72%)
Prior sterile compounding experience	Yes 19 (21%) N=7, Less than 1 month N=4, 2-4 months N=8, 1-5 years	No 71 (79%)

Overall, 28% of students (24/90) had some hospital experience (undefined type) prior to the SIM IV. Students also reported how much time they spent preparing sterile products prior to the training; this ranged from none to 5 years. No correlations could be made with sterile compounding experience being a result of hospital experience. Table 2 lists the mean of students' scores when self-evaluating the impact of SIM IV training in the laboratory, with consideration of prior experience.

Table 2. Mean of students' scores on the impact of IV Laboratory Training, with consideration of prior experience

Responses based on the Likert scale: 1=strongly disagree; 2=disagree; 3=neutral; 4=agree; 5=strongly agree

Survey Statement	All Students N=90 (SD)	With Exp[a] N=19 (SD)	No Exp[a] N=71 (SD)
IV Lab Training (Days 1 and 2)			
The content and learning materials addressed a need for, or a gap in my knowledge relative to compounding IV admixtures	4.16 (0.72)	4.37 (0.68)	4.03 (0.81)
Lecture and video on introduction to compounding sterile preparations prior to rotation benefited me on rotation	4.11 (0.76)	4.32 (0.67)	4.00 (0.84)
Getting familiar with IV admixture products and devices prior to rotation benefited me on rotation	4.56 (0.54)	4.63 (0.60)	4.48 (0.67)
Assignments and activities done in the IV lab were relevant to the objectives of the rotation	4.39 (0.65)	4.53 (0.51)	4.30 (0.78)
Practice with hands-on preparation of IV admixture within the laminar flow hood benefited me	4.53 (0.64)	4.63 (0.50)	4.45 (0.79)
I can locate resources/references that relate to IV admixture	3.72 (0.88)	3.95 (0.91)	3.66 (0.88)
While on rotation I was able to apply what I learned in IV lab	4.53 (0.57)	4.63 (0.50)	4.44 (0.71)
Overall Training			
The range of skills I was exposed to during training increased my confidence for doing rotations in the hospital environment	4.09 (0.68)	4.16 (0.76)	3.96 (0.82)
While on rotation I could recognize medication safety techniques that I learned in training	4.18 (0.76)	4.32 (0.58)	4.08 (0.87)

Abbreviation: Exp = experience preparing sterile products
(SD) = Standard deviation
[a] Independent *t* test used; no significant difference for no experience vs with experience; significance set at $\alpha \leq 0.05$

Results of the students' responses to survey statements revealed scores for all nine statements listed in Table 2 ranged between 4 (agree) and 5 (strongly agree), with the exception of one statement; being able to locate IV admixture resources/references which scored 3.72, the lowest scoring statement. This lower score may be due to the fact that this one element of training was not consistent for all groups. Due to an oversight one group did not have exposure to any of the injectable drug information resources during training so may not have been adequately equipped to locate resources.

Ninety-eight percent of students felt that getting familiar with products and devices prior to rotation was beneficial; this was the highest scoring survey statement, mean 4.56. Ninety-six percent of students agreed that they were able to use what they learned in the

training sessions while on hospital rotation, scoring next highest, mean 4.53. Students felt practice with hands-on preparation of IV admixture within the laminar flow hood benefited them, also scoring mean 4.53. Eighty-two percent agreed the IV lab training, content, and learning materials addressed a need for, or a gap in knowledge, relative to the experiential compounding IV admixture rotation.

The preceptor evaluation of overall first- year student performance was obtained at the completion of all hospital rotation blocks. This individual who was also preceptor in the past to the now second- and third-year pharmacy students, each of which consisted of 90 PY1 students, was able to compare and contrast student readiness for IV admixture hospital rotation activities. Qualitative reports from the hospital preceptor noted students in this study entered rotation prepared for IV admixture activities whereas students from earlier rotations often did not. Based on direct observation of students, the preceptor perceived this cohort of students to perform IV admixture activities better than previous cohorts and supported continuing the new instructional method.

In regards to the study's secondary objectives, survey results showed 28% of the students had prior hospital experience (Table 1). The type of hospital experience was not defined in this study. Since much of IV admixture compounding is done in the hospital setting, there was interest in gathering data regarding prior hospital experience and to identify prior experience with sterile product preparation. Findings revealed 79% of students (71/90) had little or no experience with sterile product preparation prior to the SIM IV instruction. Of interest, although a correlation could not be made with type of hospital experience and sterile compounding experience, only three students with hospital experience cross-matched with those who prepared sterile products in the past.

Students with prior experience preparing sterile products scored higher mean scores on all nine survey statements when assessing benefit and relevance of the IV lab training when compared to students without experience. However, independent *t* test analysis of the survey elements showed no significant difference between the experienced and non-experienced student groups, with significance set at $\alpha \leq 0.05$. Analysis of survey responses showed that the SIM IV training was well-received and benefited students of all types, those having prior experience with preparing sterile products as well as those without. Survey outcomes provided "value-added" reasons for continuing the new training and simulation activities with future classes to prepare students for hospital rotation. This has been folded into the PY1 curriculum and remains today with some minor modifications.

Study limitations

A self-assessment tool (survey) was used by students to evaluate perceived benefit of training and application of skills. Pre and post-demonstration of practical skills would provide stronger evidence to support continuation of added training. For safety reasons there was no pre-demonstration IV admixture compounding conducted prior to the SIM IV training. There were concerns if students were completely unfamiliar with proper techniques for handling needles and sharps, this could pose a safety risk. Although there was a post-training demonstration as part of training sign-off, no comparison could be made to pre-training competence.

There were several additional limitations to this study. First, data was evaluated for one class year and results may vary from class to class or due to changes with compounding

activities at the practice site. Secondly, there was no control group either simultaneously or historical. All students participated in the SIM IV prior to hospital rotation activities. Additionally, although post-course assessment of student perceptions may be considered a weak design to determine the valid achievement of learning objectives and course outcomes for this study, we believe the primary consideration was the quality of training students were receiving. Future research should include a pretest-posttest design approach to determine the improvement of the student knowledge, performance, and perceptions of the SIM IV as a result of this simulation training.

CONCLUSION

Most students perceived benefit of the IV admixture simulation training prior to IPPE hospital rotation as an effective means to develop their confidence and skills needed for activities encountered during IPPE hospital rotation. The hospital preceptor also perceived the benefit of this additional simulation training prior to the rotation.

ACKNOWLEDGMENTS

The authors would like to acknowledge the Class of 2015 and thank them for their participation as the first-year pharmacy students in this research project. This work was presented in part as a poster at the 2013 annual meeting of the American Association of Colleges of Pharmacy (AACP), Chicago, Illinois.

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