A Simulation Course for a Senior Medical Student Elective in Anesthesiology

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Introduction: Simulation has become increasingly important in medical education. Both medical student education and resident education frequently incorporate human simulation as a means of developing skills in patient care, crisis leadership and decision-making [1, 2]. As the overall impact of human simulation on medical education continues to evolve, the use of simulation and the number of simulators in use has increased dramatically in recent years [3].

At the University of Pittsburgh School of Medicine, the department of anesthesiology has utilized human simulation for training since 1994. Medical student participation in simulation for the third-year mandatory clerkship in anesthesiology began three years later. In 2002, a human simulation course was instituted to accompany the fourth-year elective rotation in anesthesiology. Because the students remain in one institution during the four-week period, the simulation scenarios were developed to reflect a variety of different anesthetic types and settings. This brief report details the methods utilized in this simulation course and summarizes early feedback from the students regarding the scenarios and simulation in general.

Methods: The fourth-year medical student human simulation course for the elective in anesthesiology consists of four different scenarios. Students generally participate in one scenario each week of the four-week rotation, depending upon faculty availability. Each simulation exercise is preceded by a short didactic presentation, which focuses on the area to be emphasized in the scenario which follows. At the conclusion of the didactic presentation, students are encouraged to ask questions, and they then proceed to the simulated operating room. Typically, they undergo the simulation exercise singly, but if the group is comprised of more than four students, they participate in the scenario in groups of two or three.

A technician or faculty member controls the Sim Man simulator (Laerdal Medical Corporation, Armonk, New York), a high-fidelity, human mannequin patient simulator. Scenarios are based upon written scripts which have been developed by the faculty to accomplish the specified educational goals. Student management of the simulated medical conditions and anesthetic emergencies is compared to expected performance. After the simulation is completed, students are debriefed, and, if necessary, they undergo the simulation again to allow them to perform the appropriate interventions. They then complete a survey of the quality, effectiveness and utility of the simulation exercise.

At the University of Pittsburgh, simulation exercises are held in the Peter S. Winter Institute for Simulation Education and Research (WISER) center, a multidisciplinary center for human simulation, which employs two full time technicians and two information technology specialists, as well as two secretaries. The curriculum is web-based, as are the students' schedules for simulation events. All students are required to set up an internet account on the WISER site so that scheduling and materials can be easily obtained. Medical students are requested to review the didactic materials from the WISER website before arriving for simulation. The University of Pittsburgh Institutional Review Board does not require submission or approval of investigations such as this, which report student feedback and course evaluation.

The initial scenario that the students encounter is that of a urologic surgery (transurethral resection of the prostate), for which they are required to perform a preoperative evaluation and create an anesthetic plan. Critical interventions include determining that the simulated patient is in active congestive heart failure during the history and physical examination, and then canceling the case and initiating appropriate therapy, despite the objections of the "surgeon," who wishes to proceed with the case.

A second scenario involves obstetric anesthesia. After a short presentation which emphasizes physiologic changes of pregnancy, appropriate anesthesia for labor and delivery, and the effects of anesthetics on the uteroplacental circulation, students are asked to manage a simulated patient who requires urgent Cesarean section for fetal bradycardia. In this scenario, an epidural catheter has previously been placed for labor, but its function is inadequate, even after re-dosing. General anesthesia then becomes necessary, and students are required to choose appropriate agents to conduct the anesthetic, carry out rapid sequence induction, and manage the airway. They encounter a "cannot-intubate, can-ventilate" situation. They are then required to place a supraglottic rescue airway device, call for assistance and continue providing the anesthetic for the urgent delivery.

Students initially participated in a third scenario which simulated thoracic surgery, requiring successful placement of a double-lumen endotracheal tube and confirmation of its appropriate placement with a fiberoptic bronchoscope. This scenario has been replaced by an "advanced airway management" scenario, in which students learn about, and practice with, the laryngeal mask airway (LMA;LMA of North America, Los Angeles, CA), the intubating LMA, the esophageal tracheal combitube (ETC; Kendall, Kansas City, MO) and translaryngeal jet ventilation. Each student then undergoes a scenario of "cannot-intubate, cannot ventilate" or "cannot-intubate, can ventilate" airway emergencies, for which he or she chooses an appropriate device to deliver effective ventilation to the simulated patient before hypoxemia supervenes.

The final scenario evaluates students' response to simulated brain herniation. After a didactic presentation explaining the physiology of cerebral blood flow, and the impact of anesthetic drugs on intracranial pressure and cerebral blood flow, students initiate an anesthetic in a simulated patient with a large glioma and known elevated intracranial pressure. The patient develops Cushing's phenomenon after intubation, at which time students are required to apply three interventions to reduce intracranial pressure urgently.

Results: Over a two-year period, all of the 32 fourth-year medical students who rotated through the senior elective in anesthesiology participated in the simulation course described. All students successfully completed the requirements of the scenarios. Student feedback regarding the quality of teaching and the impact of the simulations on their educational experiences has been quite positive. On a scale of 1 to 5, with higher values being most positive, students reported that the course met expectations (mean score 4.94) and that what was learned would likely be utilized by them in the future (also a mean score of 4.94). They also reported a high quality of teaching (mean score of 4.5), and likely applicability of the lessons learned to their future careers (mean score of 4.50).

Discussion: Human simulation has taken on increasing importance in undergraduate medical education. Its many advantages include reproducibility, standardization, exposure to rare events, and decision-making in a safe environment. The objective, standardized clinical examination process has been well-established as a valid and reliable means of assessment of the clinical knowledge and judgment of medical students [4]. However, the validity of mannequin-based human simulation as a tool for teaching medical students has not been as thoroughly researched. Morgan, et al, found that only five of ten selected scenarios in a proposed course of human simulation for medical students in an anesthesia clerkship demonstrated adequate internal consistency, according to experts in medical education who evaluated them [5]. Furthermore, while it was felt that the scenarios were valid, by both students and faculty who administered them, there was no correlation between student performance in simulation and on written exams, or on the overall clinical score for the clerkship [5]. It is not clear that human simulation exercises are superior to other educational methods, such as the observation of videotapes, for teaching skills in anesthesia [6]. However, human simulation exercises have proven useful in identifying particular weaknesses in student and resident management of standardized, simulated patient emergencies [7, 8].

At the University of Pittsburgh, simulation is incorporated into medical student education beginning in the first year, with objective, structure clinical examinations [9]. At the end of the second year of medical school, a clinical skills course is presented. This course involves partial task trainers, and, more recently, the Sim-Man simulator, for demonstration of proficiency in bag-mask ventilation and endotracheal intubation [10]. In the third year, all students participate in a two week anesthesiology clerkship, which likewise incorporates human simulation at the WISER center. Since 1997, mannequin-based human simulation with the Sim-Man simulator has been utilized to help medical students learn and practice airway management and safe delivery of anesthetic care [10].

More recently, we introduced a fourth-year human simulation course to accompany the senior student anesthesiology elective. The goals of this simulation experience are to improve students' management of anesthesia-related crises, develop decision-making skills, and provide exposure to aspects of anesthesia which they might not otherwise encounter. In addition, the inclusion of human simulation is anticipated to bolster student interest in the course, as it ensures exposure to a valued educational experience. We expect the students' appreciation of simulation exercises in the second and third year medical school curriculum to translate into an increase in the number of those who elect the fourth year rotation. Currently, performance in the fourth-year medical student anesthesia human simulation scenarios does not impact on the students' grade for the anesthesia elective course, but after the scenarios undergo validation by faculty, this may become a component of the overall grade for the elective rotation.

Evaluation of the impact of this simulation experience has to this point been qualitative, as described above. Future developments include the systematic comparison of student performance to benchmarks, for which we have begun to measure the time required for students to implement critical actions in each scenario. Validation of scenarios by experts in the relevant clinical areas will be conducted. Another change will be the incorporation of the didactic presentations for each simulation into a web-based, self-education format so that no lecture will be necessary before the simulations when students arrive at the WISER center. Instead, each will take a brief pre-test, and then move directly into simulation and debriefing followed by a post-test, to evaluate the impact of simulation on their knowledge base.

References:

1. Issenberg S, McGaghie WC, Hart I, et al. Simulation technology for health care professional skills and assessment. JAMA 1999; 282:861-6.

2. Lloyd GE. A course for anesthesiology residents using simulation. Med Education 2004;38:571-2.

3. Morgan P, Cleave-Hogg D. A worldwide survey of simulation in anesthesia. Can J Anaesth 2002;49:659-62.

4. Cohen R, Rothman A, Poldre A, et al. Validity and generalizability of global ratings in an objective, structured clinical examination. Acad Med 1991;66:545-8.

5. Morgan PJ, Cleave-Hogg D, Desousa S, et al. High-fidelity patient simulation: Validation of performance checklists. Br J Anaesth 2004;92:388-92.

6. Morgan PJ, Cleave-Hogg D, McIlroy J, et al. A comparison of experiential and visual learning for undergraduate medical students. Anesthesiology 2002;96:10-16.

7. Morgan PJ, Cleave-Hogg D, DeSousa S, et al. Identification of gaps in the achievement of undergraduate anesthesia educational objectives using high-fidelity simulation. Anesth Analg 2003;97:1690-4.

8. Schwid HA, Rook GA, Carline J, et al. Evaluation of anesthesia residents using mannequin-based simulation: A multi-institution study. Anesthesiology 2002;97:1434-44.

9. Mahoney JF, Rogers PL, Dunmire SM, et al. Longitudinal integration of simulation technology throughout the undergraduate medical curriculum. Anesth Analg 2004;98S:A70..

10. McIvor WR. Experience with medical student simulation education. Crit Care Med 2004;32-2(supplement):S66-69.