ORIGINAL ARTICLES

Manikin-Based Clinical Simulation in Chiropractic Education

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Objective: The purpose of this pilot investigation was to describe the development and implementation of simulation exercises and investigate the feasibility, satisfaction, and relative effectiveness of a manikin-based simulation program in chiropractic undergraduate education. **Methods:** This investigation consisted of (1) a qualitative review of other simulation environments and evaluation of related simulation literature to develop the educational processes to be used, (2) implementation of simulation scenarios for 95 student interns and their 11 supervising clinicians, and (3) implementation of simulation scenarios in a random sample of 35 1st-year and 24 2nd-year chiropractic students. Assessment of success was based on results from satisfaction and usability questionnaires and perceived achievement of learning outcomes. Anxiety scores were measured for all participants via a visual analog scale. The level of successful integration of 2nd-year basic science material was assessed using a *t* test comparing test results between students who participated in the pilot and those who did not. **Results:** Implementation methods were developed on the basis of qualitative investigation. Simulation program feedback from all participants indicated high levels of satisfaction, usability, and perceived achievement of learning outcomes. Anxiety levels among interns differed according to role chosen ($F = 8.07$, $p = .00$). Mean difference in course examination scores of students who participated in simulations versus those who did not was 3.25% favoring students who participated ($t = 1.28$, $p = .10$). **Conclusions:** High levels of student satisfaction and perceived achievement of learning outcomes were consistently achieved. A trend to successful integration of basic science knowledge provides reason for cautious optimism. More research is recommended. (J Chiropr Educ 2012;26(1):14–23)

Key Indexing Terms: Chiropractic; Education; Manikin

INTRODUCTION

This pilot project is intended to add to current knowledge in chiropractic education by providing data related to our chiropractic college's initiation of manikin-based simulations to facilitate clinical and basic science learning. Review of the literature indicates that this is the first study of the use of such simulations in a chiropractic setting. Because information regarding the use of simulation technologies in chiropractic colleges has not been available to date, this report has three aims:

1. To describe the development of the simulation learning program;
2. To describe the implementation of the simulation experiences; and
3. To provide pilot data regarding the feasibility, satisfaction, and relative effectiveness of such a program for inclusion in the chiropractic curriculum.

Educators in health care are challenged to provide uniform, case-based, real-world experience to all students when considering the diagnosis and care of patients with complex and rare conditions. In an effort to face this challenge, simulation environments using technically sophisticated, life-size manikins have been created for use in medical, nursing, and paramedic schools.[1–6]

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The success and popularity of simulation programs in health care, as well as the educational theories on which they are based, have led to a Best Evidence Medical Education (BEME) Collaboration[7] effort to characterize the important features of simulation experiences that lead to effective learning.[8] The BEME "involves an international group of individuals, universities and organizations (e.g. Association for Medical Education in Europe (AMEE), Association of American Medical Colleges (AAMC)), committed to moving the medical profession from opinion-based education to evidence-based education"[8] and can be likened to the Cochrane Collaboration for clinical care. The BEME review of simulation-based learning concluded that while more rigorous research is required, clinical simulation exercises are effective.[8] The evidence-based features associated with effective learning (largest preponderance of best evidence to smallest) from that review are listed as follows:

A. Providing feedback
B. Repetitive practice
C. Curriculum integration
D. Range of difficulty for simulations
E. Multiple learning strategies used
F. Clinical variation captured
G. Controlled environment
H. Individualized learning
I. Defined learning outcomes
J. Simulator validity

Such simulation environments have not been documented in chiropractic educational institutions for the teaching and learning of complex cases that may enter the future chiropractor's office environment. Dr. Roger Kneebone, once a general surgeon and now famous for his work at the Imperial College, London, in simulation and the contextualization of clinical learning, speaks of simulation in health care as

> . . .a safe space which can reflect the uncertainties of clinical practice and recreate the conditions of real-world learning. By reintroducing complexity and human unpredictability, simulation can provide a safe environment for assisting the transformational change that is essential to becoming a competent clinician.[9] (p. 954)

The foundational constructs to professional health care education via manikin-based simulation is grounded in a tremendous number and wide variety of learning theories.[10] These include reference[10,11] to Kolb's learning cycle from 1984[12] (wherein a feedback loop exists between abstract conceptualization, active experimentation, concrete experience, and reflective observation), as well as sociocultural learning theories related to horizontal integration,[11] whereby, as pointed out by Griffiths and Guile,[13] learning in work-based contexts allows students to practice actively extracting from their academic knowledge the relevant facts and issues to be applied in the workplace.[13]

Of particular relevance to the methods involved in the simulation process considered for this pilot study is Atherton's "know/don't know cycle,"[14] wherein finding a safe way to help a student understand and appreciate his or her lack of knowledge and clinical skill can be very helpful in claiming the student's attention necessary to facilitate the transfer of knowledge and skill.

In evaluating the many theories related to simulation learning methods, Gordon and colleagues[3] have conceived of a "unifying theory of cognitive and emotional learning" (p. 370). This approach, like the notion of sociocultural learning, recognizes the impact of the environment and includes those social interactions that would be expected to occur if the clinical experience happened in real life. Emotion is viewed as a catalyst for learning with the recognition that an actual personal encounter with a single case can generate a memory that shapes future practice. Immersion into a complex simulated, clinical scenario is viewed as a means to accelerate the development of expertise in students who are naıve to the subject matter, but for whom later lectures are likely to hold greater relevance as a result of the experience. The simulation program that was developed incorporated the theoretical notions described above as well as the features of the BEME review.

METHODS

This pilot investigation was approved by our chiropractic college's research ethics board (REB#1007X09) and was conducted in three parts. The first was the development of the manikin-based simulation experience based on theory and best practices. The second was the study of implementation of the simulation experiences to the senior students early in their clinic-based program. The third was evaluation of the implications of providing simulation experiences to more junior students and assessment of the impact on the learning of relevant basic science material in the curriculum.

Part I: Simulation Learning Experience Process Development

Ten interested faculty and administration volunteers formed the development team to investigate Simulation Lab experiences. Four members of the team were primarily teaching faculty. Five members were primarily involved in administration. One of the five administration members had particular expertise in curriculum and faculty development. That member joined the team to provide input and guidance related to intended educational learning outcomes and objectives. The final member was the school counselor. Given the perceived value of emotion as a catalyst for learning in simulated environments, the school counselor's expertise in providing an understanding of the management of emotions in this environment and as a liaison for unanticipated student responses was considered important.

Team members met on a regular basis throughout a 1-year period. Action plans were developed to gather knowledge related to manikin choice, environmental needs (eg, space requirements and camera and microphones for recording simulation sessions), scenario development, and learning outcomes. Team members visited medical, nursing, and paramedic environments already using simulations and scenarios, and two team members attended the first of a series of three educational programs leading to a simulation-based educational certificate.

Scenarios for simulation experiences were observed in the medical, nursing, and paramedic community. Experience in scenario development was gained during the educational program attended by two of the team members. In order to be certain that the scenarios chosen would be of importance to the chiropractic profession, the local Canadian malpractice insurance agency was contacted. Discussions regarding old case files and the opportunity to reproduce situations that had actually occurred in chiropractic offices provided key input to the scenarios chosen for elaboration and considered for future development of the simulation lab.

For each full scenario, related learning objectives were developed. In addition, the team created a video recording of each scenario, casting themselves in the various roles relevant to the case. This was to be used as a reference tape for feedback during student learning. Finally, relevant members of the basic and clinical science faculty were contacted and asked to evaluate each scenario and provide appropriate scientific content for use during student debriefing periods in the proposed simulation experience.

Part II: Implementation of Simulation Experiences Into Senior Student Year

Students entering their senior year at our college were provided with simulation experiences within the first 3 months of beginning their first rotation in the main campus clinic. Results from part I were used to guide these experiences. During the clinical year, students are grouped in "pods" of 8 to 10 students per licensed clinician. To ensure that each student had the opportunity to participate in the simulation lab, each pod and its clinician were scheduled for a simulation experience during the pod's normally scheduled 2-hour administrative time. Clinicians responsible for the pods were given a pre-lab orientation that included the information on the intent of the experience and the nature of the formative learning process as it applied to the environment.

The simulation experience chosen for this pilot study was a myocardial infarction progressing to arrest, occurring before a chiropractic treatment but during a patient examination for back pain. A life-size Gaumard (Hal S3000 or Susie S2000) manikin was used as the patient. The acting coordinator of the simulation lab provided the voice to the manikin and operated the computerized physiology to progress the patient to an arrest.

The simulation environment was set up to look like a chiropractic office. Students within the pod each chose their identity (doctor, spouse, receptionist, waiting room patient, patient in next room, etc) by selecting a clipboard with a concealed role on it. Students had no information regarding the case that would be used, or the role that they would play, before entering the simulation environment. On completion of role selection, the acting coordinator briefed each student individually regarding the intent of his or her role. This included, for example, explaining to the student that his or her persona was to persist in asking questions from a layperson's perspective or that he or she was to become very emotional as the scenario unfolded. There was no collaboration between students before the onset of the experience. Students were also not made aware of what the scenario with the patient would be.

In recognition of the role that emotion may play in learning, throughout the simulation experience, students were asked at eight different time points to rate their level of anxiety on a 100-mm visual analog scale. Those time points were (1) upon entering the lab, (2) after discovering the role they had chosen, (3) after the initial briefing, (4) after the first attempt at the scenario, (5) after the first debriefing, (6) after the second attempt at the scenario, (7) after the second debriefing, and (8) just before leaving the lab.

At the end of the experience, students were also asked to complete a learning outcomes survey, a modified version of the System Usability Scale[15,16] and a Satisfaction Questionnaire fashioned after the work of Morgan and Cleave-Hogg[17] and modified to include a question regarding comfort from the work of Peckler et al.[18] Descriptive statistics were used to summarize outcomes. Analysis of variance was used to determine if the overall anxiety level (that is, the average of all eight anxiety scores) of students was different depending on which role they chose while having the simulation experience. Each student had one complete simulation experience and only played one role in that experience. For this analysis, therefore, there was one summary anxiety score per student.

Part III: Providing Simulation Experiences Early in the Chiropractic Curriculum—Potential Impact on Basic Sciences

In order to gather pilot data regarding the feasibility, satisfaction, and effectiveness of manikin-based simulation experiences within the chiropractic curriculum, a small number of these experiences were also provided to students in their 1st and 2nd years of chiropractic education. At the beginning of the 2010–2011 academic year, students were randomly selected from each of years I (35 students) and II (24 students). Students who elected not to participate after being randomly selected were replaced by convenience sampling. Participants were placed in groups of five to seven individuals in order to be certain that all roles in the scenarios were covered. Scenarios were selected relative to the appropriate level of learning that students had in each year. That is, 1st-year students were placed in a scenario that largely involved patient–doctor interaction, while 2nd-year students were placed in a scenario that required some integration of basic science knowledge with the clinical case.

The same outcome measures were used to determine anxiety, usability, and satisfaction and the same analysis methods were used for these outcomes. In addition, it was noted that the basic science information relevant to the 2nd-year scenario would be tested during a portion of one of their examinations 2 months after their experience. The faculty teaching the related material was not told that the students had the simulation experience and the students were not made aware of the potential connection between that course's material (which had not been covered at the time of the pilot study) and the scenario they experienced. The relevant exam results from this assessment were partitioned such that they formed two groups: those who had experienced a scenario and those who did not. Differences in exam scores were assessed via a one-tailed unpaired t test.

RESULTS

Part I: Simulation Learning Experience Process Development

The simulation development team identified a total of 16 complex or serious cases that could be based on actual occurrences in chiropractors' offices and that would be appropriate for the learning needs of the students involved. These were prioritized and the first four reference tapes based on these cases were recorded. In addition, for all four reference-tape scenarios, relevant faculty provided appropriate content to be used for the debriefing periods (BEME Feature C).

Upon reviewing the BEME criteria, the information gained from other simulation sites and reviewing educational theory, the following steps (in sequence) were identified as comprising a complete simulation experience:

1. **Introduction to the Simulation Lab:** Before beginning the first scenario, students are given a brief tour of the Simulation Lab. During this portion of the experience, the rules of the lab are described, as is the intent of the scenario that they will be part of, and the purpose of the data collection. Students are asked to sign a Confidentiality Agreement and are further asked to consent to having the scenario and their performance videotaped.
2. **Briefing:** The students are provided with a general description of what a simulation scenario is and the roles that they may play in that scenario. The coordinator reviews the intended learning outcomes (BEME feature G).

Table 1. Level of satisfaction (% agree or strongly agree) with simulation experience

	Intern Response		Clinician Response	
Modified Simulation Satisfaction Questionnaire Items	*n*	% Agree	*n*	% Agree
1. Briefing phase introduction was helpful	95	95%	11	100%
2. Understood the purpose of this experience	95	100%	11	100%
3. Comfortable with the setting	95	80%	11	100%
4. Reflected a realistic setting	95	85%	11	82%
5. Reflected the learning objectives	95	97%	11	100%
6. Feedback was given	95	100%	11	100%
7. Learned something from experience	95	100%	11	100%
8. Might be used as an evaluation tool	95	92%	11	100%
9. Prior exposure needed before its use as an evaluation tool	95	73%	11	73%
10. Talking to the mannequin difficult	95	15%	11	18%

After Morgan and Cleave-Hogg[17] and Peckler et al.[18]

3. **Assignment of Role:** Students choose their part by selecting a clipboard that has been turned over so as to conceal the role they will be asked to play (eg, doctor, spouse, receptionist, additional patient, etc). Once a clipboard has been selected, a student must stay with that role.
4. **Scenario Enactment 1:** Students take their places in the scenario and role play the event. The purpose of this step is to "make learners aware of their ignorance" as proposed by Atherton[14] (BEME features G, H, J).
5. **Debriefing 1:** Feedback is provided on doctor and group performance (BEME features A, E, I). This is a lengthy process that includes the opportunity for reflection by the student participants and an opportunity for the lab coordinator to demonstrate equipment and for students to try to work with the available equipment. Questions are answered and other questions are posed as needed to facilitate the learning outcomes. During this process, students view the reference tape and discussion continues regarding the actions taken in the tape and how those actions can be translated to the second scenario enactment.
6. **Scenario Enactment 2:** Students again assume the role they are assigned and redo the scenario (BEME features B, G, H, J). Small changes occur with other members of the team as they choose to play their roles in a slightly different manner as the second enactment unfolds (BEME feature F).
7. **Debriefing 2:** Student groups have the opportunity to see the tape of their performance. Feedback is again provided and remaining questions are asked and answered. Students once again have the opportunity to reflect on their performance and consider how their experience could be expected to translate into an actual practice setting. In addition, students reflect on the expected learning outcomes and judge the extent to which those learning outcomes have been met (BEME features A, E, I).

BEME feature C (curriculum integration) and BEME feature D (range of difficulty for simulations) were met through the development of the initial four reference tapes, the identification of additional reference tapes needed, and piloting the simulation scenarios to three of the four academic years with content relevant to both the clinical and basic sciences.

Part II: Implementation of Simulation Experiences Into Senior Student Year

A total of 95 interns associated with 11 clinicians (a total of 11 pods consisting of eight or nine students in each pod) participated in the pilot study involving the main campus clinic. As shown in Table 1, results indicated a high level of satisfaction with the experiences overall.

In addition, usability of the lab was also rated highly, as shown in Table 2.

With respect to the learning objectives, 37% of students perceived that at least one of the learning objectives did not apply to them because they were not in a role that would be expected to undertake that objective. For example, one learning objective was stated as: "Allowed me to accurately assess the patient's condition." For that objective, only 71 out

Table 2. Level of usability (% agree or strongly agree) with Simulation Lab

Adapted System Usability Scale Items	Intern Response		Clinician Response	
	n	% Agree	*n*	% Agree
1. Would like to use the Simulation Lab frequently	95	88%	11	81%
2. Found Simulation Lab unnecessarily complex	95	2%	11	0%
3. Found Simulation Lab easy to use	95	81%	11	91%
4. Needs technical support person to use Sim Lab	95	40%	11	45%
5. Functions of Simulation Lab are well integrated	95	87%	11	100%
6. Too much inconsistency in Sim Lab	95	11%	11	0%
7. Most people would learn to use lab quickly	95	83%	11	82%
8. Lab is cumbersome to use	95	4%	11	9%
9. Felt confident using Simulation Lab	95	48%	11	64%
10. Needed to learn a lot before could get going with Sim Lab	95	8%	11	9%

After Lewis and Sauro.[15]

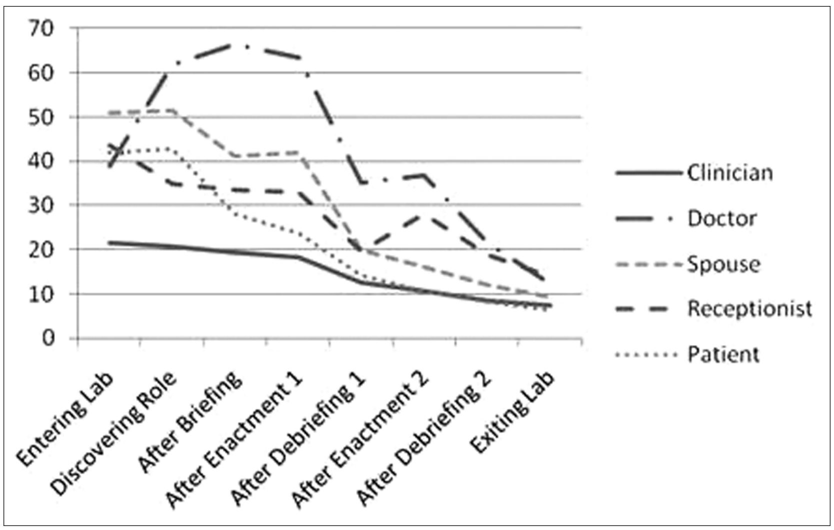

Figure 1. Anxiety levels (as measured by visual analog scores out of 100) for eight time points, by role in simulation. Note: "Clinician" refers to a licensed chiropractor observing the simulation experience and "doctor" refers to the student role chosen.

of 95 (75%) subjects responded with some level of agreement. Of those 71 subjects, 83% agreed or strongly agreed that the objective had been met for them, regardless of the role they played in the scenario. The range of agreement that any individual learning outcome had been met was from 83% (described above) to 98%. Virtually all of the students responding (94/95) to the learning outcome that the Simulation Lab provided a safe environment within which they learned a relevant clinical crisis agreed or strongly agreed (98%) that that outcome had been met.

Anxiety levels were summarized by role and graphed over the eight time periods in which this outcome measure was taken during each simulation experience. These data are represented in Figure 1.

Analysis of variance on the average (over all eight time periods) anxiety score by role (excluding the clinician who did not play a role in the simulation experience) indicated a statistically significant difference in anxiety levels between roles ($F = 8.07$, $p = .001$). In particular, post-hoc testing using the Scheffe test indicated a statistically significant difference between students assigned to the role of doctor, compared to wife ($p = .04$), receptionist ($p = .03$), and the role of another patient ($p = .00$).

Part III: Providing Simulation Experiences Early in the Chiropractic Curriculum—Potential Impact on Basic Sciences

Sample sizes for the year I and year II students intended to participate in this pilot program were bounded by the class schedule and available time outside of the curriculum during the early part of the 2010–2011 academic year. No formal sample size analysis was conducted.

Of the 24 students randomly selected from the year II class for participation in the lab, a total of six students chose not to participate. Those students were replaced by convenience on the day of the scheduled simulation. Three students of the 35 from the year I class who were randomly selected for participation chose not to undertake the simulation experience. Those students were also replaced by convenience on the day of the scheduled simulation. An informal poll of students choosing not to participate indicated that they were unaware of the intent of the simulation exercise and/or had not paid attention to the e-mail regarding their participation.

Usability, satisfaction, and learning outcomes data from the 35 students randomly selected from the year I class and 24 students randomly selected from the year II class were descriptively evaluated in the same manner as intern data. Very similar levels of usability, satisfaction, and perceived achievement of learning outcomes were found.

In addition, the data from the year II group was compared with testing related to the basic science course that contained material relevant to the simulation experience. The distribution of grades for both students who participated in the experience and for those who did not was determined to be normal. The mean for the 165 students who were not part of the pilot study was 66.75% (SD 11.21) and the mean for the 24 students who did participate was 70.00% (SD 13.69). The mean difference between groups, therefore, was 3.25%. The *t* test resulted in a *t* value of 1.28 and a subsequent *p* value of .10. Power was evaluated at 30%.

A separate two-tailed, unpaired *t* test was conducted for the year II group, dividing the students into those who had been randomly drawn ($n = 18$) and those who had been replaced by convenience ($n = 6$). No statistically significant difference was determined ($t = 0.23$, $p = .82$).

DISCUSSION

Providing health care students the appropriate quality and quantity of clinical apprenticeship is an ongoing challenge to their education. As discussed by Seabrook,[19] apprenticeship learning and teaching can be considered “diffuse, unbounded and opportunistic” (p. 667). Concerns around lack of standardization due to variability in mentorship, disparity of goals, and the haphazard nature of presenting clinical conditions have a long history.[20–22] This challenges the notion that the typical apprenticeship model provides sufficient and consistent training in complex clinical cases that are important to see in a contextually related clinical environment. Gorman and colleagues[22] suggest that this historically revered form of training is likely to rely more on technology in the future.

In chiropractic education, it has been observed that the apprenticeship-based clinical experience received by interns before graduation is less than that of their medical counterparts.[23] As noted by Coulter and colleagues, when the actual number of hours spent intentionally teaching the clinical sciences are calculated, the professions’ hours dedicated to clinical care are more similar.[23] This understanding, however, does not speak to the need for a more standardized experiential learning environment intended to integrate student knowledge from all levels as related to the complex clinical cases that may enter in search of care.

As pointed out by Brass,[24] even greater emphasis is now being placed on experiential learning and apprenticeship-type education,[25] with growth in the use of algorithm-based approaches suggested as being evidence based. Brass cautions, however, that training to the common clinical problems is problematic when interns and new clinicians are confronted with challenging and complex cases that necessitate moving outside of common algorithms. In such cases, students and clinicians alike must reach back to first principles and integrate basic science knowledge effectively in order to understand and appropriately manage a case. Simulation experiences have been suggested as a means of fostering such integration at the undergraduate level,[3,26] while maintaining contextual relevance and facilitating the standardization of apprenticeship. Such methods have been tested successfully with respect to the preclinical use of toxicology.[27]

The purpose of this pilot investigation was to provide data for the implementation of manikin-based simulation experiences into the undergraduate curriculum at the chiropractic college. Simulation team investigation regarding the structure of other simulation environments, complex and challenging cases that had been documented as occurring in chiropractic offices, learning theory, and the BEME criteria resulted in the development of a seven-part learning experience. The average time required for each experience was 2 hours in length and debriefing included integration of knowledge from the undergraduate curriculum as well as discussion regarding legislation, jurisdiction, and professional behavior. The seven-part simulation experience represents a departure from other mechanisms observed by the development team either in training or through visitations, in that students are not informed about the clinical case they will encounter and a second opportunity after the first debriefing is provided so that students are able to reach a successful conclusion in the encounter. Further study is needed to determine if these theory-based factors make a significant difference to learning.

Data from the pilot study indicated high levels of usability and satisfaction among students using the lab at all academic levels. Low level of "confidence" (48% felt confident using the Simulation Lab) in lab usability is believed to be related to the relative lack of experience that students have had both with the clinical environment and with the technology itself. It is hoped that with additional opportunities in the Simulation Lab confidence will increase.

A majority of students indicated achievement of all learning objectives, although just over one-third of the students perceived that at least one of the learning objectives was not applicable to them based on the role they selected. Students who assumed the role of "doctor" in these simulations were more clearly able to rate their successful achievement of all learning outcomes.

In addition, it was observed that, initially, students selecting the doctor role had significantly higher levels of self-reported anxiety than students who had selected other roles. All students, however, were successfully able to manage their anxiety levels. Further, anecdotal reports indicated that by the end of the experience, students playing other roles requested opportunities to come back to the lab and assume the doctor role. Such requests were granted later in the year by providing optional simulation opportunities.

Of particular interest was the notion derived from Gordon and colleagues[3] that simulation experiences might be well placed in earlier academic years and that the emotional interest from those experiences may facilitate deeper learning. In the third part of this pilot investigation, students in the 1st and 2nd academic years were provided with simulation experiences suitable to their level of clinical development. Data from these experiences were consistent with results from interns. In addition, it was interesting to note that while not statistically significant, there was a 3.25% higher mean grade for 2nd-year students who had participated in the simulation experiences versus those who had not. This is especially intriguing since the provision of information from the simulation experience was not a direct match with the course material (which reflected only the basic science knowledge) and occurred approximately 2 months before the course content delivery by a lecturer who was unaware of the study. The relevance of a 3.25% change can be contextualized through the work of authors such as Schlairet and Pollock,[4] who compared the clinical knowledge acquisition of nursing students when traditional clinical experience was contrasted with simulated experiences in a cross-over design. They noted that among their 74 students, both groups had significant gains in knowledge pre- to posttesting ($p =$ .015), with pre- to posttest 1 mean knowledge scores of 3.05% for the simulation group and 2.11% for the traditional group. Our comparative results are well in line with anticipated changes from such an educational intervention and as such we suggest that this trend toward change is worthy of further investigation.

LIMITATIONS

There are, of course, limitations to this investigation. First, although the instruments used to gather data regarding both usability and satisfaction were based on previous studies, these questionnaires were adapted. Although face validity is evident, further reliability and validity testing on these instruments has not been completed. With respect to data regarding anxiety levels, a simple 100-mm visual analog scale was used. Although there are good data related to reliability and validity of the visual analog scale relative to pain outcomes, there are no such data related to anxiety. In this study we have assumed transference of acceptability for this instrument and that assumption may not be true.

Finally, relative to the evaluation of 2nd-year student study participant achievement on a related basic science examination, the sample size was clearly very small. In addition, six students were replaced from the random sample in a haphazard manner. It is understood that this may have biased the results. However, students selected in this haphazard fashion were not volunteers, nor particularly chosen. Rather, these participants were by happenstance, in a location near the Simulation Lab at the time the event was to occur. Regardless, the results from this portion of the pilot study, while encouraging, should be taken with caution until further more rigorous study is conducted with a larger sample size.

CONCLUSIONS

This pilot investigation provided encouraging data regarding the usability, satisfaction, and learning of students involved in simulation experiences that were included in their undergraduate curriculum. Anxiety levels, while initially high for students assuming the role of "doctor," were managed without problem. Cautious optimism regarding the potential for greater integration of basic and clinical science learning through these simulation experiences appears warranted from the data retrieved through the study of year II participants. Further study, however, will be necessary to determine to what extent, if any, such results are generalizable. Nonetheless, the data from this pilot investigation provided sufficient information from which to integrate manikin-based simulation experiences into the formal curriculum in our educational environment.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

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