Chapter 51. Enhancing Patient Safety in Nursing Education Through Patient Simulation

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Background

The alarming rise in morbidity and mortality among hospitalized patients throughout the United States heightens concerns about professional competency.[1] Nurses and other health care professionals are under increased scrutiny to provide safe, effective care. Likewise, nursing education programs are faced with increased pressure to produce graduates who are capable of providing safe patient care. Toward that end, nursing education programs develop curricula, hire qualified faculty, and select learning experiences for students in an effort to train and graduate competent, effective nurses. The instructional strategies utilized in both didactic and clinical components of nursing education courses are highly influential in determining critical thinking and clinical decisionmaking ability as well as in developing the psychomotor skill performance of new graduates.

Of course, it is unrealistic to think that graduates of nursing education programs have received all the training they need when they depart the doors of academia. Orientation programs for new graduates and continuing education for nurses are essential tools to help practitioners improve their knowledge, skills, and expertise so that quality patient care is provided and outcomes are optimized while errors are minimized. Ongoing evaluation of nursing competence is necessary to promote patient safety.

In the Institute of Medicine (IOM) report, *To Err is Human: Building a Safer Health Care System*, simulation training is recommended as one strategy that can be used to prevent errors in the clinical setting.[1] The report states that "… health care organizations and teaching institutions should participate in the development and use of simulation for training novice practitioners, problem solving, and crisis management, especially when new and potentially hazardous procedures and equipment are introduced"[1] (p. 179).

Nursing education has long utilized simulation in some form to teach principles and skills of nursing care. Models of anatomic parts, whole body mannequins, and various computer-based learning programs have provided educators with training tools for students seeking to become professional nurses. Current interest in simulation as a clinical teaching tool has largely been fueled by development of the human patient simulator.

Human patient simulation is a relatively new teaching strategy that allows learners to develop, refine, and apply knowledge and skills in a realistic clinical situation as they participate in interactive learning experiences designed to meet their educational needs. Learners participate in simulated patient care scenarios within a specific clinical environment, gaining experience, learning and refining skills and developing competencies; all this is accomplished without fear of harm to a live patient. The use of simulation as a teaching strategy can contribute to patient safety and optimize outcomes of care, providing learners with opportunities to experience scenarios and intervene in clinical situations within a safe, supervised setting without posing a risk to a patient.

The focus of this chapter is on the use of patient simulation in nursing education programs. A review of the various types of simulation is presented, followed by detailed information about the human patient simulator and its use as an instructional strategy. Specific information is provided about use of patient simulation in relation to prevention of medication errors, developing critical thinking and clinical decisionmaking skills, use of effective communication skills, and the importance of teamwork. The use of the METI® Human Patient Simulator (HPS) in a university nursing program is described, and an example of a patient care simulation that is used with undergraduate students is given.

Types of Simulation

In general terms, simulation is a technique or device that attempts to create characteristics of the real world. Simulation allows the educator to control the learning environment through scheduling of practice, providing feedback, and minimizing or introducing environmental distractions.[2] In health care, simulation may refer to a *device* representing a simulated patient or part of a patient; such a device can respond to and interact with the actions of the learner.[3] Simulation also refers to *activities* that mimic the reality of a clinical environment and that are designed for use in demonstrating procedures and promoting decisionmaking and critical thinking.[4] In health care education, simulation can take many forms, from relatively simple to highly complex. The various types of simulation are listed in Table 1, along with advantages and disadvantages of each. The types are briefly described in the following paragraphs.

Part Task Trainers

Part task trainers, also known as low-tech or static task trainers, are designed to replicate only a portion of the body or the environment. Many of these represent selected anatomical areas of the human body and are used to teach basic psychomotor skills and procedures. They range in complexity from an item as simple as an orange that is used to teach injection technique to an arm for teaching venipuncture or a mannequin for teaching cardiopulmonary resuscitation (CPR). These simulation tools are relatively inexpensive, and multiple models are often available for use within the same institution, allowing for larger numbers of learners to practice simultaneously.

Simulated Patients

Simulating patients through role play between learners and educators is commonly used in medical and nursing education. Physical assessment skills, history taking, and communication techniques are often taught using student pairs. Trained simulated patients can be used to simulate psychiatric interactions where the learners can try out appropriate interventions. Live female pelvic and male prostate models/teachers provide a dual role of allowing students to refine their exam techniques on the model while receiving real-time feedback about the pelvic or prostate exam. Expense and scheduling are challenges for this type of simulation.

Screen-Based Computer Simulators

Screen-based computer simulators are designed to model various aspects of human physiology or specific tasks or environments. Through a variety of computer programs, learners

use information to make clinical decisions and observe the results in action. There is often feedback during and after the interaction. Computer-assisted instruction programs or Web-based programs are relatively inexpensive and reusable and can be used individually or in groups.

Complex Task Trainers

Complex task trainers involve virtual reality and haptic systems, representing the highest level of computer-based technology. Haptic refers to technology that can sense where touch occurs as well as the amount of pressure being applied. This type of technology is particularly useful in learning environments where the faculty cannot clearly see where the student is assessing the patient. For example, during a pelvic exam, it is difficult for the faculty to determine if the learner is doing a thorough exam. With haptic technology, sensors are placed inside a pelvic model to provide feedback to the learner about areas assessed with touch and the amount of pressure applied. Complex task trainers are often combined with part task trainers so that a physical interaction can occur within the virtual environment. This type of simulation is gaining popularity for training practitioners in surgical techniques such as laparoscopy. While such technology is reusable, it can also be relatively expensive.

Integrated Simulators

Integrated simulators combine computer technology and part- or whole-body mannequins to provide a more realistic learning experience. The degree of sophistication of the mannequin and the computer that drives it determine the degree of engineering fidelity of the system. According to Maran and Glavin,[5] fidelity can be defined as the degree to which the appearance and capabilities of the simulator resemble the appearance and function of the simulated system. Human patient simulators, therefore, are generally categorized as low, intermediate, or high fidelity systems (see Table 2).

Human patient simulators. Human patient simulators are among the most recent technologic advances in instructional methodologies for medical and nursing education. These interactive mannequins are capable of realistic physiologic responses, including respiration, pulses, heart sounds, breath sounds, urinary output, and pupil reaction. Additionally, the more advanced models can communicate with the student, responding to questions posed by the learner in real time during the simulation exercise.

The authors are most familiar with the Human Patient Simulator by Medical Education Technologies Incorporated (METI®) and SimMan™ by Laerdal™. Each company has a variety of portable simulators representing different patient ages to meet the educational needs of the learners at all levels. Both vendors have models with realistic anatomy and clinical functionality.

The METI HPS represents the latest in state-of-the-art simulation technology. Physiological and pharmacological models are used as the operating platform, allowing the simulator to react like a live human. These unique integrated models imitate the human response in a multilayered, real-time manner, providing a realistic clinical presentation.[6] The HPS has a data recorder that records the learner's actions, allowing precise accounts for review and debriefing. Additionally, the HPS interfaces with a patient monitor like those used in most hospitals. Adjustments to the patient scenario can be made "on the fly" as the educator deems necessary.

Laerdal's SimMan operates using personal computer (PC) software. The simulator displays patient physiologic parameters on a PC screen that emulates a patient care monitor. The SimMan software includes the first Integrated Video Debriefing System. The video Web camera records

video and audio that is synchronized with the event log, providing a valuable tool for debriefing. Laerdal's software allows ease of management of patient parameters during scenarios.[7]

Although most simulators owned by schools of nursing are adult males, infant and pediatric models are also available. The simulators have interchangeable genitalia so that the mannequin can present as a male or female. It is possible to adapt the appearance of the mannequin to represent a range of ages from young adulthood to geriatric. Additionally, with the aid of a wig, makeup, and female clothing, the realism can be enhanced as the male mannequin is transformed into a female patient. The mannequin can also be successfully outfitted to present as a pregnant female with the appropriate props.

Promoting Safety Through Education With the Patient Simulator

Patient safety is a multidimensional concept that is central to clinical education. Numerous aspects and principles of patient safety can be easily incorporated into education of nurses and nursing students using the patient simulator. This discussion will focus on four primary areas: preventing medication errors, developing critical thinking and clinical decisionmaking skills, promoting effective communication, and encouraging teamwork.

Preventing Medication Errors

The 2006 IOM report, *Preventing Medication Errors*, concludes that at least 1.5 million preventable medication errors occur each year in the United States. (This number does not take into consideration the errors of omission.) The report indicates that, on average, a hospitalized patient is subjected to more than one medication error each day.[8]

In the National Safety Goals for 2007 of the Joint Commission (formerly the Joint Commission on Accreditation of Healthcare Organizations, JCAHO),[9] improving the safety of medication use is listed as the third goal, preceded only by improving the accuracy of patient identification and improving the effectiveness of communication among caregivers. Goal #8 also relates to medication safety: "Accurately and completely reconcile medications across the continuum of care."

Research has shown that medication errors, otherwise known as adverse drug events (ADEs), are most likely to occur during the prescribing and administration stages and are attributed to a variety of factors. ADEs commonly occur at transition points during hospitalization: admission, transfer between units, and discharge. Errors are often due to confusion caused by similar drug names. Another factor is lack of understanding by patients about their medications, including the risks and side effects of medications and what to do if side effects occur.[8] Medication errors directly related to nursing practice usually involve inappropriate medication dosage, overlooked allergies, giving the wrong drug, and incorrect administration site. All these errors are impacted by environmental distractions, miscommunication, and drug labeling problems.[10]

Medication administration is a vital aspect of nursing practice and a critical component of nursing education curricula. Faculty in schools of nursing are concerned with teaching students about safe medication administration. Educating students about safe administration of medications is multifaceted and involves instruction about actions and uses of medications, safe dosage, side effects, and nursing implications.

A recent analysis of 1,305 medication errors by nursing students over a 5-year period showed that the most common medication errors were those of omission and giving the wrong dose of a drug. Errors were primarily attributed to students' performance deficits with significant contributing factors identified as inexperience and distractions.[11]

Calculation of medication dosages has been identified as a deficit for many nursing students.[11–13] This may be related to weak math skills resulting in computational inaccuracy and to the lack of opportunity to utilize dosage calculation in the clinical setting. The advent of unit-dose packaging has limited the need for calculation of medication dosages.

Safe administration of medications is more than a psychomotor or mathematical skill. It also requires critical thinking and clinical decisionmaking. To safely administer medications, students must be able to assess and manage side effects and educate the patient and family about the prescribed treatment regimen. The patient simulator provides a realistic approach to medication administration in a safe setting where patient risks are eliminated. The computer technology of the METI HPS utilizes a barcode system in which specific medications can be scanned to activate physiologic responses in real or compressed time.

Incorporating medication administration into patient simulation scenarios offers numerous learning opportunities and benefits to students. Understanding of the rationale for medication use is enhanced as students are able to see how medications fit into the treatment of selected conditions. They have an opportunity to identify the appropriate drugs, determine safe dosages, calculate dosages, properly identify the patient, administer medications by a variety of routes, observe for side effects, and evaluate the effectiveness of medications. The simulation presents a realistic simulated clinical setting with inherent distractions that may interfere with safe medication administration. For example, in the midst of activities surrounding a code situation, students are exposed to the reality of medication administration in an emergent situation and to the importance of providing the right patient with the right medication in the right dosage at the right time by the right route. Students can be taught to identify areas of potential error risk during patient transitions and handoffs, including shift report, transfer, and discharge. The importance of effective communication can be emphasized and practiced through accurate reporting of medications and aspects of the treatment plan through simulated handoffs.

Patient and family education related to medications can be incorporated into patient simulations. As part of a simulated scenario or role play, students can ask the patient or family member about current medications in an effort to identify medications, including over-the-counter medications and herbal medications the patient is taking, and to determine if the medications are being used appropriately. As students inquire about side effects of medications that the patient may be experiencing, they can use critical-thinking skills to determine if the medications may be related to the patient's current health problems. As part of a scenario, students may be required to provide patient or family teaching about medications.

Developing Critical-Thinking and Clinical Decisionmaking Skills

Nursing educators are challenged to teach students to think critically, to go beyond simply "knowing," to advance to synthesis and application of knowledge as they assess, plan, implement, and evaluate nursing care. Simulation provides an alternative to the traditional teacher-centered approach to nursing education with emphasis on the learning needs and preferences of contemporary nursing students. Simulated learning experiences with the patient simulator allow faculty to expose students to situations that they may never see in their clinical practicum experiences. Because students are placed in a variety of units for their clinical

experiences, there is a lack of consistency in learning opportunities across and among students. Use of the patient simulator enables faculty to provide structured simulation lab experiences instead of trying to find appropriate and/or rare patient care opportunities in a health care setting.[14]

Promoting Effective Communication

The overwhelming majority of untoward events occurring in health care settings involve miscommunication. The Joint Commission identifies communication as the root cause of approximately 70 percent of all sentinel events.[15] Effective communication and teamwork are fundamental to quality patient care. According to the Joint Commission, patient safety is improved when communication is clear, accurate, complete, and timely. The significance of the quality of communication among team members is emphasized by the Joint Commission in one of its National Patient Safety Goals for 2007: "To improve the effectiveness of communication among caregivers."[9] Because errors often occur during times of patient transition in health care settings, the Joint Commission specifies that facilities must "[i]mplement a standardized approach to handoff communications, including an opportunity to ask and respond to questions."[9]

Communication is an essential component of all health care curricula; however, intradisciplinary communication is typically the focus. Each discipline has its own terminology, expectations, and idiosyncrasies relative to communication, all of which can impact the effectiveness of communication across disciplines. Because health care involves multiple disciplines, a means of standardized interdisciplinary communication is needed to enhance quality of care and promote patient safety.

A recently proposed model of interdisciplinary communication, known as SBAR, is gaining increased attention. This is a shared model for standardized communication designed to facilitate and improve communication between and among health care personnel. SBAR can be applied to both verbal and written communication. The model consists of four components:

Situation—statement of what is happening at the present time that has triggered the SBAR

Background—information that puts the situation into context and explains the circumstances that have lead to the situation

Assessment—statement of the communicator's ideas about the problem

Recommendation—statement of what should be done to correct the problem, by when, and by whom[16]

Patient care scenarios using the human patient simulator provide an opportune way to teach students to effectively use a standardized communication method such as SBAR and to allow them to practice this technique. With minimal effort, SBAR can be added to each simulation, requiring practitioners at all levels to develop and refine their communication techniques to be more effective. Ideally, students representing various health care disciplines can work together in patient care simulations, practicing communication techniques that are representative of the actual health care setting.

Encouraging Teamwork

The 2000 IOM report has heightened awareness about the need for system changes to promote patient safety and quality. The report urges organizations to develop strategies to improve team function, thereby increasing the quality of care for the patient.[1] In an effort to enhance teamwork, many organizations have adopted the principles of Crew Resource Management (CRM), originated by NASA and used in the aviation industry in response to aviation disasters. The CRM training model focuses on leadership, decisionmaking, communication, and team training.[17] It also provides training in ever-changing team structures for members who need to have portable skills to apply to various health care settings such as operating rooms, emergency departments, or intensive care units.[18] Ostergaard, Ostergaard, and Lippert[19] suggest that the individual should develop general team competencies that can be transferred from team to team.

Medical and nursing educational programs train students as individuals; yet, as practitioners they are most often required to work in teams within organizational systems. In the practice setting, nurses and physicians interact on a regular basis with each other and with other personnel in the health care institution. Working together as a team and sharing information among team members can contribute to enhanced quality and safety of patient care. Research findings indicate that the risk of serious events seems to be reduced when team training has been implemented.[17, 20, 21]

Simulation emphasizes the importance of teamwork in providing care for patients. It allows the learner to practice as a team member. Working in small groups with the simulator, students may be assigned specific roles such as primary nurse, secondary nurse, medication nurse, communicator, or recorder. They learn how to delegate tasks appropriately, to follow directions, and to communicate effectively with nurses and other practitioners. The simulation allows learners to assess the patient and the situation, identifying pertinent information that must be communicated to the primary health care provider. Students determine appropriate nursing interventions and implement orders from the health care provider. They evaluate patient responses and the outcomes of their assessments and interventions.

To prepare practitioners to work as effective team members, educational programs for all health care personnel need to increase opportunities to work in interdisciplinary teams.[22] Simulation can be used to train individuals in the context of team activities, creating a more realistic clinical environment. Ostergaard and associates[19] state that simulation is the preferred educational strategy to teach teamwork skills such as leadership, communication, and cooperation. Students from several disciplines such as nursing, medicine, respiratory therapy, pharmacy, and social work can be brought together in a patient simulation scenario. This allows each learner to practice their patient care role and relate in real time to the other professionals with whom they will need to work to effectively provide safe and quality patient care. Johnson[23] states that CRM or team training needs to be introduced early and reinforced often. He further acknowledges that accomplishing quality teamwork requires that practitioners (crews) are trained as a team throughout their educational experiences.

While patient simulation scenarios provide a means of teaching interdisciplinary teamwork and communication, it is important to remember that it is also an excellent strategy for educating students about intradisciplinary teamwork and communication. For instance, as nursing students participate in simulated patient scenarios, they assume a variety of nursing roles, particularly if they are learning in groups. Acting as a team providing nursing care, someone must assume the

leadership role, directing other team members and delegating tasks and responsibilities. A primary nurse is identified as the team leader and is assisted by a secondary nurse. Other students may be assigned specific roles such as recorder, communicator, or resource person. Simulated scenarios allow students to work collaboratively as team members with the additional benefit of having faculty present to facilitate teamwork and observe the effectiveness of teamwork.

Use of Patient Simulation in Nursing Education Programs

Patient simulation is an instructional strategy that can be implemented in a variety of settings. The versatility and adaptability of the technology provide a broad range of uses for the patient simulator.

Nursing Education Programs

University and community college nursing education programs use patient simulators with a variety of learners. Patient simulators are used to teach basic assessment and psychomotor skills with beginning students, evolving to complex clinical scenarios as students advance in the curriculum.[4, 15, 24–30] Graduate nursing programs utilize the patient simulator to teach advanced practice skills and concepts in nurse practitioner and nurse anesthesia programs.[31–34] It is used by clinicians to teach new procedures, to validate competencies, and to transition new graduates into the clinical practice.[35, 36] The patient simulator can be used in research concerning best practice for patient care and education.[37] It has potential for use in master's and doctoral-level education programs to train future faculty members.

Continuing Education

The patient simulator can be incorporated into a variety of continuing education programs, departing from the traditional lecture format to provide a more experiential learning experience for participants. Physical assessment classes, nurse anesthesia updates (e.g., airway management), advanced cardiac life support (ACLS) certification, critical care courses, and nurse refresher programs can be conducted using patient simulators.[30]

Nurse refresher courses typically consist of didactic and clinical components to prepare nurses to return to practice after an extended absence. Using patient simulators, these nurses can practice assessment and psychomotor skills before entering the clinical area. This helps promote self-confidence in the nurse refresher students as they resume hands-on care in a setting that does not endanger a live patient.

Population-specific classes can also be taught using the patient simulator. For example, it can be utilized to teach nurses to recognize and respond to critical situations that may occur in geriatric patients in acute and long-term care situations.

Staff Development

Health care institutions can use simulators in staff development programs such as orientation of new graduates and continuing education programs. Orientation programs for new graduates can utilize the human patient simulator to present specific policies and procedures, to assess clinical competence, and promote communication and collaboration among the nurses. Simulators can be used in continuing education to introduce new equipment, to teach new

procedures, to assess competency of nurses in responding to specific clinical situations, to assess adherence to specific protocols, and to promote teamwork.[28, 35, 36]

Evidence Supporting the Use of Patient Simulation in Nursing Education

Search of the literature on patient simulation reveals that the majority of research related to use of the patient simulator has been conducted in medical and anesthesiology settings. Evidence supporting the use of simulation as an instructional strategy in medical education is clear, although experts have pointed out that such research needs improvement in terms of rigor and quality.[38]

Issenberg and associates[38] conducted an extensive review of the medical literature on simulation, identifying 670 articles, of which 109 were used in their analysis. Based on the available evidence, the researchers concluded that simulation can enhance learning by providing feedback (47 percent of articles), repetitive practice (39 percent of articles), curriculum integration (25 percent of articles), a range of difficulty level (14 percent of articles), multiple learning strategies (10 percent of articles), a capture of clinical variation (10 percent of articles), a controlled environment (9 percent of articles), individualized learning (9 percent of articles), defined outcomes (6 percent of articles), and simulator validity (3 percent of articles).

An integrative review of medical and nursing literature was conducted by Ravert[39] in an attempt to identify quantitative studies related to computer-based simulation in health care education and to determine the effect of simulation on learning. Nine studies out of 513 references met the inclusion criteria; five were conducted in medical schools with medical students and four were done by registered nurses using samples of nurses. Seventy-five percent of the studies indicated positive effects of simulation on knowledge acquisition and/or skills training.

Evidence in the literature related to the use of patient simulation in nursing education and practice is ever increasing, although still sparse in comparison to the medical literature. The majority of articles in the nursing literature are descriptions of how patient simulation is utilized in a particular setting. There is a definite paucity in actual research studies that have been conducted about patient simulation.

The first reports of patient simulation in nursing education describe its use with nurse anesthesia students.[31, 33, 40] Incorporation of the human patient simulator into nurse practitioner and clinical nurse specialist education programs occurred somewhat later and is described in articles by Hravnak, Tuite, and Baldiserri,[32] and Scherer, Bruce, Graves, and Erdley.[34]

Numerous articles have been published describing the use of simulation and how simulation programs have been developed within schools of nursing, primarily with undergraduate students.[4, 14, 24–29] There are limited reports of patient simulator use by hospitals to train registered nurses.[35, 36]

Seropian and associates[41, 42] provided detailed descriptions of simulation technology and guidelines related to development of a simulation program. The articles review the types of simulation and offer rationale for selection of the appropriate technology to fit the educational needs of learners.

Henrichs, Rule, Grady, and Ellis[43] explored perceptions of nurse anesthesia students about the use of a human patient simulator in their first year of clinical training. Analysis of data collected through observations, student journals, and focus groups indicated that students felt the

simulation experience was educational, although they experienced feelings of apprehension, uneasiness, or fear during the sessions.

In another study of nurse anesthesia students, Farnsworth and colleagues[44] examined the efficacy of the human patient simulator in teaching conscious sedation skills. A sample of 20 nurses completed pretests and then experienced a training session consisting of 4 patient simulation scenarios followed by a practical exam. They were asked to complete post-tests and evaluations of the patient simulation training sessions. Overall scores on the post-test were significantly higher than pretest scores. As part of the evaluation, students were asked to rate the training session on a scale of 1 to 4 with 1 = poor and 4 = excellent. The mean rating score was 3.75, indicating that the participants found the training session to be both beneficial and enjoyable.

Nehring and Lashley[30] conducted an international study of human patient simulation in nursing education. They examined the use of the METI HPS by nursing schools and associated simulation centers. The researchers mailed surveys to 66 nursing programs and 150 simulation centers, hospitals, and other institutions of higher education that were located near nursing programs. Thirty-four nursing schools (18 universities and 16 community colleges) and 6 simulation centers throughout the world responded by completing the 37-item closed- and open-ended survey designed by the researchers. Results were categorized and reported as follows:

(1) Curricular use: Greater use of the HPS was reported by community college programs for more hours in all courses with the exception of the maternal newborn course. In university programs, the HPS was most often used in basic skills courses, while community colleges reported the greatest use in advanced medical-surgical nursing courses. Most schools used the HPS as part of required clinical time.

(2) Faculty use: Ninety-three percent of schools indicated that 25 percent or less of their faculty used the simulator; more than half of the sample states that their faculty was generally receptive to HPS use in their courses.

(3) Student views: Twenty-one schools reported collecting information on student perceptions of the HPS. In relation to use of the HPS for competency evaluation of undergraduate students, 42 percent of schools stated that it should be used, 36 percent agreed it should be used in some circumstances, and 22 percent indicated it should not be used.

(4) Other uses of HPS: Only six institutions indicated that they were conducting research about HPS use. Six nursing programs and four simulation centers reported use of the HPS in continuing education programs.

Feingold, Calaluce, and Kallen[45] conducted a study to evaluate nursing student and faculty perceptions about patient simulations using the Laerdal SimMan Universal Patient Simulator. Using a 20-item tool, the researchers surveyed 65 students who had participated in simulations during 2 consecutive semesters. Four faculty members were surveyed using a similar 17-item tool. Findings showed that while the majority of students and faculty felt the simulations were realistic and valuable, only half of the students agreed that skills learned in the simulation were transferable to a real patient care setting. Faculty indicated that simulations reinforced clinical objectives and adequately tested clinical and decisionmaking skills. Concerns of faculty members relative to patient simulator use included extra preparation time and lack of faculty support to use the technology.

Bearnson and Wiker[46] explored the benefits and limitations of using the METI HPS as a substitute for a clinical day in a junior-level nursing course. Each student had a 2-hour session

involving three preprogrammed scenarios. Following the scenarios, the students completed a brief survey instrument (four items) consisting of a Likert-type scale (1 = strongly disagree to 4 = strongly agree) and three open-ended questions. Responses indicated that the HPS increased knowledge of medication side effects (mean = 3.13), increased knowledge of differences in patients' responses (mean = 3.31), increased ability to administer medications safely (mean = 3.06), and increased confidence in medication administration skills (mean = 3.00). Responses to the open-ended questions were overwhelmingly positive.

Alinier and colleagues[47] demonstrated the effectiveness of scenario-based simulation training on nursing students' clinical skills and competence. A sample of 99 undergraduate nursing students in the United Kingdom was divided into control and experimental groups, with the experimental group being exposed to patient simulation training using the Laerdal SimMan. Students in both groups completed a pretest and post-test as well as a questionnaire. There was a statistically significant difference in the mean scores of the two groups from pretest to post-test, with the experimental group demonstrating higher overall scores.

In a recent study, Bremner and associates[48] examined the value of using the human patient simulator as an instructional strategy with novice nursing students. A sample of 41 students completed a questionnaire about their learning experiences with the human patient simulator. The simulator session was rated as good to excellent by 95 percent of the students, and 68 percent recommended it as a mandatory component of their educational program. Over 60 percent of the students indicated that the patient simulation experience increased their confidence in physical assessment skills. Limitations of the technology identified by students included not having enough time to work with the simulator, initial anxiety when first encountering the patient simulator, and a lack of realism.

Advantages of Patient Simulation in Nursing Education

The major advantage of using the patient simulator as an instructional strategy in nursing education is that it provides opportunity for active and interactive learning without risk to an actual patient.[3] Learners can be permitted to make mistakes without fear of harming a live person.

Use of the patient simulator allows for an immersive, experiential learning activity.[50] Students are active participants, not merely recipients of didactic content as in a lecture class. Small numbers of students are typically involved in each scenario, with each student having a role in the simulation. The patient simulator provides a hands-on experience in which students are able to witness the results of their actions in real time.

Clinical simulation with the patient simulator is consistent with adult learning theory. It is a learner-centered approach to education, building on previous knowledge and experiences. The patient simulator provides opportunities for self-study as well as group interaction.[50]

The sophisticated computer technology of the patient simulator has appeal for contemporary learners. Although increasing numbers of nontraditional students continue to enter nursing programs, the majority of learners currently enrolled are younger than 25 years of age. They represent the computer-savvy Generation X and Generation Y, having grown up with gaming systems such as Nintendo®, computers, and the Internet. Individuals from these generations typically possess an inherent fascination with technology and are accustomed to fast-paced communication through means such as instant-messaging. They always want to be in touch; cellular phones, MP3 players, and personal digital assistants (PDAs) have become a way of life.

Effective educational strategies must capture the learners' aptitude with and desire to use technology as they gain and apply necessary skills and knowledge.

Patient simulation scenarios provide a bridge between theory and clinical practice. Working with the patient simulator, students are able to visualize physiological responses that may be difficult to understand simply through didactic classes or readings. Critical thinking and clinical decisionmaking skills are developed and refined as students apply previous knowledge in simulated patient situations. Synthesis learning experiences can be provided through patient simulations. Knowledge and skills attained from classroom and clinical experiences can be applied in patient care situations

Scenarios can be selected or designed to meet specific course objectives and in accordance with learning needs of the students. Simulations allow faculty to expose students to situations that they may never see in their clinical practicum experiences.

The instructor is in control of the events and timing of the scenario and can pause the action as needed for reflection or correction. Scenarios can be repeated to provide consistency of learning experiences across student groups.

Skills and procedures can be practiced in a realistic situation, and immediate feedback is provided as learners observe patient responses and interact with faculty facilitators. If needed, students can be allowed to repeat skills and procedures until proficiency is achieved.

Working in small groups with patient simulation scenarios, learners benefit from each other's successes and mistakes. They also learn to work as a team and can experience a variety of roles as team members.

Learning experiences with the human patient simulator can boost students' self-confidence and help reduce anxiety in the actual patient care setting. Students are able to practice assessment and psychomotor skills and implement nursing interventions under the supervision of faculty so that they feel more confident and competent when they enter the practice setting and are assigned care for patients.

Learning experiences with the patient simulator help students to identify gaps in their knowledge and experience base. The following comments from baccalaureate nursing students illustrate this point (note: "Stan" or "Stan the Man" refers to the human patient simulator):

- Stan stimulates me to want to learn more. I found that when I was in the situation and didn't know what to do, I wanted nothing more than to be able to go and look up what was going on and gain an understanding. After the first day of working with Stan, I went back and read about the specific illnesses that we had encountered in our practice. I found that while we had done many things right, there were many things we had missed.

- During my work with Stan the Man, I realized that my knowledge of normal ranges for central venous pressure, pulmonary pressure, and pulmonary wedge pressure was lacking. Also I realized that I didn't have a firm grasp of the ABCs of emergency care. Stan showed me what happens when these things (airway, breathing, circulation) are not taken care of and in that order. We had a simulation where a spontaneous pneumothorax (which is commonly treated in the ED) resulted in Stan crashing, and ultimately we lost him. This happened mainly because we didn't get a chest tube inserted in time, but had we paid more attention to the ABCs at the beginning of the simulation, we might have been able to avoid him coding on us.

> ♦ I think the most valuable thing I learned was what I do not know. For example, while my group was working with Stan, I discovered that my ability to apply what I thought I had learned in pharmacology is lacking. In several cases I had no idea which drug to use or why. If it had not been for the suggestions from the instructors, I would not have been able to figure out which drugs to use. Thus I have identified pharmacology as a topic that I need to study more.

A major benefit of using the simulator in nursing education is that most students and faculty enjoy this type of learning experience. The dynamic and interactive nature of simulation provides learning experiences that are stimulating and beneficial.[43–45]

Teaching with the patient simulator provides opportunity for faculty development and increased job satisfaction. Nursing educators who enjoy interactive teaching methods may welcome the use of patient simulation into the curriculum and volunteer to participate in training programs and implementation of this technology with students.

As nursing education programs are seeking to hire new faculty, the patient simulation may serve as a recruitment tool. Those schools of nursing that own or have access to patient simulators may be able to attract faculty members who desire to teach using creative and innovative strategies.

Limitations of Patient Simulators

Limitations or disadvantages of the patient simulator are primarily related to its cost, which is prohibitive for many schools. The cost of the equipment can range from approximately $30,000 to $200,000, depending on the manufacturer and features of the patient simulator. Additional expenses include physical space to house the equipment, supplies and equipment needed to simulate the desired clinical environment, the cost of training faculty to utilize the technology, and faculty time involved in developing scenarios.[14, 27]

While a justifiable argument against the use of the human patient simulator is the expense involved in purchase and maintenance, there are ways to make its use more affordable.[27, 30] Educators and administrators need to carefully examine what is the best fit for their agency. They need to identify a plan to integrate the simulator into their curriculum, develop the complexity of the simulated cases, and determine the degree of realism required. As educators become more adept at using the simulator, higher-level performance will be desired of the simulator, so long-term usability and adaptability of the simulator should be weighed against its initial cost. Nursing education programs may procure the simulator through their annual budget, grants, special allocations, or private donations. To help recover some of the costs, some schools of nursing rent the simulator to a variety of groups and agencies, charging an hourly or daily rate.[30]

The portability of the simulators facilitates multicenter sharing. Schools of nursing can partner with hospitals to share the costs of the simulator and training. Realistic clinical environments for simulation can be more easily created through shared props such as intravenous (IV) pumps, dressing supplies, etc. Nursing faculty can collaborate with expert clinicians to develop realistic scenarios that reflect current practice. The two groups can cooperatively teach with the patient simulator. For example, in a university setting, two clinical specialists from the intensive care units at a local hospital lectured to a group of senior students about how to respond in a “code” situation (cardiopulmonary arrest); these two clinical experts provided case studies of actual situations that were developed into scenarios for use with the human patient simulator. The scenarios were used with the seniors and, later, with a group of new intensive care unit staff

nurses. The faculty and the two clinical specialists worked together to facilitate the scenarios for both groups of learners.

The cost of the simulator can be shared by a variety of health care disciplines. The simulator can be used in a multidisciplinary environment where medical, nursing, and other health care specialists work as a team to assess, intervene, and evaluate care provided to simulated patients in specific situations. Collaboration among schools of nursing, medical schools, and other health care disciplines can result in the development of scenarios designed to incorporate the knowledge, skills, and experience of all the related professions.

Schools of nursing and health care institutions can partner with community agencies in purchasing the patient simulator. Community agencies that wish to utilize the patient simulator may be able to barter with schools or hospitals, trading other services for personnel and time to use the human patient simulator. Although use of the human patient simulator began in inpatient health care, its use has extended into the field for training programs that prepare first responders, military, and health care professionals to respond to natural disasters or acts of bioterrorism.

The complex nature of the technology requires a commitment to training educators in the use of patient simulation. This means that faculty time and energies are involved in learning to operate and incorporate simulation into existing curriculum. Since faculty workloads are already heavy, this may seem to be an additional burden. Faculty time involved in actual teaching with simulation has been cited as a potential disadvantage of its use.[45] Student/faculty ratios are typically lower when teaching with a patient simulator. While traditional clinical groups may consist of 8–10 students, the maximum number of students that can be accommodated in a patient simulated learning experience is 5 or fewer, depending on the scenario.

Another potential disadvantage or limitation of the patient simulation that has been identified is lack of realism in the scenarios and patient responses. The realism of any simulation depends upon multiple factors, including the fidelity of the simulator, the environment, props, and the description of the scenario. Realism is also affected by the facilitator's expectation of students to suspend disbelief and treat the simulator as a patient. As realism is enhanced, the effectiveness of the scenario as a learning tool is increased.[41]

Student anxiety related to the use of patient simulation is a potential limitation to its effectiveness.[43, 48] Unfamiliarity with the simulator and fear of the unknown may evoke anxiety. Students may worry about their ability to manage a critical care situation. They may experience some discomfort about working under the direct supervision of faculty facilitators. If students are being evaluated and assigned grades for their participation in scenarios, anxiety may be elevated. The authors' experience with undergraduate nursing students demonstrates that although students may be somewhat anxious when they first encounter the simulator, this anxiety is not necessarily a negative influence. Having participated in scenarios using the METI® HPS, one student commented, "The experience was outstanding! I was terrified, but teamwork got us through. This forced me to deal with my fear of what do I do when a patient comes in. I was proud of myself and the group. Together we did it."

Patient Simulation and Undergraduate Nursing Education

The use of human patient simulators for undergraduate nursing education and evaluation offers an excellent means by which to provide learning experiences and to measure competency of knowledge and skills.[14] In the simulation lab, students collaborate in patient care as they conduct assessments; monitor physiologic parameters such as vital signs, heart sounds, breath sounds, and symptoms; perform nursing interventions; obtain and carry out physician's orders;

administer medications; and evaluate patient responses. This type of learning activity allows the learners to synthesize and apply knowledge they have gained from structured courses and/or clinical experiences.

The use of human patient simulation as an instructional strategy can enhance patient safety and optimize outcomes, providing a means of allowing nursing students to "practice" critical thinking, clinical decisionmaking, and psychomotor skills in a safe, controlled environment, without potential risk to a live patient. Errors can be allowed and corrected without concern for patient safety.

Simulation allows a condensing of vital learning experiences that assists the learner in developing clinical reasoning and decisionmaking skills. Additionally, a simulation can be repeated to allow students to correct misconceptions, fill in knowledge gaps, and hone clinical skills. This can be beneficial in boosting self-confidence and self-esteem as students are learning to think and act like nurses.

The patient simulator is intended as an adjunct teaching strategy to complement—not to replace—the traditional clinical practicum. It may be an addition to clinical hours or may be utilized as a means of remediation for students who encounter difficulties in the clinical setting. Scenarios using the patient simulator can be useful for students who may have been away from the clinical setting for a period of time; for example, students who must drop out of the program temporarily may benefit from patient simulations to refresh clinical knowledge and skills before they return to the clinical area.

The patient simulator provides an alternative to traditional clinical experiences. As enrollments in schools of nursing are rising, there is increased competition for clinical sites. The use of the human patient simulator is one means of providing clinical learning experiences outside the health care institutional setting. Faculty may elect to send students through care scenarios with patient simulation in lieu of a day or portion of a day on the clinical unit in the hospital. The simulation experiences may be used instead of a clinical conference. The time spent in a well-structured simulation experience can be powerful and far outweigh what can be accomplished in a traditional clinical conference.

The patient simulator can help faculty address problems related to lack of consistency in students' clinical experiences. The traditional model of undergraduate clinical education dictates that students are assigned to groups of 8 to 10, supervised by a clinical faculty, working in a health care setting for several hours at a time. Students are placed throughout hospitals and community agencies, working on a variety of units. There is inevitably lack of consistency in student learning experiences. Even students assigned to the same unit will encounter individual patients with unique problems and needs. It is impossible to assure that every student who graduates from a nursing education program will have had the same opportunity to provide care for any specific type of patient. Many variables influence student learning experiences in the clinical setting. These include such things as patient acuity and diagnosis, facility access, time of day, as well as clinical and teaching expertise of clinical instructors and nursing staff. Use of the human patient simulator allows for greater consistency in learning experiences. Learning occurs in a controlled environment where groups of students are exposed to the same scenarios, under the same conditions. Simulation is an efficient way to offer "standardized [experiential] learning in concentrated periods of time"[51] (p. 13).

The versatility of the technology means that patient simulation can be incorporated into courses throughout the nursing education curriculum. It can be used in beginning nursing courses to demonstrate such things as pathophysiological and pharmacological principles, normal and

abnormal physiologic parameters, and responses to interventions. Faculty can utilize the patient simulation with beginning students in physical assessment courses to demonstrate principles and techniques of systematic assessment. Students can hone their assessment skills with the simulator as they practice assessment of specific body systems and as they learn the head-to-toe examination. The simulator can be used to help students understand the concept of doing an initial patient assessment, assist them to understand how to approach a patient, and provide them with introductory interaction skills.

Patient simulation is an instructional strategy that bridges theory and practice in a variety of courses throughout the undergraduate curriculum (e.g., medical-surgical nursing, pediatrics, obstetrics, community health, psychiatric nursing, geriatric nursing). Undergraduate nursing faculty often employ the patient simulator as part of a synthesis learning experience with students enrolled in "capstone" medical-surgical nursing courses.[30] Students are expected to apply theory from current and previous didactic courses and to draw from their previous clinical experiences as they respond in the various scenarios. In the last semester prior to graduation, students enrolled in the nursing program at the University of North Carolina at Chapel Hill participate in a series of medical-surgical simulations cases: congestive heart failure that has progressed to pulmonary edema, tension pneumothorax, and ventricular tachycardia that leads to a full "code." These three cases are presented in a 1-hour time frame. The congestive heart failure/pulmonary edema case takes approximately 30 minutes and is provided as an example in Appendix A. The next two cases move more rapidly due to the emergent status of the patient and the necessary interventions. Later in the semester the students return to the simulation lab for a second hour where they encounter a hyperglycemic hyperosmolar nonketotic coma case that incorporates factors such as cultural issues, use of herbs, use of an interpreter for a non-English speaking patient, regulations under the Health Insurance Portability and Accountability Act (HIPAA) regarding family communications, and issues related to access to care.

Teaching with simulation offers opportunities to experience and act in common situations that students are likely to encounter in the clinical setting. Likewise, simulation can be used to teach students how to respond in situations that are relatively uncommon, yet warrant prompt action to prevent deleterious consequences.

The patient simulator allows for purposeful exposure to critical care scenarios that the learner may not encounter in the clinical practicum. Acquisition of this type of experience is important because the nurse needs to intervene promptly to prevent adverse patient outcomes. Simulation allows students to be immersed in critical care scenarios, requiring them to be active participants identifying pertinent changes in patient status and intervening appropriately, in a timely manner, to effectively treat the changes or to limit adverse outcomes. Even if they do not intervene appropriately or quickly enough and the simulated patient dies, there is educational value to be gained through debriefing.

Most nursing students have minimal opportunities to work in a critical care setting during their clinical practicum, yet it is important that they recognize signs of deterioration in patient status and are knowledgeable about appropriate assessments and interventions. Students on the clinical unit have limited opportunities to participate in emergent situations. If a patient develops cardiac or respiratory arrest and a "code" is called, the team of experts rushes in; the student is typically pushed to the periphery to act as an observer. Students can be taught how to respond in a "code" situation. A cardiopulmonary arrest can be simulated and students are expected to intervene, calling the "code" team and participating in the resuscitation. Students can actually use the portable defibrillator to "shock" the mannequin.[52]

Communication with the team and the health care provider is an important element of any patient simulation scenario. As student nurses working on a clinical unit, there is typically little opportunity for students to contact health care providers directly to discuss concerns or questions about their patients. For example, students do not make calls to physicians to report a patient's declining health status. In simulation, they may be asked to notify the provider, conveying pertinent information in a concise, professional manner and acting as an advocate for the patient. As orders are received from the provider, the student must document and communicate accurately to the team so that they may proceed with implementation.

Scenarios using simulation also provide important lessons about the importance of documentation, particularly in fast-moving critical care cases. One student may be assigned to record everything that is happening, ranging from the patient's vital signs to steps in cardiopulmonary resuscitation. The old adage, "if it is not documented, it was not done," can be emphasized and important lessons reinforced.

Role of the Educator in Patient Simulation

Just as the construction industry emphasizes the importance of using the "right tool for the job," so it is with the choice of an instructional strategy in nursing education. While the uses for the human patient simulator are broad, it is not intended as a panacea that can be implemented effectively at any place and time within a nursing curriculum. There must be careful thought in selecting patient simulation as the instructional method of choice to meet specific learning objectives.

Benner[53] (p. xiv) states that "providing nursing care involves risks for both nurse and patient, and skilled nursing requires well-planned education programs. Experience-based skill acquisition is safer and quicker when it rests upon a sound education base." When planning an educational activity, it is helpful to consider what type of tool will be most appropriate to teach the task at hand and to optimize the situation for the learner. Beaubien and Baker[2] dispel the myth that simulation is a unidimensional concept that has been used to describe the capabilities of the equipment such as high or low fidelity. It is not the level of the simulation fidelity that determines the effectiveness as an educational tool, but rather the faculty who designs the educational experience. Simulation is a multidimensional concept requiring the educator to examine not only the equipment, but also the environment and the psychological perceptions of the learner and educator.[2]

The patient simulation is only as effective as the faculty who are using it. The creativity, clinical knowledge, teaching expertise, and technological abilities of the faculty are highly influential in the effective use of patient simulation. A combination of standardized patients, part task trainers, and static mannequins can be coupled with the mannequin-based high-fidelity simulator to provide a more comprehensive learning experience. Patient simulation is a learner-centered instructional strategy where faculty act primarily as facilitators. The role varies somewhat, depending on whether the patient simulation is utilized for student learning or as a means of evaluating student performance.[4]

It is important to acknowledge that the patient simulator is a highly sophisticated, technologically advanced teaching tool. Training is required to enable faculty to effectively utilize the simulator. In most institutions, one or two faculty members are initially trained and are subsequently charged with training other faculty members in use of the patient simulator. It is helpful to have a "champion" who can present the patient simulator to faculty in a positive way,

citing the advantages to be gained in educating students with this teaching tool. Faculty who are unfamiliar with the simulator can be invited to orientation sessions where they can have hands-on experience with the mannequin and witness the capabilities of the technology. They can also be invited to observe teaching sessions in which students are involved in patient care scenarios using the simulator. Faculty who see the potential benefits of patient simulation may be more likely to want to use the simulator in their teaching. Those who are innovative, creative, and enjoy learning through active participation may be more apt to try the patient simulator as a teaching strategy.

While the novelty and versatility of patient simulation technology can be very appealing, learning to use the equipment can be daunting. This may be especially true for older faculty who have grown accustomed to traditional teaching methods, while younger faculty who have grown up with computer technology may be more interested and adept at learning to use patient simulators. Teaching assistants, who are often graduate students, are utilized in some settings to operate the patient simulator and to assist faculty in writing and running scenarios.

The time factor associated with use of patient simulation may be seen as a disadvantage.[30, 45] Typically, the student/faculty ratios are lower than in classroom or clinical settings, which means that more faculty time is required to offer the simulation experience to students. Faculty may be unwilling to commit more of their time, particularly if they already feel stretched. Those faculty who see the value of the learning experience for the students may be more likely to commit to using the simulator. Using patient simulated scenarios in place of clinical hours may enhance the appeal of this technology; substituting a day of clinical practice for equivalent time in the simulation lab may be an option. In many curricula the credit hours allotted to labs and clinical are the same and allow for 1:1 hour exchange between the two learning environments.

Developing and Using Patient Simulation Scenarios

Manufacturers of patient simulators provide a variety of predefined scenarios for use in health care education. Both METI HPS and Laeradel's SimMan have preprogrammed patient care scenarios. These standardized cases serve as the foundation for other scenarios that can be created by the user to fit curricular and learning needs. The METI Program for Nursing Curriculum Integration™ focuses on nursing educational concepts and competencies. It provides a strategy for implementing simulation use across a 4-semester nursing curriculum. The 90 clinical simulations include objectives, pre-scenario questions, evidence-based references, and more.

Faculty members may choose to adapt or create their own patient simulator scenarios to be more consistent with specific learning objectives and student needs. When adapting an existing simulated program or developing a case scenario, there are important considerations:

- **Q: Are there preprogrammed scenarios that can be used, or is it necessary to develop a scenario?**
  A: Even if an existing program is used, it is likely that the faculty will choose to elaborate and embellish it, including information to make it seem more realistic, framing the scenario with patient background and history. The patient simulator may be used in conjunction with other instructional strategies such as unfolding case studies or problem-based learning activities. Other types of simulation such as part task trainers may be used in conjunction with the patient simulator. If faculty choose to create their own simulated scenarios, they may draw ideas and data from previous experiences, from staff members,

or from students. As a course assignment, students may be asked to write a critical incident paper that can provide ideas for simulated cases. Students may be asked to create cases that can be adapted to the simulator. Of course, patient anonymity must be protected.

- **Q: What are the goals of the experience?**
  A: It is important to identify specific learning objectives. There may be primary and secondary objectives. For example, one of the primary goals may be for students to identify physiologic responses to hemorrhage, while a secondary objective may relate to recognition of cultural and religious beliefs related to use of blood products. Beyond the major objectives, the educator should think about what other teaching points can be incorporated into the case, such as family dynamics, cultural issues, use of alternative therapies, HIPAA regulations, working with an interpreter, etc.

- **Q: Is there an evaluation component to the simulation?**
  A: Students tend to be less anxious in working with the simulator when their performance is not being evaluated. Prior to beginning the case, it should be made clear to the students whether or not any type of evaluation would be done during the simulation. If there is evaluation involved, students should be provided with clear information about the criteria used for evaluation.

- **Q: What is the context of the patient simulation learning experience?**
  A: If used within a specific course, it is important to consider didactic and clinical content that precedes use of the patient simulator. Additionally, previous courses or clinical experiences that students have had should be considered. The patient simulator provides an excellent opportunity for a synthesis experience in which students can apply what they have learned previously to the current situation.

- **Q: What is the level of the students? Are these beginning students who have not yet started the first clinical practicum, or are these advanced students who will be graduating in a few weeks?**
  A: Cases are developed to match the level of the learners. Ideally, students can be introduced to the simulator early in the curriculum as they practice assessment and other basic psychomotor skills. Then, as they progress through the program, they can be involved in patient simulation scenarios that increase in complexity as their knowledge level increases. Ultimately, the patient simulator can be used as a synthesis experience in which students are expected to apply knowledge, experience, and skills that they have acquired up to that point in the program.

- **Q: How much time is allotted for the scenario?**
  A: In general, the more complex the scenario, the greater the time required for completion. It is reasonable to think that most scenarios can be conducted in 30 minutes. It is important to allow time for debriefing when the scenario is over.

- **Q: How many students will be assigned to each scenario?**
  A: Generally, small groups of no more than five students work well together in a simulated scenario. The case is designed with consideration of the number of roles that students can assume and the tasks that are to be accomplished during the case. Although

there is benefit to having students act as observers if space allows, there is greater learning potential when there is hands-on participation in the scenario.

- **Q: Have the students had previous experience with the patient simulator? If so, how much?**
  A: Orientation to the equipment and the technology is essential prior to having students participate in an actual case scenario. There is some anxiety associated with encountering a new teaching method, particularly when it is novel and unfamiliar. Both students and faculty need the opportunity for hands-on orientation to the mannequin, doing such things as listening to breath and heart sounds, being informed of the capabilities of the system, viewing the bedside computer display, and identifying the location of supplies and equipment within the environment.

- **Q: How many faculty/staff are available to assist with the scenario?**
  A: Ideally, there are at least two to three persons involved in running a patient simulated case. It is advantageous to have a coordinator or team leader who is familiar with all aspects of the simulation. This person is responsible for assigning and delegating tasks to other team members, checking the setup and equipment, directing, and troubleshooting as the scenario progresses.[41] The team leader may also be involved in facilitating the scenario, although there are usually one or two other faculty members serving in that capacity. There must be an operator who runs the computer and makes the simulation happen in real time, making adjustments as necessary according to learning needs and actions of the participants. The operator, facilitator, or other staff assistants may periodically move into acting as family members, friends, or other health care personnel who may be involved in the scenario. All faculty/staff who are serving as facilitators will need to be flexible to also assume such roles intermittently as needed during the case.

- **Q: What type of environment is needed to represent the clinical setting for the scenario?**
  A: The educator needs to examine the situation, props, and environment to determine if they are as realistic as possible. Realism of the situation is critical to the learning experience for the student during the scenario. Suspending disbelief by creating a situation as realistic as possible encourages learners to immerse themselves in the experience with minimal distractions. Gaba[3] suggests that learners who are immersed in experiential learning are more able to suspend disbelief and perform as they would in a real-life situation. Additionally, it may enhance the ability to transfer what has been learned in the scenario to an actual patient situation. While the patient simulator is typically housed in a particular room or space, it may be possible to adapt the environment to increase the realism of the simulated case. Real patient care equipment should be used whenever possible. Visual and auditory props may be as simple as a telephone that can be used to simulate phoning the health care provider. Gather the props and equipment and have the environment prepared in advance of the case. For example, intravenous fluids or blood products may need to be mixed and hung. Depending on the patient being simulated, the mannequin may need transforming with makeup, masks, or a wig.

- **Q: What audiovisual equipment is needed and available?**
  A: A whiteboard, blackboard, or flipchart is needed for recording patient data and nursing interventions during the scenario. Video recording of a simulation session is useful in providing feedback for the participants. Video playback can be a powerful teaching tool as participants are able to observe and critique the scenario. The video recording is also helpful for the operator and others to see the simulation from all angles.[41]

- **Q: Is there time for debriefing?**
  A: The debriefing is a critical part of the patient simulated scenario, providing participants with an opportunity to reflect on their learning experience. During this time, participants may be asked to consider key questions such as: "What went well?" "What could have been done better?" "How did you feel in the role of _____?" (See Postsimulation.) The debriefing is also a time to review key concepts and knowledge related to the scenario. Important points can be discussed; pathophysiology of patient symptoms and responses to interventions can be reviewed; rationale for interventions can be identified; actions, dosages, side effects, and administration of medication can be discussed.

Presimulation

Presimulation Faculty

Prior to use of the simulator with students, faculty must be fully prepared to facilitate the learning experience. This means familiarity with the equipment and with the particular scenarios that are to be used. The computer operator needs to be skilled in the technology of the simulator. They need to know how to set up the equipment, connecting the mannequin to the computer, and initiating the program to be used. If a preprogrammed scenario is used, the operator starts the program and allows it to run. However, if the scenario allows physiological parameters to change outside of the program, the operator must be knowledgeable about how to make the necessary adjustments as students are in the midst of the scenario. For example, if students do not intervene promptly and appropriately in recognizing and treating hemorrhage, the "patient" may progress to hypovolemic shock and subsequently arrest. The operator can determine how quickly the patient's condition deteriorates and the patient's response to interventions.

It is important to provide all involved in the case with a script a few weeks prior to the simulation so that they can prepare adequately to be a facilitator. You might color code each role in the script to allow ease of following the case. The script should be in a large font and double-spaced, allowing quick referencing during the case. It is helpful to rehearse the simulation scenario before utilizing it with students. This allows for refining and adjusting the scenario and/or roles as needed prior to implementation to promote its effectiveness as a learning strategy. Because this is an unfamiliar educational method for most nursing educators, faculty may benefit from in-service classes about teaching with the simulator. Additionally, they need the opportunity for hands-on learning with the simulator so that they are better able to assist students and facilitate their learning experiences. Having faculty participate as students in scenarios can be very effective in increasing their comfort level with the patient simulator.

Using clinical faculty as facilitators of patient simulator scenarios can be very effective, particularly with their own clinical groups. This can provide opportunity for faculty to gain

insights into how the students function as team members; to identify leadership qualities; to assess communication, critical thinking, and skill performance; and to observe how students react under pressure if a critical situation occurs.

Using the METI HPS With Baccalaureate Nursing Students

The following paragraphs describe how the METI HPS is used with senior students in the baccalaureate nursing education program at the University of North Carolina at Chapel Hill. Simulation is used to provide students with a synthesis learning experience in which they have the opportunity to utilize previous knowledge and experiences as they assess, intervene, and evaluate the care of a rapidly deteriorating patient. This critical care experience requires that students demonstrate competency in assessment, critical thinking, communication, teamwork, skill performance, and documentation. It is an excellent means of reviewing important concepts as students prepare to take the National Council Licensure Exam for Registered Nurses (NCLEX-RN) and enter practice within a few months.

Presimulation logistics. The course coordinator for the senior-level capstone medical surgical nursing course assigns students to groups for the simulation experience. Each clinical group is divided into two groups of five students. (Five seems to be the maximum number for effective use of the HPS.) Each clinical faculty member assists with the simulation experience for his or her group. Students spend a total of 2 hours in the simulation lab during the semester as they encounter four simulation scenarios involving care of an acutely ill adult patient. The cases that are typically used include congestive heart failure progressing to pulmonary edema, tension pneumothorax, hyperglycemic hyperosmolar nonketotic coma, and cardiac arrest. These cases were adapted from preprogrammed HPS scenarios.

The HPS is located in a room that is dedicated to its use. The room houses the mannequin on a stretcher, the patient monitor display, a cart with medications and emergency supplies (oxygen, IVs, syringes, etc.), a set of cabinets that includes a countertop and sink, a white erase board, resource books, and a telephone. There is an adjoining control room that houses the operating tower and computer interface. A one-way mirror enables the computer operator to observe the students and faculty as they participate in the scenario. An infant sound monitor is placed near the head of the mannequin and the receiver is placed in the control room so the operator can hear what is being said in the simulation room.

Two nurse educators who act as facilitators and a graduate teaching assistant who operates the computer usually conduct the simulation scenarios. The nurse educator who is most knowledgeable and experienced with the HPS takes the lead and directs the simulation. The other nurse educator (usually the clinical faculty) assists and supervises students' performance. Both faculty members assume additional roles as needed, such as a family member and physician or nurse practitioner. The graduate teaching assistant operates the computer from the control room, initiating and managing the physiologic responses of the mannequin in accordance with each particular scenario or simply starting and stopping a preprogrammed scenario. The teaching assistant also is the voice of the patient (the HPS mannequin has a voice box in his neck), responding to the students' history and assessment questions. The infant sound monitor allows the teaching assistant to hear the students' questions.

Presimulation student instructions. In an effort to promote realism in the cases, students and faculty dress as they would for the clinical experience in the hospital. In addition, they are asked to wear identification badges and to bring their stethoscopes. It is made clear to students that the HPS simulation is a required experience. Students are expected to come to the HPS

simulations with some background knowledge and experience. They may have assigned readings or written assignments to complete prior to the simulation. A completed written assignment (e.g., study questions) may be used as a student's admission ticket to the scenario.

Presimulation briefing. All simulation scenarios begin with a presimulation briefing (see Simulation Box 1). During this time, students are oriented to the mannequin and the learning environment. A faculty member who will be assisting with the subsequent scenarios conducts this session.

Each group of students enters the simulation room, accompanied by one of the nursing educators who will facilitate the cases. The first time students encounter the human patient simulator, the technology and equipment involved with the mannequin are explained (see Simulation Box 2). Students are encouraged to uncover and examine and touch the mannequin, listen to the heart and breath sounds, palpate the pulses, and observe pupil response. The voice of the mannequin is demonstrated. It is important to remind students that they are to treat the mannequin as they would a patient in the scenarios. Students are oriented to the environment, including the computer display and the location of equipment and supplies. After each student has had an opportunity to become acquainted with the mannequin and the environment, the group of four or five is escorted outside the simulation lab where they receive instructions about how the scenarios will proceed. Each student is assigned a specific role during the scenario: primary nurse, secondary nurse, communicator, recorder, and resource/medication nurse (see Simulation Box 3). The students draw 5" × 7" index cards to determine their assigned roles. Each card identifies the responsibilities of that particular role. In subsequent scenarios, role assignments are changed so that no student repeats a role they have already performed. During the briefing, students are given a concise report on the patient they will meet in the scenario. The setting (e.g., emergency department, intensive care unit), patient history, presenting problem, family situation, and other pertinent details are described to the students.

The use of index cards to assign specific student roles evolved after conducting a few simulations in which students appeared disorganized and confused about what each one should be doing. For example, one student would think of something to do and all the students in the group would set about attempting to perform that intervention. There was no evidence of teamwork. In an attempt to remedy this problem, students were asked to volunteer for a role in the scenario (primary nurse, secondary nurse, communicator, recorder, and resource/medication nurse). Students were hesitant and took too long deciding who would perform each role. Subsequently, faculty developed index cards to identify each role and the associated responsibilities of that role. During the presimulation briefing, a faculty facilitator shuffles the cards and asks students to draw their roles prior to each scenario. In addition to saving some time, this technique provides the students with some direction as they begin the scenario.

Simulation Box 1. Presimulation Student Preparation

Instructions to the student:

- Prior to simulation, complete assigned readings, case materials.
- Be prompt to your assigned simulation time.
- Dress as in clinical.
- Wear name badge.
- Bring stethoscope.
- Address and treat mannequin as though a patient.

Simulation Box 2. Presimulation Briefing—Orientation to Simulator & Learning Environment

Orientation to the mannequin:

- Heart and lung sounds
  - Instruct students to listen to the heart and lungs sounds so that they are be able to differentiate from normal, which is what they are hearing during orientation, and abnormal, which is what they will hear when the scenario begins. Help students to adapt to the mechanical sounds associated with the heart and lung sounds.
- Palpate peripheral pulses (no posterior tibia pulse).
- Perform PERRL (no A or accommodation).
- Explain to students what mannequin does not do/have:
  - Bowel sounds
  - Sweat
  - Seizure
  - Change color such as cyanotic, flushed, or pale
- Demonstrate how to connect mannequin to monitor.
- Inform students that patient data is located on the patient care monitor. Detail the data as presented so that they can interpret later in a case.
- Differentiate for them what data they can expect to get from the monitor and what will require their assessment.

Orientation to the learning environment:

- Monitor
- Mannequin on stretcher or hospital bed
- Oxygen and delivery devices
- Defibrillator
- Medications
- Suction
- Patient chart
- Realistic lab values, chest x-rays, EKGs
- Phone to call physician/nurse practitioner and labs

Simulation Box 3. Role Assignment Cards

Position:	**Role**:
Primary RN	Team leader, assessment, history, sets priorities, and delegates.
Secondary RN	Assists with assessment, performs nursing skills and medication administration as directed by primary nurse.
Recorder	Writes down pertinent information on whiteboard.
Communicator	Speaks to family, health care provider, lab, radiology, etc.
Resource/Medication RN	Looks up needed information for team (e.g., safe medication dosage, rate of administration of medications) and administer medications as needed.

**The roles are printed on colored 5" X 7" index cards with the role name on one side and the responsibilities of role on the other side. These cards are laminated and used over and over for each simulated case.*

Intrasimulation

The actual simulation begins as students enter the simulation room. If it is their first encounter with the simulator, they may need some assistance and encouragement in getting started. The faculty facilitators coach the students as needed. The students acting as primary and secondary nurses are expected to introduce themselves to the patient and family. The communicator assumes the position near the telephone, the recorder goes to the whiteboard, and the resource/medication nurse locates the reference materials. The primary nurse begins the assessment and directs the secondary nurse to assist or to do other tasks as needed. Based on the assessment findings and any physiologic changes that may occur, the primary nurse determines the interventions that are needed. He or she may collaborate with the secondary nurse or other team members as necessary. The recorder documents all assessment findings on the whiteboard. At the point it is determined that a call to the health care provider is warranted, the communicator gathers the necessary data and contacts the provider by telephone. Using the SBAR communication method, pertinent information is relayed to the provider and orders are obtained. The communicator documents the orders. As soon as she or he is finished, the facilitator uncovers a foam board with the orders prewritten large enough that they are visible to the entire team. The orders are implemented at the direction of the primary nurse, who is also involved in carrying out the orders. The resource nurse looks up any medications that are ordered to identify the type of drug, the actions, dosage, administration, and potential incompatibilities with other medications. This information is communicated to the team prior to administering any medications. The primary nurse can delegate some of the medication administration to the resource nurse.

The faculty facilitators may be involved in numerous aspects of the simulation. One may be assisting with medications, while another may be helping with skills such as applying oxygen or testing blood sugars on the patient. If the students do not intervene appropriately, the patient may go into respiratory arrest and/or experience cardiac arrhythmias. Faculty assist the students as they perform CPR and administer emergency medications. The simulation ends at the predetermined “end” of the case, when the patient “expires,” or as determined by the faculty.

Postsimulation

Debriefing is used to correct any misinformation or improper practice techniques the students may demonstrate. Beaubien and Baker[2] stress the importance of feedback to enhance the ability of students to integrate correct behaviors into their skill set. Through the simulation, gaps in knowledge are identified in individual students that would otherwise go undetected. Additionally, in the debriefing students are asked to reflect on their own skills and knowledge. They identify what they have done well and areas that warrant improvement. Because there are multiple activities occurring throughout the simulation and students may be focused only on their specific roles, debriefing can be used to review key points about the simulation. This includes discussion of the events that occurred, psychomotor skills such as setup of a chest tube drainage system, selection of oxygen delivery method and application, rate and technique for IV push medications, etc. (see Simulation Box 4)

Simulation Box 4: Postsimulation Debriefing and Discussion

Ask students:

- What do they think they did well? – Validate what they know and affirm what they are currently doing well.
- How did this case make them feel?
- What would they do differently if they had to do it again? – Critique their performance as a group and assist them to identify additional learning needs.
- How did they like working with the HPS?

Review key concepts:

- Describe and interpret scenario.
- Students will
  - Discuss roles of team members – point out teamwork, communication, and use of appropriate and inappropriate delegation.
  - Highlight areas for potential patient safety issues – communication with each other, transcription of orders, handoff and transfer of patient.
  - List what signs and symptoms Mr. Jones exhibited.
  - State how Mr. Jones' presenting signs and symptoms varied from the textbook picture.
  - Identify what precipitated Mr. Jones' CHF and pulmonary edema – past medical history and pathophysiology.
- Discuss pathophysiology of CHF and pulmonary edema.
- Review lab reports, x-ray, EKG.
- What should be immediate interventions? (Focus on ABCs.)
- Review communication with health care provider:
  - SBAR
  - Key points to include
- Discuss rationale for each of the health care provider's orders.
- Identify important nursing considerations:
  - Conserve Mr. Jones' energy – do not ask complete history while he has dyspnea.
  - Explain to Mr. Jones what you are doing – be brief, concise.
  - Communicate with Mrs. Jones – provide information, but do not offer false reassurance; have staff member escort her out of room.
- Do a skill review:
  - Non-rebreather mask and why it is best choice for oxygen delivery
  - Insertion of IV: choice of angiocath size, insertion site, fluid, rate of administration
  - IV push medications and technique for administration
  - Foley catheter to straight drainage (urometer for hourly outputs)

It is important to provide students with an opportunity to evaluate their experiences and the use of the patient simulator as an instructional strategy. This is done as part of the debriefing, but should also be part of a computerized or written evaluation. It may be part of a course evaluation or a separate evaluation tool specific to the patient simulation experience.

Student Evaluations of HPS Scenarios

The students who have participated in METI HPS simulations in the baccalaureate of science in nursing and continuing education programs have given overwhelmingly positive evaluations of the simulator as an instructional strategy. This is consistent with other reports of student evaluations in nursing[43–45, 48] and medical education.[51, 54, 55] One student commented, "Simulation was very effective. It took into account many facets of care, for example, assessment, communication with family, doctor's orders, medications, including herbs."

Many students feel that the simulation experience taught them all they know. This concept is evident in the following student evaluative comment:

> The simulator was awesome and so realistic. We were required to do rapid assessments of a critically ill patient and to pull it all together to provide care. Now I better know what I do not know and can work on improving. I learned more in this hour than I have my whole curriculum.

Students do not recognize that the simulation provides a synthesis experience in which they draw from previous knowledge and experiences. The didactic and clinical components of their educational experience to date have been instrumental in preparing them to think and act like nurses. The "aha!" experience of patient simulation promotes student confidence in their critical-thinking and clinical-decisionmaking skills and in their ability to practice as safe, competent nurses as they enter the workplace.[46, 48]

Practice Implications—The Future of Patient Simulation in Nursing Education

Use of the patient simulator as an instructional strategy holds great promise for nursing education. Simulation can become an integral part of nursing education because of its ability to improve patient care and patient safety. No live patients are placed in jeopardy at the expense of the learner. Simulation provides standardization of cases, promotes critical thinking, allows mastery of patient care, provides immediate feedback, and helps students integrate knowledge and experience. It is an ideal synthesis learning experience.

Because the patient simulator is a relatively new educational tool, nursing educators must become acquainted with the technology, its potential uses, and benefits to learners. Toward that end, it is important that the nursing literature on patient simulation is increased, both in descriptive articles and in research reports. As faculty become more aware of the advantages of educating students with patient simulation, its utilization in educational programs should increase.

Because of the investment of money and faculty time associated with patient simulation, it is imperative that administrators and educators see the value of teaching with simulation. Administrators need to commit financial resources to procuring patient simulation equipment and training faculty in its use. Faculty time must be dedicated to the development and implementation of simulation programs.

Nursing faculty need to look for new ways to utilize the patient simulation technology with all types of learners. Schools of nursing can optimize the use of a patient simulator and increase its cost effectiveness by incorporating it into undergraduate, graduate, and continuing education programs.

Research Implications

The paucity of nursing research on the use of patient simulation demonstrates the need for further study. Studies are needed to investigate the best ways to utilize patient simulation in nursing education.[39] Evaluative studies are needed to examine the success and effectiveness of patient simulation in all types of nursing education programs. Research is also needed to demonstrate that knowledge and skills acquired in a simulated environment are transferable to actual patient care situations. The cost effectiveness of using simulation also needs to be explored.[47, 56–58]

Conclusion

The use of patient simulators in nursing education is a relatively new instructional methodology. The rationale for using simulation as an educational strategy includes the absence of risk to a live patient; the ability to provide standardization of cases; the promotion of critical-thinking, clinical-decisionmaking, and psychomotor skills; the provision of immediate feedback, and the integration of knowledge and behavior. Through patient simulation scenarios, essential elements of patient safety can be emphasized, such as prevention of medication errors, promotion of effective communication, and the importance of teamwork. Learners can be exposed to critical care scenarios and have the opportunity to respond without fear of harming a live patient.

By providing students with exposure to a variety of clinical situations through clinical practicum experiences and patient simulations, they can be better equipped to provide safe, effective care and work as contributing members of the health care team.

The challenge is for faculty to embrace patient simulation as an instructional strategy and to seek its effective implementation in nursing education programs. The exciting technology of patient simulation is only as good as the faculty who use it. The potential benefits to learners outweigh the costs of the equipment and faculty training.

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Table1. Teaching/Learning Strategies Using Simulation

Type of Simulation[59]	Description[59]	Advantages[60, 61, 62]	Disadvantages[60, 61, 62]
Low-tech (static) task trainers e.g., food items: oranges for injections, chicken breast for biopsy, pigs feet for suturing, injecta pads, adult/child/infant mannequins, breast and gyn/prostate models, eye/ear models, IV arms, CPR mannequins, case studies, etc.	Props, models, or mannequins used to practice skills and procedures	No threat to patient safety Readily available Reusable Develop role memorization Allows for return demonstration of skills Large groups of learners Low to moderate cost	Task training Consistency Learner – memorization Lower veracity Return demo without critical thinking
Simulated patients e.g., standardized patient (trained actors), learner/learner, educator/learner, patients playing role of patient, female and male human models for pelvic and prostate exams, unfolding case studies	Role-play patients for training, simulates assessment of history taking, physical exams, communication, and therapeutic psychiatric interventions	No threat to patient safety Great tool for high communication skills Provides relatively consistent experience for all students	Moderate to high cost with each use Limited learners
Screen-based computer simulators e.g., computer-assisted instruction (CAI), virtual reality excursions (VRE), Web-based programs	Programs to train and assess clinical knowledge and decisionmaking.	No threat to patient safety Provides relatively consistent experience for all students Reusable	Variable amount of critical thinking Moderate cost
Complex task trainers e.g., virtual reality devices such as bronchosocpy, laparoscopic surgery, IV access (Cath Sim^{R}), haptic (touch cue) simulators such as pelvic exam, cardiac catheterization and stent placement, respiratory intubation, neonate (umbilical artery, lumbar, intubation) models	High-fidelity visual, audio, touch cues with interfaces with computers	No threat to patient safety Provides relatively consistent experience for all students Promotes realism Improves psychomotor skills	Moderate to high cost Limited learners

Type of Simulation[59]	Description[59]	Advantages[60, 61, 62]	Disadvantages[60, 61, 62]
Human Patient Simulators ***Low-fidelity*** e.g., Noelle birthing mannequin – uses compressor to birth newborn every 7 minutes ***Moderate-fidelity*** e.g., Laerdal™ SimMan™ ***High-fidelity*** e.g., METI Human Patient Simulator®	Full-length human mannequins Simulated anatomy and physiology Computer-driven scenarios that responds as programmed Computer-driven physiologically based that responds in real time to interventions	No threat to patient safety High degree of realism and veracity Low educator/learner ratio (1:5) Active involvement of learner Decreases emphasis on memorization Consistent experience for all students: serious or uncommon clinical problems can be presented to all learners Creates a standardized setting for honing and enhancing critical-thinking, problem-solving, and decisionmaking skills Enhances ability to assess variations in patient responses and the learners' ability to pick up important assessment data Increases competence and ability to formulate a strategy for a specific situation Learners are better prepared for clinical practicum Practice communication with multidisciplinary team members. Teamwork and leadership skills can be practiced Communication and delegation skills can be fine tuned Psychomotor skills can be applied and refined Increased organization of patient care	High cost (startup and ongoing cost) Maintenance Resource intensive: monetary and faculty Limited learners High staffing ratio No validation of transfer of learning to clinical setting Learner's disbelieving attitude Hypervigilance because being observed Anxiety of learner interferes with performance Lack of knowledge at time of simulation experience of learner Physical space for simulator and associated teaching sessions needed Lack of comfort with simulator as teaching strategy for educators

[59] Adapted from Ziv A, Wolpe PR, Small SD, Glick S. (2003). Simulation-based medical education: an ethical imperative. *Academic Medicine*, 78(8):783-788.
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Table 2. Key Terms and Definitions

Terms and Acronyms	Definitions
ABCs	airway-breathing-circulation
ABG	arterial blood gases
ACLS	advanced cardiac life support
ADE	adverse drug event
ASA	aspirin
BSN	baccalaureate of science in nursing
BP	blood pressure
CAI	computer-assisted instruction
Capstone	A course occurring at the end of a curriculum allowing students to synthesize what they have learned.
CBC	complete blood count
Champion	A person who will be a leader in the use of a new technology, helping to bring additional faculty along in their implementation of the technology across the curriculum.
Chem 7	Blood work that is done on serum examining seven chemical tests: blood urea nitrogen (BUN), serum chloride, carbon dioxide, creatinine, glucose, potassium, and sodium.
CHF	congestive heart failure
Code	Respiratory and/or cardiac arrest
Complex task trainer	Highly sophisticated computer technology that provides training on specific skills or procedures; includes virtual reality and haptic systems.
CPR	cardiopulmonary resuscitation
CRM	Crew Resource Management
CXRs	chest x-rays
ED	emergency department
EKG	electrocardiogram
Fidelity	The degree to which the appearance and function of the simulator resemble the simulated system; low, intermediate, or high[5]
FiO_2	fraction of inspired oxygen
Generation X	Refers to the generation of people born between 1961 and 1981 (dates vary among different sources) and describes behaviors in terms of life experiences.
Generation Y	Refers to the generation of people born between 1977 and 2003 (dates vary among different sources) and describes behaviors in terms of life experiences.
GYN	gynecological
Haptic	Technology that interfaces with the user via the sense of touch.
High-fidelity patient simulators	Highly sophisticated computerized mannequins, capable of realistic physiologic responses.
HHNC	hyperglycemic hyperosmolar nonketotic coma
HIPAA	Health Insurance Portability and Accountability Act
HOB	Head of bed
HPS	human patient simulator; high-fidelity computerized mannequin, produced by Medical Education Technologies Incorporated (METI®).
HR	heart rate
Hypovolemic	Decreased circulating blood volume.
ICU	intensive care unit
I/O	intake and output
Integrated simulators	Simulators that combine computer technology and part- or whole-body mannequins.
Injecta pad	Gel-filled pad used to teach and practice giving intramuscular and subcutaneous injections.
IVs	intravenous line or intravenous fluid
K-Dur	Oral form of potassium chloride, a potassium supplement.
JCAHO	Joint Commission on Accreditation of Healthcare Organizations (now known as the Joint Commission)
Laparoscopy	Minimally invasive surgery in the abdomen or pelvic area where thin instruments are used to view, remove, or repair areas through small incisions.
mEq	milliequivalents
METI	Medical Education Technologies Incorporated
mg	milligram(s)

Terms and Acronyms	Definitions
MD	medical doctor
ml	milliliter(s)
MP3 player	MPEG-1, Audio-3, a portable, compressed, digital encoding device that allows a person to listen to music and/or watch video.
MSO_4	morphine sulfate
NASA	National Aeronautics and Space Administration
NRB mask	non-rebreather mask for delivery of oxygen
NCLEX-RN	National Council Licensure Exam for Registered Nurses
NS @ KVO	normal saline (intravenous fluid) at keep-the-vein-open rate (30 ml per hour)
O_2	oxygen
Part task trainers	Low-tech or static task trainers, designed to replicate a portion of the body or the environment; many represent selected anatomical areas of the human body and are used to teach basic psychomotor skills and procedures.
Patient simulators	High-fidelity computerized mannequins.
PC	personal computer
PDA	personal digital assistant, a hand-held data device.
Pedal edema	Excessive fluid in the extremities. When the tissue is pressed with a finger over a bony prominence, the depression remains, and the amount of depression is graded from 0 to 3+ to indicate severity of the fluid overload.
PERRLA	pupils equal round and reactive to light and accommodation
PERRL	pupils equal round and reactive to light
PMH	past medical history
PO	*Per os,* Latin for “by mouth”
Pulmonary edema	Fluid collecting in the lungs primarily due to left-sided heart failure but may occur with right-sided heart failure.
QD	every day
Q 5 min	every 5 minutes
RN	registered nurse
RR	respiratory rate
SBAR	Situation, background, assessment, recommendation: A model of communication that is clear, concise and to the point. Sharing key information about situation, background, and assessment, and providing a recommendation.
Screen-based computer simulators	Computer programs designed to model various aspects of human physiology, specific tasks, or environments; learners use information to make clinical decisions and observe the results in action; feedback is provided during and/or after the interaction.
SimMan™	High-fidelity patient simulator produced by Laerdal™
Simulated patients	Live persons acting as patients through role play; student partners practicing assessment skills or procedures; live actors as trained patients.
Simulation	A technique or device that attempts to create characteristics of the real world; in health care, a device representing a patient or part of a patient that can respond and interact with actions of the learner;[3] activities that mimic a clinical environment, designed for use in demonstrating procedures and promoting decisionmaking and critical thinking.[4]
SL	sublingual
SOB	shortness of breath
Stat	*Statim,* Latin for “immediately” or “now”
T	Temperature
Tension pneumothroax	A patient care emergency where air enters the pleural cavity but cannot exit, causing increased pressure in the pleural space and leading to the collapse of the lung on the affected side. This change in pressure will eventually compress the heart and major vessels, and the lung on the affected side will not be able to expand.
TV	television
VRE	virtual reality excursions

Appendix A: Simulation Case Presentation

Simulation Scenario: CHF Pulmonary Edema

Simulation participants:

- Lead faculty: director and facilitator
- Clinical faculty: facilitator, assume additional roles (wife, MD), assist students with psychomotor skills, etc.
- Computer technician: (in control room, behind two-way mirror): "patient" voice and computer operator
- Students

Note: To facilitate ease of role identification, when we prepare scripts for the faculty, we color code all the different roles, double space, and highlight key points. The case is then bound and distributed to all the facilitators.

Facilitator: Role context is an RN who has worked the night shift in a busy emergency department (ED). Students are told they are coming reporting to work on the day shift in the ED. It is 7:00 a.m. and time for report.

> *Thank goodness you all are here. We have had a terrible night. There is a code going on down the hall, so I'll be quick. I need for you to take over care of the patient in room 1. His name is Alex Jones; he is a 62-year-old Caucasian male, just brought in by his wife. He is complaining of shortness of breath and chest pain. He says he has been up all night, and his wife finally made him come to the ED because it had gotten so bad. His wife has gone to park the car and has all of his meds. I'm sorry; all we have done so far is get him in a room. He hasn't been connected to the monitor, and no one has assessed him yet. Thanks for taking him over! I'll check on you later. I have to run back to the code.*

Facilitator: Escorts students into the simulation room. Direct communicator to area where phone (phone is a prop and is not connected) is located; direct recorder to white erase board and resource nurse to reference materials. If students are hesitant to begin their assessment, provide encouragement.

Students:
Primary and secondary nurses should introduce themselves to Mr. Jones and begin to do the following:

- Connect patient to the monitor.
- Obtain vital signs.
- Auscultate heart and lungs.
- Administer O_2 – 100 percent non-rebreather (be sure to fill bag with O_2 before putting mask on patient).
- Start IV – NS @ KVO.
- Elevate HOB.

- Assess pain (rate and describe).
- Assess for peripheral edema (he has on puffy socks to simulate 3+ pedal edema).
- Obtain history – recognize the need to limit questions due to his SOB.

Facilitator: Students need to ask patient appropriate questions. If they seem like they are getting off track, give redirection and guidance to their assessment and history. (The primary and secondary nurses may take directions/suggestions from the other team members.)

Computer technician: (Computer operator on other side of one-way mirror is the voice of Mr. Jones, voice is transmitted through microphone).
Voice of Mr. Jones: Make voice sound very anxious, keep repeating until nurse intervention, *"I just can't catch my breath," "It hurts all over my chest," "I can't take lying down like this,"* and *"You've got to help me."*

When asked by the students, Mr. Jones gives the following responses:

- Pain: *"10" on a scale of 1–10, all over my chest, feels different from when I had heart attacks.*
- PMH: *I've had four heart attacks. When? The first one was when I was 36 and my last one was 2 years ago. I've never had open-heart surgery.*
- Medications: *"Oh, honey, I can't keep track of all of them. My wife is bringing them in." "I took all of them this morning at about 3:00 a.m. before we came in."*
- Social history: *No alcohol, quit smoking 20 years ago.*
- Recent changes: *"When I take my socks off, my leg looks like they are still on," "I tell my wife that I fall asleep watching TV every night in the recliner, because I don't want her to worry. But, the truth of the matter is, I just can't sleep lying down anymore,"* and *"I thought maybe I just ate too much at (fill in appropriate holiday), because I've gained 10 lbs in the past 2 weeks."*

Faculty facilitator: (One of the faculty facilitators acts as wife of Mr. Jones.) At some point, preferably when the students are engaged with the patient, a concerned wife runs into the room, anxiously asking about her husband, trying to get to him to hold her hand. Ask the nurses, *"Is he okay? What is going on? Is he having another heart attack?"* Continue to be "in the way" until one of the students responds to you and takes you aside to talk to you.

Give the paper bag full of his medication bottles from home to one of the students.

List of meds:

- Nitrostat 0.3mg SL prn chest pain Q 5min x 3 doses
- Ramipril 2.5 mg PO QD
- K-Dur 20 mEq PO QD
- Furosemide 20mg PO QD
- Tenormin 50mg PO QD
- Lanoxin 0.25mg PO QD
- ASA 81mg PO QD

Student: The student acting as **communicator** should take the wife out into the hall and identify herself/himself and explain who she/he is and what role they have in the care of Mr. Jones.

Use therapeutic communication to explain that Mr. Jones's heart rhythm is regular, which is a good sign, but that you will have to do an EKG and additional tests to determine if he is having/has had another heart attack. Assure her that the team is doing everything they can for him. Attempt to calm the wife down and give her no more than two tasks. Tell her that the secretary will accompany her to registration/admitting and then she should come back to the waiting room. Tell her your name again, and explain that you will be here for the next 12 hours. Tell her you will be out very soon to update her on her husband's condition. Thank her for bringing in his meds and reassure her that she did the right thing by bringing him to the ED.

Note: Since the "wife" is a faculty/facilitator she/he can come out of role and give the student feedback and direction as needed during or after the interaction.

Computer technician: When you think that the students are starting to pick up on the diagnosis of congestive heart failure [can be cured by lead faculty], begin coughing (as Mr. Jones).

Facilitator: Once Mr. Jones starts coughing, hand the students the emesis basin with pink, frothy sputum.

Recipe: Pink, frothy sputum can be simulated by mixing a small amount of red powdered Jell-O, ivory dish detergent, and water, shaking it vigorously, pouring off liquid, and putting pink suds in emesis basin.

Students: The students should recognize this as a cardinal sign of pulmonary edema. If they feel that they have enough data, they need to anticipate the following orders:

- Diuretic
- Narcotic analgesic
- Nitroglycerine
- EKG
- Chest X-ray
- Blood gases
- CBC, Chem 7, cardiac enzymes
- Foley catheter (strict I/O)
- Continue 100 percent oxygen per non-rebreather mask

Students: When the students feel they are ready, the **communicator** places a call to the health care provider. A prop telephone is available for the student to use. The student is expected to do the following: (If student is having difficulty, they can use the script that follows. Faculty hands card with script to **communicator**.) Using principles of SBAR (situation, background, assessment, recommendation), student accomplishes the following:

- Introduce yourself and state where you are located.
- State who the patient is and describe him.
- State chief complaints and relevant signs and symptoms.
- Provide brief history with relevant information for current status.
- Give quantitative vital signs, always include FiO_2 with pulse ox.
- Identify interventions that have been done.
- State what you think is going on with the patient.
- Ask health care provider for further orders.

Figure 1. Communication With Health Care Provider

"Dr. _____, This is [*state your name*], one of the nurses in [*state your department*].

We have a new patient, [*patient's name*], a [*age*] year-old, [*race*], [*gender*]. He came in with complaints of_____

_____, which started at [*time of onset*].

His vital signs are [*HR*], [*RR*], [*BP*], [*T*], and [*pulse ox, amount of O_2 and type of delivery*].

He has a history of _____.

On assessment, we found_____.

So far, we have [*tell what interventions you have done so far*].

I think he may have _____.

I think he needs some_____.

What else you would like for us to do?"

Restate what needs to be done, including reading back the orders.

Confirm when the health care provider will arrive to assess the patient.

Facilitator: (One of the faculty facilitators acts as the health care provider responding to the student's call.) The health care provider gives the following orders and states she/he will be down to see the patient shortly. The student should write down the orders and read them back to the health care provider. After this is done, the orders are displayed on a prewritten foam board so that they can be seen by all the students simultaneously.

The orders are as follows:

- Lasix 40mg IV stat
- Morphine 4mg IV stat
- Nitroglycerine 0.4mg/spray 2 sprays SL stat
- Normal saline at 30 ml per hour
- Stat ABG
- Stat EKG and serial EKGs
- Stat CBC and Chem 7
- Stat cardiac enzymes
- Stat portable CXR
- Foley catheter to straight drainage
- Hourly intake and output
- Continue 100 percent NRB mask

Students:
The primary nurse delegates tasks to secondary nurse (med administration, Foley, etc.) and directs communicator to call lab, x-ray, and EKG.
The resource nurse needs to look up the proper rate of administration for Lasix and MSO_4. The primary and secondary nurses administer the Lasix and morphine IV push through the peripheral IV that they placed earlier.
The communicator places a call to lab, radiology, and EKG to request stat testing.

Facilitator: State "After about 15 minutes, you get the test results on Mr. Jones."

- EKG: Sinus tachycardia, indicative of old MIs **(Give students EKG.)**
- CXR: Enlarged heart, enlarged hila with indistinct margins (perivascular edema), and prominence of veins draining the upper lobes (cephalization of flow) **(Show students CXR.)**
- Lab results: respiratory acidosis **(Show students ABG.)**

Students should recognize and state need to call results to the health care provider as soon as possible.

Facilitator: "Where do you think Mr. Jones should be transferred?"
Students should state that Mr. Jones will likely go to an intensive care unit.

SCENARIO ENDS

Debriefing

This is one of the most important aspects of simulation. It is imperative that it is done well in order to help students have the best possible synthesis experience.

Take the students outside the simulation room. Begin debriefing (see Simulation Box 4) while other simulation staff reset the room and mannequin for the next case. Distribute handouts with key points and materials for the student to take with them and review.

Remind students they are not to share information with their fellow students because

- All students should have the same opportunity to learn.
- It is best for the student to move through the case as they did, experiencing the hot seat as they did.
- To discuss the case is similar to sharing answers from a test and would be considered an Honor Code violation.