A Simulation Course on Lifesaving Techniques for Third-Year Medical Students

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Background: The University of Virginia School of Medicine discontinued animal vivisection in February 2004 for teaching lifesaving procedures to third-year medical students. Consequently, a 1-day course using simulation technology was developed to meet objectives previously covered in the animal laboratory. The authors sought to evaluate the course and hypothesized that the students' confidence in lifesaving procedures as well as their acceptance of simulation technology as a teaching tool would increase.

Methods: The course was designed in a two-session format. The first session (first half of the day) concentrated on individual procedure skills, utilizing part-task trainers. The second session (second half of the day) used a Medical Education Technologies Inc. (METI) Emergency Care Simulator (ECS) full-body patient simulator to present a major trauma scenario. The study design was a prospective, pretest-posttest study without a control group. A 10-question pre and post survey used a Likert scale to explore students' confidence in their skills as well as their acceptance of simulation technology. A course evaluation used a similar Likert scale for evaluation of the course substations, the trauma scenario, and students' self-assessment of their skill levels as well as a 100% point scale for an overall rating of the course.

Results: A total of eight 1-day courses were successfully held over 2 years with a total enrollment of 240 students utilizing 20 instructors inclusive of faculty, residents, and other emergency medicine health care providers. For the pre and post survey results, there was a significant increase in students' confidence in performing lifesaving procedures as well as their acceptance of simulation as a teaching tool ($P < 0.05$ for each question with pre $n = 222$ and post $n = 226$). For the course evaluation results ($n = 190$), all of the course substations were rated in the good to excellent range and the course received an overall score of $97.55 \pm 7.23\%$ out of 100%. Furthermore, students reported a significant increase in their skill level ($P < 0.05$).

Conclusion: This lifesaving techniques course utilizing simulation technology successfully covered objectives previously taught with animal vivisection, increased students' confidence levels in performing lifesaving procedures and was highly accepted by the medical students.

Key Words: Simulation, Simulation technology, Simulation course, Human patient simulator, Medical education, Lifesaving procedures, Medical students

(*Simul Healthcare* 2007;2: 11–15)

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The authors have indicated they have no conflict of interest to disclose.

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ISSN: 1559-2332/07/0201-0011

The University of Virginia (UVa) School of Medicine discontinued animal vivisection in February 2004 for the teaching of lifesaving procedures to medical students, and alternatives including simulation were explored to fill this need. From flight simulation in the 1920s to the first full-body medical simulator SimOne in the 1960s, simulation technology has long been implemented to meet curricular needs.[1,2] The American College of Surgeons underscore this trend by stressing the use of simulation in education through an accreditation program for centers of educational excellence.[3] Faculty in the UVa Department of Emergency Medicine proposed that the objectives of the third-year medical students' lifesaving procedures class, previously covered in the animal laboratory, could be successfully addressed in a simulation-based course. This was approved by the University of Virginia Medical School Curriculum Committee.

Studies have shown that simulation as a mode of training for medical students is both accepted and efficacious. In the 1980s, Gordon and colleagues described the effective use of a cardiology simulator named Harvey to teach heart auscultation skills.[4,5] Recently, Issenberg et al. described use of the same simulator to teach cardiology to medical students in the United Kingdom.[6] Tan et al. reported that first-year medical students studying cardiovascular physiology using a human patient simulator thought simulation was a better teaching tool than lectures, and they felt more topics should be taught with simulation.[7] Similar studies describe overwhelming support from students for the use of human simulation in their education.[8,9] Steadman et al. provide evidence that for fourth-year medical students, simulation-based learning was superior to problem-based learning for the acquisition of critical assessment and management skills.[10] Similarly, Gordon, Brown, and Armstrong showed that a simulated critical care encounter accelerated short-term learning and enhanced sustained learning at 1 year for cardiac physiology.[11]

A number of simulation courses and curricula have been described. Seropian introduced concepts and methodology of simulation in medicine.[12] Holcomb et al. describe a curriculum utilizing simulation technology to train new interns.[13] In addition, McLaughlin, Doezema, and Sklar describe a 3-year curriculum for emergency medicine residents using human simulation both to teach and assess the Accreditation Council for Graduate Medical Education (ACGME) core competencies.[14] Marshall et al. discuss the use of a human patient simulator in conjunction with an advanced trauma life support (ATLS) class, noting enhanced development of trauma management skills and increased acceptance of simulation among surgical interns.[15]

Despite all of these studies, there is minimal investigation on courses using simulation to teach medical students lifesaving procedures, especially to specifically replace an animal laboratory. Also, medical student courses that integrate part-task trainers with full body human patient simulators are not frequently described in the literature. Our course, described here, addresses both issues. Furthermore, we hypothesized that the students' confidence levels to perform life saving measures as well as their acceptance of simulation as a teaching tool would improve following the course.

METHODS

Study Design

This was a prospective, pretest-posttest study without a control group. We evaluated learner satisfaction and confidence utilizing pre and post simulation surveys and a course evaluation instrument. We obtained an Institutional Review Board waiver for permission to use the students' responses without their explicit consent.

Setting and Population

The data was collected from a total of eight 1-day courses held over a 2-year period. Each course was comprised of 30 to 40 third-year medical students from the University of Virginia, for a total of 240 students involved in the study. The procedure substations were taught by emergency medicine (EM), surgery, and anesthesia residents. The simulation scenario took place in an emergency department clinical environment (trauma room) with "actors" comprised of one attending leader, one attending consultant, two nurses, and one x-ray technician. In addition, the simulator was managed by a behind-the-scenes team comprised of an EM resident as the voice of the computerized mannequin and simulator technicians.

Course Description

The course comprised two sessions. The first session concentrated on specific procedural skills, utilizing part-task trainers. Procedural skills sessions were divided into three major areas: vascular access, airway management, and chest/abdomen procedures, with each area having two procedure substations. Groups of four to six students rotated a total of 45 minutes in each of the three major areas with resident physicians as teachers. Table 1 shows a list of the objectives,

TABLE 1. Procedure Stations: Objectives and Simulaid/Materials

Objectives	Simulaids/Materials
Vascular Access Station	
Teach relevant anatomy	Peripheral access mannequin
Practice peripheral venous access	Central access:
Practice femoral venous access	femoral and subclavian/IJ/EJ mannequins
Practice subclavian venous access	Intraosseous mannequin
Discuss IJ and EJ venous access	
Practice intraosseous access	
Airway Management Station	
Teach relevant anatomy	Intubation mannequins
Practice bag-valve mask ventilation	Cricothyrotomy mannequins
Practice endotracheal intubation: neonate/peds/adult	Pig tracheas (non-living specimens)
Practice cricothyrotomy:	Bronchoscope simulator
Needle procedure with jet ventilation	
Surgical procedure	
Practice bronchoscopy	
Chest/Abdominal Procedure Station	
Teach relevant anatomy	Chest tube/thoracostomy mannequin
Practice needle thoracostomy	Chest tube model using pig ribs and saline bags
Practice placing a chest tube	DPL model using pig skins and saline bags
Discuss technique of pericardiocentesis	Suturing mannequin/pig skins
Discuss technique of DPL	
Practice suturing techniques:	
Simple interrupted, running, running lock,	
Vertical/horizontal mattress, securing chest tubes	

TABLE 2. Results of Pre- and Postsimulation Surveys

	Average ± Standard Deviation		
Question	**Presimulation**	**Postsimulation**	***P* Value**
1. I am confident in my ability to handle a major trauma patient.	1.86 ± 0.82	2.96 ± 0.81	<0.05
2. I am confident in working with a team to handle a major trauma patient.	2.87 ± 1.02	3.77 ± 0.69	<0.05
3. I am confident in performing orotracheal intubation.	2.07 ± 0.98	3.61 ± 0.73	<0.05
4. I am confident in placing a chest tube.	1.80 ± 0.85	3.32 ± 0.79	<0.05
5. I am confident in obtaining intraosseous access.	1.59 ± 0.83	3.42 ± 0.94	<0.05
6. I am confident in obtaining peripheral venous access.	2.82 ± 1.03	3.99 ± 0.70	<0.05
7. I am confident in obtaining central venous access.	1.78 ± 0.55	3.28 ± 0.84	<0.05
8. I believe that simulation training was realistic.	3.22 ± 0.88	3.97 ± 0.71	<0.05
9. I believe that simulation training was fun.	3.87 ± 0.82	4.54 ± 0.63	<0.05
10. I believe that simulation training is a critical learning experience that should be offered in the future.	4.03 ± 0.84	4.63 ± 0.61	<0.05

Results are based on a Likert scale of: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree. For presimulation, n = 222; for postsimulation, n = 226.

previously taught by animal vivisection, and materials used at each substation.

The second session used a METI ECS patient simulator and presented a major trauma scenario for the students to manage. Groups of four to six students per team participated in a videotaped 30-minute trauma scenario led by an attending physician. Each team member was given a preassigned role as either "team leader," "airway manager," "right side of patient procedures," "left side of patient procedures," "foot of the bed procedures," or "procedure assistant." The simulation concluded with a debriefing session led by an attending physician that incorporated review of the videotape.

Measures

The pre- and postsimulation surveys, shown in Table 2, were identical; the first was completed immediately prior to the course, with an online form or a paper copy, and the second at the end of the course, with a paper copy. We used a five-point Likert scale in the surveys. At the end of the second session, students completed a paper-based course evaluation. The course evaluation contained a five-point Likert scale and a 0–100% scale for an overall rating. Both the surveys and evaluations were voluntary and answered anonymously.

Data Analysis

We compared the results of the pre and post surveys using means and standard deviations for each question. The data sets were aggregate in nature without identification of any particular participant. Consequently, a *P* value for each question comparing the pre and post data was calculated using an unpaired Student's *t* test. Similarly, means and standard deviations were calculated for the course evaluation data. Lastly, the self-assessment of skill data in the course evaluation, also aggregate data sets, was compared using an unpaired student's *t* test.

Equipment

Each procedure substation used part-task trainers (Simulaids, mannequins, or nonliving animal parts). A METI ECS patient simulator was used for the trauma scenario.

RESULTS

A total of eight courses over a 2-year period were successfully conducted with an enrollment of 240 students and taught by a team of 4 faculty, 8–10 residents, 2 simulation technicians, and 4–6 other emergency medicine health care providers (nurses, radiology technicians, emergency medicine technicians and paramedics). Of the 240 students, 222 responded to the presimulation survey and 226 responded to the postsimulation survey. The overall course evaluation was not requested during the first course; therefore, the total overall course evaluations completed were 190 out of a possible 200.

The pre and post simulation survey questions as well as the results, including mean, standard deviation, and *P* value, are depicted in Table 2. There was a statistically significant improvement for each question following the course ($P < 0.05$). Questions 1 through 7 address the student's confidence. For these, the mean answers generally increased from the "strongly disagree" to "disagree" range before the course to the "neutral-agree" range after the course. Interestingly, this was true for both specific tasks as well as the general management of trauma. In another point, the items of least risk, handling a trauma as part of a team and peripheral venous access (questions 2 and 6), had the highest presimulation confidence levels. The results for questions 8 through 10 address the students' acceptance of simulation as a teaching tool. Of note, the means of these questions had relatively high presimulation levels in the "neutral-agree" range.

The results for the overall course evaluation are depicted in Table 3. All evaluations of the procedure stations as well as the full-body simulation fell in the "good" to "excellent" range. The average student self evaluation of his/her skill level in performing life saving procedures significantly increased ($P < 0.05$). Students rated their skill level after the course just above midrange between unskilled and skilled. This is consistent with the postsimulation results regarding confidence falling in the "neutral-agree" range. The overall evaluation for the course was 97.55 ± 7.23% on a 100% scale. These results further support the students' high acceptance of simulation as a teaching tool.

TABLE 3. Results of Course Evaluation

Question	Average ± Standard Deviation
n	190
1. Please rate each station: 1 = poor, 2 = fair, 3 = average, 4 = good, 5 = excellent	
a. Chest tube and DPL	4.64 ± 0.52
b. Airway/Intubation	4.71 ± 0.49
c. Cricothyrotomy	4.56 ± 0.58
d. IV/IO access	4.58 ± 0.58
e. Advanced airway skills	4.67 ± 0.56
f. Simulation in emergency department	4.71 ± 0.52
2. Consider a scale of 1 to 5, where 1 = unskilled and 5 = skilled	
a. What was the level of your skill in life-saving techniques before you took the workshop?	1.71 ± 0.81*
b. What is the level of your skill in lifesaving techniques now, after completing the workshop?	3.30 ± 0.74
3. Overall, what grade would you give the workshop (on a scale of 0–100%)?	97.55 ± 7.23

*P value is <0.05, comparing question 2a and 2b data.

DISCUSSION

The new lifesaving course successfully integrated both part-task trainers and full body simulation, allowing for both specific procedure practice and real-time trauma simulation. The trauma simulation sought to offer students an exciting experience that allowed them to integrate learned procedures, and provided an opportunity to debrief and reflect on their overall clinical skills and experience. As the results show, not only did the students feel more confident in specific tasks such as orotracheal intubation and thoracostomy, but they also felt more confident in managing a trauma patient in general. Likewise, the evaluations of both the specific procedure stations as well as the trauma scenario were extremely positive. Our results support the utility of the two-session format using both part-task and full-body simulation in the design of a lifesaving procedures course that replaced animal vivisection.

The results from the surveys and evaluations related to student acceptance are not surprising given similar previous study results of simulation in medical education. The results regarding the students' confidence levels from the surveys and self-assessed skill level from the evaluations demonstrate that the course was effective in increasing the students' self-confidence in performing several lifesaving techniques. However, these results should be interpreted with caution because they were based on self-assessment data. Ward and colleagues have reported that there are several potential methodological problems when research is based only on self-assessment and provided numerous examples showing learner self-assessment correlates poorly with actual performance.[16] We agree and feel the increase in self-assessed skill cannot be relied on as an objective measure, but merely suggests the increase in confidence after the course.

Limitations

The study design offered a pragmatic and convenient solution to investigate the acceptance and initial effectiveness of the new course; however, it may have inherent bias and limitations. Regarding specific procedure skills, the survey outcomes may not have been directly related to the use of simulation technology itself, limiting this discussion. The survey questions, developed from authors' consensus, may have been leading as stated and thus influenced the participant to answer in a positive manner. Likewise, negative responses may have been minimized because the students had little time for reflection and critique of the new learning experience before completing the postsimulation survey and course evaluation. Student's knowledge of the study may have also influenced their responses. Compliance with the presimulation surveys, postsimulation surveys, and course evaluations were 92.5%, 94.2%, and 95%, respectively. Consequently, we felt that the low percentage of nonresponders was unlikely to impact the overall results. Lastly, given that the course had to meet the needs of the medical school and was a requirement for all students before graduation, it was difficult to design a control group. One solution to this limitation may be to design a randomized control trial where all the controls are put on a wait list to attend the required course at a later date.

CONCLUSIONS

A simulation course integrating both part-task trainers and full-body simulation was designed to teach lifesaving procedures to third-year medical students. The course successfully covered objectives previously taught with animal vivisection, increased student's confidence in performing lifesaving procedures, and was highly accepted as a teaching tool. This simulation course in lifesaving techniques for third-year medical students continues to be a requirement in the University of Virginia medical school curriculum.

ACKNOWLEDGMENTS

The authors thank Jane Carlson, Consultant Editor, for her assistance with the manuscript and Steve Hartman, Ryan Meszaros, and Robert Mullinax for their technical assistance with human patient simulation.

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