Simulation as a Teaching Strategy for Nursing Education and Orientation in Cardiac Surgery

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When exactly did you understand pulmonary artery (PA) catheters? Was it the first time you read about the mechanics of a PA catheter? Was it in the critical care course when the educator passed a catheter around and you could see all the ports? Was it when you saw a PA catheter inserted? Or was it the very first time you were the one responsible for putting a PA catheter together, assisting in the insertion, and then caring for the patient? Truly pinpointing exactly when you finally understand is probably difficult. Most likely it was a combination of these events that led to your full comprehension. The truth is, the understanding of something as complex as a PA catheter, or for that matter many aspects of critical care practice (eg, pacemakers, chest tubes, vasopressor drugs), does not happen in a single moment. This type of learning is cumulative, integrative, and multifaceted.

Understanding PA catheters involves knowledge of anatomy, physiology, pathophysiology, cardiopulmonary hemodynamics, electronics, physics, and even engineering in the form of stopcock manipulation. Determining the best method to teach these complex and integrative critical care skills and concepts has long challenged educators and preceptors. One teaching method that is receiving increasing interest from both nursing and medical educators is computer-integrated simulation. In this article, I review simulation as a teaching strategy for education on and orientation to cardiac surgery and outline the experience of a center in which simulation is used in critical care education.

Simulation as a Teaching Strategy

Simulation is an event or situation made to resemble clinical practice as closely as possible. Simulation can be used to teach theory, assessment, technology, pharmacology, and skills. The emphasis in simulation is often on the application and integration of knowledge, skills, and critical thinking. Unlike a classroom setting or a paper-and-pencil test, simulation allows learners to function in an environment that is as close as possible to an actual clinical situation and provides them an opportunity to “think on their feet, not in their seat.” Simulation has been successfully used as a teaching strategy in both clinical and formal education.

Simulation has been used outside healthcare for decades. The aviation, transportation, and nuclear power industries and the social and behavioral sciences have all used simulation to teach concepts; to allow risk-free practice; and to teach, practice, and/or evaluate critical-thinking skills. In healthcare, the first types of simulators were the stagnant models (eg, rubber body parts). These types are still used to learn basic skills such as insertion of urinary and intravenous catheters. Learning more complex skills via simulation became possible as technology advanced. For example, interactive simulators connected to hemodynamic monitors allow learners to master working with the monitor, which displays patients’ data without being connected to an actual patient. Intra-aortic balloon pump simulators connect to the pump, allowing the display of electrocardiographic and pressure waveforms on the screen. Nurses can learn timing, troubleshooting alarms, and the general mechanics and function of the pump...
The most recent technology incorporates computer-based simulators that support CD-ROM applications. Learners progress through a clinical situation by responding to questions and selecting therapies. These applications require learners to analyze the data and make a response. Interactive computerized cardiopulmonary resuscitation or Advanced Cardiac Life Support simulators allow learners to practice psychomotor skills and receive feedback on the learners’ performance.

**Why Use Simulation in Critical Care Education?**

Simulation is an excellent teaching strategy for many skills but especially for critical care nursing. Learning in adults is most effective when the environment is both participative and interactive. Another important feature is that learners receive immediate feedback. An old Chinese proverb states, “I hear, I forget; I see, I remember, I do, I understand.” As far back as Socrates, it was known that teaching methods that require a learner to think through data or information and come to a conclusion or predict an outcome are more effective than is reading or lecture.\(^{14,15}\) The minute-to-minute care and monitoring of critically ill patients requires nurses to collect, analyze, and react to data and information. Simulation is an excellent way to both teach and practice these skills.\(^{2,7,10,15,16}\)

Traditional teaching methods emphasize linear thinking; a single concept is taught at a time. In physiology and critical care courses, the body is divided into organ systems and studied. Although this method is appropriate to help learners dissect complex information, organ systems do not function in isolation from one another. For example, in a critical care course, new cardiac surgery nurses learn about ventilator mechanics, hemodynamics, and renal pathophysiology in separate lectures. Thus, novice nurses may have difficulty understanding why chest wall bleeding in a postoperative patient who is receiving mechanical ventilation is treated by increasing positive end-expiratory pressure, resulting in decreases in the patient’s cardiac and renal outputs as well as a decrease in blood pressure. Grasping the nursing care priorities for such a patient requires an integrative or circular type of thinking about physiology, pathophysiology, and treatment because the priorities are interrelated.

Simulation is a method of teaching that allows or requires learners to apply theory to practice in an integrated manner. If the simulation demonstrates more than a single event or parameter at a time, nurses learn to identify relationships essential and common to clinical practice. The Georgetown University Simulator (GUS) can simulate several conditions simultaneously to assist learners in integrating physiological data.

**The Georgetown University Simulator**

GUS is a life-sized mannequin with computer-integrated physiological features. Different profiles of patients (e.g., a 42-year-old man with coronary artery disease, a 90-year-old woman with heart failure and atrial fibrillation) can be selected, and different events (Table 1) are available for training sessions. Learners must use critical thinking to determine the abnormality and select the appropriate treatments or interventions. The mannequin’s chest rises and falls with breathing; it has heart and lung sounds, an electrocardiographic tracing, PA and arterial waveforms, pulses, and papillary reaction; and it responds physiologically to treatments. The simulator actually measures the inspired oxygen level and will simulate oxygen desaturation if minute ventilation or oxygen intake is inadequate. The expired carbon dioxide level can be measured as well. GUS can be intubated or have a tracheostomy tube inserted and can be treated with mechanical ventilation.

**Table 1**

| Options for simulated events |

Drug administration can be simulated, and with the use of the drug recognition unit, the simulator will respond physiologically. For example, a simulated morphine injection will cause the pupil size of the mannequin to change and the respiratory rate, heart rate, and blood pressure to decrease. The response to any drug depends on the dose of the drug and the weight and clinical condition of the simulated patient at the time. Instructors can pause the simulation to review assessments, detect problems, or discuss treatment.

Unlike the situation in a clinical setting, with GUS, mistakes cannot actually harm a human being and are therefore useful opportunities for learning. The subsequent consequences can be witnessed in the simulated scenario. With the use of this simulator, assessment skills; pharmacological, physiological, and pathophysiological concepts; and basic and advanced cardiac life support techniques can all be taught, reinforced, and evaluated. With GUS, the classroom is transformed into a realistic practice environment. Learners can practice skills, administer medications, and observe the effects of various treatments on a life-like “person” at the learners’ own pace. Instructors can set up and control many
Simulation as an Essential Component of Clinical Education

All healthcare professionals must have a combined knowledge of physical and behavioral science and technical and clinical education. Unfortunately, much of the technical and clinical learning often takes place in the clinical setting, posing risks to the safety of both patients and learners such that close supervision by experienced preceptors and instructors is required to avoid disastrous consequences. Yet in the clinical setting, preceptors often do not have control over the types of experiences a learner will have or the conditions under which skills can be observed, learned, or practiced. A new critical care nurse could potentially complete an entire orientation period and not experience a common or high-acuity event that the nurse must be competent to deal with in order to practice safely in an intensive care unit. In contrast with the real clinical setting, simulated clinical situations involve only a few safety concerns and allow instructors and preceptors to completely control the events.

At Georgetown University School of Nursing and Health Studies, all 4 levels of the undergraduate curriculum include classroom, technological, and clinical instruction. GUS is used as an essential teaching tool in clinical nursing courses. Simulation sessions have also been incorporated into the curriculum of all of the graduate programs. The nurse anesthetist students are the most frequent users of the simulator. The laboratory features a hemodynamic monitor and an anesthesia machine with the appropriate gases. The students practice intubation, induction of anesthesia, continuous administration of anesthetic agents, and monitoring of level of consciousness.

Developing and demonstrating critical-thinking skills are strongly emphasized during these simulation sessions. In their text Critical Thinking in Nursing, Bandman and Bandman define critical thinking as follows:

> ... the rational examination of ideas, inferences, assumptions, principles, arguments, conclusions, issues, statements, beliefs, and actions. This examination covers scientific reasoning, includes the nursing process, decision making, and reasoning in controversial issues. The four types of reasoning that comprise critical thinking are deductive, inductive, informal or everyday, and practical.

The scenarios are developed to require students to use classroom knowledge, incorporate assessment skills, and create and implement a plan. They are then given an opportunity to witness the outcome and evaluate their plan and make the appropriate changes if necessary. With the use of simulation, they can implement the entire nursing process and are required to think critically.

Simulation as an Essential Component of Critical Care Education

Simulation is an excellent teaching and evaluation method for critical care and also for enhancing and evaluating critical thinking, problem solving, and team leading for proficient and competent senior staff. After 2 years of success with simulation at the school, Georgetown University Hospital Critical Care Service integrated simulation (ie, GUS) into the step-down and critical care nursing orientations in the hospital.

With the opening of a new cardiac surgery step-down unit, many nurses required additional training. After completing the traditional courses in cardiac surgery (eg, electrocardiographic rhythms, pacemakers and temporary pacing wires, chest tubes, cardiac drugs, discharge teaching), the nursing staff for this new unit attended a simulation session. Three scenarios were developed to allow the nurses the opportunity to integrate and use the theory they were taught in class. High-frequency and high-acuity situations were selected, such as new-onset unstable atrial fibrillation in a patient who had valve replacement; new premature ventricular complexes leading to ventricular tachycardia after diuresis in a postoperative patient; and an inferior wall myocardial infarction, heart block, and papillary muscle rupture in a postoperative patient with history of cardiac disease. The nurses were able to demonstrate many skills through simulation, including interpretation of rhythms, evaluation of hemodynamic stability, and assessment and reporting of data. Nurses also demonstrated implementation of treatments and could observe changes that occurred in a simulated patient’s condition as a result of the interventions.
Although the skill levels and abilities of the nurses varied, evaluations of the simulation sessions were universally positive. According to students’ self-reports and to evaluations by the instructors, the students who demonstrated strong assessment and critical-thinking skills became more confident, and the students who did not adequately demonstrate these skills were better able to identify specific deficits. An additional benefit mentioned in both the written and verbal evaluations of the sessions was that the nurses had “no idea” how quickly a patient’s status or condition could become unstable and how important the application of their assessment skills and response times were to improving the patient’s outcome. Although this phenomenon was emphasized in the theory courses, witnessing it “real time” with simulation certainly surprised many of the nurses.

The simulation session held at the end of the course for the intensive care unit received an equally positive response. This session was developed around a single scenario: a patient in a general care unit who is admitted to the intensive care unit in acute distress because of sepsis. The first part of the session focused on respiratory assessment, intubation, initiation and management of mechanical ventilation, and progression of acute respiratory distress syndrome. The second part focused on insertion of pulmonary and arterial catheters, hemodynamic monitoring, and pharmacological management. The nurses were able to assist with intubation and with insertion of catheters. Complications such as intubation of the right main bronchus and ventricular tachycardia were assessed and treated.

Requiring the nurses to assemble the equipment while caring for a simulated patient in a safe and controlled environment was a great learning experience. Through the use of simulation, the nurses were able to think through their actions and the events without jeopardizing care of an actual patient. The nurses stated on the evaluations that they liked being able to “pause action” and seek assistance or clarification from their peers or the instructors at any point. They also stated that they were more eager to learn because in a simulated environment they avoided “looking dumb,” a situation that reduced their intimidation. The sessions were originally scheduled to take 4 hours but invariably ran longer because the nurses requested to try or see a few more things.

Review of the Literature on Simulation

The success with simulation as an educational tool in critical care education is not unique to George-town University. Articles in research and critical care literature2–4,6,10,13,15,16,20 indicate that compared with traditional methods, this method of teaching and evaluating learners is more realistic, enhances both acquisition and retention of knowledge, sharpens critical-thinking and psychomotor skills, and is more enjoyable. Issenberg et al6 maintain that the use of simulation will reduce the pitfalls inherent in skills practice: decreases in the availability of patients and the instructional time required for medical education.

Rogers et al10 studied fourth-year medical students during the students’ rotations in critical care. The students were evaluated before and after the rotations by using a multiple-choice written examination, a skill station test, and an interactive simulation with a high-fidelity simulator. Although the test results before the rotations were similar for all 3 types of evaluations, the results after the rotations differed. The students performed much better on the written examination than on the simulation tests after the rotations, showing that although theory could be applied in a written case study, application of theory was not as easily demonstrated in a clinical simulation.

Gordon et al16 surveyed both students and educators about simulation as a teaching tool. Both groups thought that the advantage of “practice without risk to patient” outweighed the disadvantage of the simulator’s cost. These authors16 also described the advantages and disadvantages of simulators (Table 2).

Majors Eaves and Flagg2 of the US Air Force created a 10-bed simulated medical unit by using live actors, full-body simulators, and other specialized mannequins. As part of the new graduate orientation, nurses worked shifts on the simulated unit. They started and ended their workdays by simulating shift reports with a clinical educator. Realistic case scenarios and related technical skills were rehearsed. Problem solving, critical thinking, communication, and delegation were also incorporated in the simulations. Performance was videotaped, providing the students an opportunity to view their reactions and responses under stress. According to Eaves and Flagg, the pilot study received outstanding reviews from the new graduates, the educators, and the preceptors in the clinic setting where the new graduates were being oriented.
The Future for Simulation in Critical Care Education

As technology advances, our ability to simulate patients’ situations will become more sophisticated. Virtual reality is a reality in many aspects of education and training. Critical care nursing is fast paced and requires a high level of attention to details, quick assessment skills, and critical thinking. These skills are difficult to teach and are best learned through experience and practice. Simulation allows the opportunity to learn and practice critical care skills in a controlled and safe environment. The research available is not sufficient to support having simulation replace clinical education, but simulation is a wonderful bridge between theory and practice.

Acknowledgments

I acknowledge the following nurses at Georgetown University Hospital who were significant in the development of and/or support of the simulation sessions described in this article: Mary Herold, Lisa Kirchner, Terri Palazzo, Donna Stanzack, and Doris Tavares. Special thanks to Joseph Haymore, Lisa Kirchner, and Donna Stanzack for teaching the sessions.

Special thanks also to Terri Palazzo and James Rauen for thoughtful review of the manuscript and to the faculty and staff at Georgetown University School of Nursing and Health Studies for supporting simulation as a teaching strategy during this developmental period.

Footnotes

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