Simulation in Radiology Education: Thinking Outside the Phantom

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Objective: The purpose of this article is to discuss the use of simulation in radiology education.

Conclusion: Simulation is an engaging way to educate radiology trainees. It allows trainees to improve their procedural and clinical skills in a calm, supportive environment that optimizes patient safety. Familiarity with the principles of simulation education may help radiologists evaluate their training curricula to identify skills that could be augmented with simulation training.

Key Words: Radiology education; simulation; interventional radiology; resident education.

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An eager resident excited to start her interventional radiology rotation approached me several years ago with a predicament. Ever diligent, she had been practicing ultrasound-guided biopsies on a chicken breast and venous access with a phantom limb, but was limited in her ability to practice percutaneous abscess drainage within the institution’s current resources. Inspired by her proactive efforts, I sought to create a simulator that would allow her to practice percutaneous abscess drainage. There were no existing tools to help my resident practice this important skill before starting her work with interventional radiology patients. Most training programs teach ultrasound-guided fluid aspirations and drain placements via faculty supervision of trainees performing the procedures on a patient, ie, the “in vivo” training. Although there is close supervision of the trainee, there is still room for error. There is also a challenge from the faculty’s perspective. When training with a real patient, the faculty is ultimately responsible for that patient and may feel it necessary to interrupt trainees’ attempts owing to inaccuracy or potential for patient harm. Because the patient is often conscious, the faculty may find it difficult to verbally coach the resident. Surely, it would be in everyone’s best interest if the trainee was able to practice a skill like percutaneous abscess drainage with simulation to meet an experience threshold before performing procedures on a live patient.

Simulation is the act of imitating a process by means of something equivalent. It is commonly applied in educational scenarios to allow the learner the opportunity to repetitively practice a skill in a safe environment. Unlimited guidance and supervision can be provided to the learner as the skill is being mastered. Educational simulation techniques were initially developed in the aviation and military fields. Edwin Link was a pioneer of simulation education in 1929 when he developed the first flight simulator. Link’s flight simulator grew in popularity and use before and during World War II as the United States Army employed the simulator to train pilots in the wake of multiple crashes. In fact, more than 500,000 US pilots were trained on the Link flight simulator (1).

Likewise, simulation techniques have vast potential for medical education to bridge the gap between the classroom and the patient. Students are able to simulate a hands-on experience with a “patient” in a nonthreatening manner that is not limited by time or patient anxiety. The acquisition of appropriate clinical skills is essential to health education (2). However, in a healthcare environment that increasingly emphasizes quality and patient satisfaction, it has become more difficult for trainees to acquire procedural skills directly on patients. Simulation options in medical education have arisen in part from patients becoming increasingly concerned that trainees were “practicing” on them (3). The advantages of simulation in medical education are many; clinical simulation integrates bedside teaching with traditional medical education while maintaining and fostering patient safety and procedural quality. It allows the trainee repetitive practice and personal feedback in a controlled, calm environment. Furthermore, simulation provides the capability to tailor specific simulation tasks to each learner, as well as allowing training programs to establish curriculum competencies and assessments. Medical schools, the Accreditation Council for Graduate Medical Education, and medical boards have all integrated simulations into training, assessments, and licensing exams (4).

Multiple types of simulators have been developed for use in medical education (5). For example, simulated physician-patient interactions can be accomplished with either standardized patients or mannequin simulators. Standardized patients are
actors trained to simulate various symptoms, give medical histories, and display emotions during an examination or interaction (6). This approach helps learners develop their interpersonal patient skills in a supportive setting. Radiology training programs may use standardized patients in an objective structured clinical examination format to develop and assess communication and interpersonal skills (7) for roles such as procedure consent, breaking bad news, and conveying results. The use of mannequin simulators may allow students to practice physical exam approach and technique. Educational documents with detailed simulated animations can be made to supplement trainees’ self-directed learning. Simulation procedures may be used in preparedness training for casualty assessment or emergency response scenarios. Finally, procedural or surgical simulation can be implemented with the use of either high- or low-fidelity simulators.

Fidelity is a term used in simulation education to describe the degree to which the simulation matches the actual experience, as well as the level to which the skills in the real task are captured in the simulated task. Fidelity should be appropriate to the intended task and training stage. Along this spectrum of reality, simulators are classified into low-, medium-, and high-fidelity simulators (2,8,9). Low-fidelity simulators are often static and lack realism or situational context (2). In radiology education, there are multiple examples of low-fidelity simulators used, which may include meat products or other nonmobile phantoms to practice image-guided biopsy procedures or a mannequin arm used for intravenous insertion training. These low-fidelity simulators offer an effective, relatively inexpensive means for trainees to practice image-guided procedures. As fidelity increases, so too does the cost of the simulation product. A moderate-fidelity simulator may have a more realistic feature such as pulse or breathing sounds. Most realistic, a high-fidelity simulator is often based on a computerized mannequin capable of mimicking physical and physiological actions and responses. There are multiple levels of simulator fidelity to consider. Equipment fidelity is the degree to which the simulator visibly looks like the real setting. Environmental and psychological fidelity refer to the degree to which the simulator acts like the real setting and makes the learners feel like they are in the real setting, respectively (10). Authors have found variable educational outcomes between low- and high-fidelity simulators. Several authors have reported no difference in performance or educational outcome between students trained on low- and students trained on high-fidelity simulators (11–13). Either a high- or a low-fidelity simulation system may be better suited to mastery of a particular skill. Most radiology procedure training can be accomplished with low-fidelity simulators, easing the financial burden.

Back to the dilemma with my eager resident; although there are several commercial phantoms to practice biopsies, peripherally inserted central catheter (PICC) placement, vascular access, lumbar punctures, and other small-caliber percutaneous procedures, there is no suitable simulator for ultrasound-guided percutaneous abscess drainages with a larger caliber catheter. An emerging consensus in health care is that it is not acceptable to use patients for first-time practice at needle placement. A percutaneous abscess drainage simulator needs to be developed for our trainees! Necessity is the mother of invention after all, so we created a low-fidelity phantom using a small whole chicken stuffed with a gel “abscess” and were able to simulate the ultrasound-guided abscess drainage procedure.

Evidence supports the use of simulation training in medical education (3). Trainees who have practiced a procedure on a simulation system became more proficient in performing that procedure on a patient sooner than trainees who have not trained with simulation (14). In addition, a study of a cholecystectomy virtual reality simulation training system found that simulation-trained residents had significantly improved surgical performance metrics than those not trained with simulation (15). These trends may be similarly applicable to improving proficiency and accuracy of trainees learning image-guided procedures. Simulation experiences may be best applied to radiology education in terms of procedural training, and training for contrast reactions and emergency procedures. In fact, computer simulation models are available to train radiologists in management of contrast reactions (16–18), crisis management in radiology (19), on call simulation for new residents (20), and interventional radiology (21). Finally, mock consents are also very valuable in resident training and allow the learner to practice in a less stressful environment.

Simulation training is a novel, engaging way to deliver medical education. It is an effective means to improve trainees’ acumen in procedural and clinical scenarios in a safe, supportive environment that optimizes quality and patient safety. Familiarity with the principles of simulation education may assist readers to examine their radiology residency curriculum and identify areas where traditional radiology education can be supplemented with simulation training.

REFERENCES


