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ANNALS OF MEDICINE

A MODEL PATIENT

by JEROME GROOPMAN

How simulators are changing the way doctors are trained.

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Four students in their third year at Harvard Medical School recently met a patient named Mr. Martin. The students' mentors, two physicians, told them that Martin had come to the emergency room complaining of abdominal pain that had grown steadily worse over several days.

Martin was lying on a stretcher, moaning. A monitor next to the stretcher indicated that his blood pressure was dangerousl low—eighty over fifty-four—and his heart was racing at a hundred and eighteen beats per minute. An X-ray mounted on a light box on the wall showed loops of distended bowel, called an ileus. The intestine can swell like this when it is obstructe or inflamed.

"It hurts!" Martin cried as the students reviewed his chart. "They told me you'd give me something for the pain."

"Should we give him something?" one student asked.

"I guess so," another replied.

The first student emptied a syringe of morphine into an intravenous line attached to Martin's arm. Within a few seconds, Martin stopped moaning. Then the monitor started to beep rapidly. Martin had stopped breathing. The syringe had contain twenty milligrams of morphine, a potentially lethal dose for someone in his condition.

The students began to perform CPR. One passed an endotracheal tube through Martin's vocal cords into his airway. Anoth began to pump oxygen into the tube.

Dr. Nancy Oriol, the dean of students at Harvard Medical School, showed me a videotape of the students' encounter with Martin. "The students didn't figure it out," she said. The cause of Martin's abdominal pain was acute inflammation of the pancreas. Not only had the students failed to diagnose his illness; they had not taken into account his vital signs. Martin's blood pressure indicated that he was at risk of going into shock and urgently needed fluids. But the students had focussed his pain, and, distracted by his cries, had given him too much morphine and then neglected to administer naloxone, a morphine antidote, while attempting to resuscitate him. "When the patient is in that much pain, the students' minds go blank," Oriol explained.

Fortunately, Martin is not a real patient but a mannequin, an electronic instructional device known in medicine as a simulator. In many ways, he looks and behaves like a living person: his blue eyes blink, his pupils dilate, his skin is pliant, and his chest expands and contracts as he breathes. If you place a stethoscope over the spot where his heart should be, you can hear authentic beating sounds. His lips, tongue, and windpipe can swell—as a person's would in the event of a severe allergic reaction—and his teeth can be knocked out.

Martin is connected by a cable to a computer terminal, and comes with software that enables him to mimic the symptoms dozens of medical conditions, including septic shock and flash pulmonary edema. (His physiological settings can also be adjusted to correspond to actual cases.) When the students opened Martin's mouth to insert the endotracheal tube, they fou realistic reproductions of a pharynx and an epiglottis. When they passed the tube through his vocal cords, it entered what looked like a real trachea. If they had pushed the tube too far, it could have slid into the right lung—a potentially grave err frequently made by novices. The X-ray in the scenario belonged to a man with acute pancreatitis, and Martin's voice, broadcast over a speaker lodged in his head, was that of a Harvard faculty member, speaking into a wireless microphone i the next room and imitating a patient in severe pain. A consortium of anesthesia departments at Harvard purchased Martin 1993, for a hundred and sixty-five thousand dollars. A 2005 model, which can be put to sleep with real anesthetic, costs about two hundred thousand dollars. The session that I observed was hardly unusual. "Every group overdosed the patient, Oriol said.

At most schools, medicine is still taught largely as it has been for centuries, with students and young doctors serving as apprentices to veteran physicians. Training begins with textbook descriptions of cases and is followed, in the second or thi year of medical school, by instruction at the patient's bedside, an approach known as "See One, Do One, Teach One": the student or intern observes the diagnosis and treatment of a particular disorder and is encouraged to take charge the next tin a similar case occurs. The amount of autonomy granted to novices varies. Many senior physicians believe that the sooner an intern takes responsibility for a patient—what some doctors call being in “the hot seat”—the better. During my internship, in the nineteen-seventies, I was often on call alone and rarely asked for assistance; consulting a superior was widely perceived as evidence of incompetence or lack of preparation.

However, the apprenticeship model is becoming increasingly difficult to sustain. As insurers reduce reimbursements to hospitals, senior doctors are under pressure to focus on revenue-generating work—treating sick people and conducting procedures—rather than on teaching. Moreover, in order to cut costs, operations and therapies that once took place over several days are now performed in a few hours, or in outpatient settings. As a result, students are spending less time with individual patients and have fewer opportunities to observe a case from diagnosis to resolution. Some life-threatening conditions, such as anaphylactic shock or a ruptured aortic aneurysm, occur infrequently enough that a trainee may become a licensed physician without encountering such disorders or mastering the skills to treat them. Health care may be unique among high-risk fields in that learning takes place largely on human beings.

Dr. David Gaba, an anesthesiologist who directs a simulation center at the Veterans Affairs Palo Alto Health Care System, and who teaches at the Stanford University School of Medicine, created one of the first patient simulators nearly twenty years ago, in an effort to change the way physicians are taught. Gaba estimates that fewer than half of the medical schools in the United States routinely use the devices today. (METI, a Florida company that is one of this country’s principal manufacturers of high-tech medical simulators, says that it has sold more than sixty to schools in the past eight years.) “You wouldn’t get on an airplane unless the pilot had been trained in a flight simulator and certified to use the new instruments on a jet,” Gaba told me. “Why would you place yourself in the hands of a doctor who hadn’t proven his competency and been certified on a simulator?”

For the past several years, Harvard Medical School has offered simulation training to medical students. Dr. James Gordon, who directs a simulation program at the school, estimates that about half of the third-year students currently participate in some form of simulation training as part of their instruction in surgery and internal medicine. He invited me to try an exercise with Stan—a 1994 simulator whose name is short for “Standard Patient.” I hesitated. It had been nearly three decades since I had been an intern in the emergency room; I was afraid I might embarrass myself.

“Let’s play,” Gordon said. He retreated behind a curtain. I looked down at Stan. His blue eyes were blinking. I ran my fingers over his chest, which felt soft, like human skin. I took my stethoscope out of my pocket and draped it around my neck, an affectation common among interns.

“Doctor, I don’t feel well,” Stan said. His voice was raspy, and his speech sounded pressured.

“What’s the matter?” I asked.

“I’m having trouble breathing, Doctor.” Stan began to cough.

I asked whether he had had trouble breathing before. He replied that a doctor had told him that he had asthma. I asked what medications he took, and he said that he didn’t know.

I could feel my heart begin to race. My palms grew moist. “Do you use an inhaler?”

“Yes, sometimes, Doctor,” Stan said. “I’m having more trouble breathing.”

I asked whether he had any allergies. He said no. The beep of the monitor displaying his vital signs seemed to grow louder and more rapid. Stan’s pulse had increased to a hundred and ten beats per minute, and his oxygen level was dropping.

“I’m going to examine you, Stan,” I said. I placed my stethoscope on his chest and heard harsh wheezes typical of asthma.

“It’s getting harder to breathe,” Stan said.

“Administer an albuterol inhaler, please,” I said. Dr. Gordon, sitting at a computer behind the curtain, manipulated Stan’s vital signs to indicate that he had received the drug. But the medicine seemed to have little effect. Stan’s pulse continued to accelerate, and his oxygen level to fall.

“Doctor . . . Doctor . . . I can hardly breathe,” he gasped.

For a moment, I almost panicked. I placed my stethoscope on Stan’s chest again and listened intently. The breath sounds were much fainter over the right lung.

“Do you want a chest X-ray, Doctor?” a voice said from behind the curtain. It had the coaxing tone of an E.R. nurse speaking to an intern.

“Yes,” I said.

On a large plasma screen not far from the stretcher, a chest X-ray appeared. Around the right lung, I could see a thick band of black.

“Pneumothorax,” I said aloud. Stan had ruptured his lung. This can happen to people with asthma and other chronic lung diseases: a weakened segment of tissue gives way, and air moves into the space between the lung and the chest wall. The air appears black in an X-ray. A pneumothorax can press against the heart and blood vessels and cause the lung to collapse entirely. Unless a tube is inserted into the chest to evacuate the air, the patient is likely to die.

Gordon was smiling when he stepped from behind the curtain. But I was sweating. When I was an intern, an elderly lady with rheumatoid arthritis had been brought to the emergency room from a nursing home because she was having trouble breathing. She was terribly deformed by her disease, and her lung tissue had begun to deteriorate. I examined her and detected faint breath sounds on the right side of her chest. An X-ray showed a pneumothorax, so I made an incision in her chest and inserted a tube to release the trapped air and reëxpand her lung. I thought that I had made a brilliant diagnosis, and was proud of my performance in front of the nurses. I left the woman and attended to other patients. Several minutes later, I was summoned to her bedside. She was no longer breathing and had gone into shock. I was unable to resuscitate her. When I looked again at her chest X-ray, I saw that there had been a second pneumothorax, over her left lung. I had missed it, and my error had caused her death.

The attending physician in the emergency room tried to comfort me, pointing out that the woman had had no family, that she had been severely debilitated by her lung disease, and that she might not have recovered even if I had inserted a second chest tube. But for days afterward I felt sick.

As a medical student, I had read about pneumothorax, but I had never encountered an actual case. After the incident, the diagnosis immediately occurred to me whenever someone entered the emergency room with shortness of breath. I could not look at a chest X-ray without lingering over the area between each lung and the chest wall. Gordon was unaware of my experience when he chose to simulate a pneumothorax. It was the reason I had been able to detect Stan’s problem so quickly. I had learned well, but at an incalculable cost.

Shortly after my session with Stan, I spoke to David Gaba, at Stanford, and told him what had happened. Practicing medicine on a mannequin is “more profound for seasoned doctors than for novices, because they fill in the gaps of their experiences in the real world,” he said. “For the novices, they are still filling in their imagination.”

Gaba, who is fifty years old, has a degree in engineering. In the mid-eighties, near the beginning of his career as an anesthesiologist at Stanford, he read “Normal Accidents,” by Charles Perrow, which contains an analysis of the catastrophe at the Three Mile Island nuclear power plant. He was struck by the similarities between the power plant and the operating room; in both places, accidents often occurred because staff members failed to communicate with one another when equipment malfunctioned and lives were in danger. He wondered how anesthesiologists could be taught to be more effective during a medical crisis. The academic studies of decision-making in medicine were not particularly helpful; most were based on doctors’ responses to theoretical scenarios, rather than on observations of their actual behavior during emergencies. “Classic literature in medical decision-making would have you believe that everyone generates a hypothesis and then follows a pathway with decision points,” Gaba said. “But no one really works that way.” He considered asking teams of anesthesiologists and surgeons to let him watch them perform procedures on dogs, but abandoned the idea when it proved both expensive and ethically problematic.

In 1986, he decided to build a dummy patient. With the help of Abe DeAnda, Jr., a student who was also a trained engineer, Gaba fashioned a crude simulator from a plastic head-and-neck mannequin used to teach intubation. He extended the mannequin’s trachea with a tube and made a lung out of a breathing bag. Then he ran a cable from a computer to a clinical waveform generator, a device that translates heart rhythm and blood pressure into electrical impulses, and which biomedical engineers use to test the accuracy of hospital equipment. On the computer’s monitor, undulating lines appeared, representing cardiac and blood-pressure data.

Though the mannequin was useful for practicing how to treat various cardiac arrhythmias and respiratory conditions, it was essentially inert, requiring users to imagine physiological events corresponding to changes in the vital signs displayed on the monitor. Over the next several years, Gaba and his student developed a software program to go with their dummy, painstakingly translating mathematical models of physiological processes—pressure levels in major arteries and shifts in blood volume—into computer code. In 1992, Gaba licensed the software to CAE-Link, a company that made aviation simulators for military pilots. Two years later, CAE-Link began selling an electronic medical mannequin—an early version of Stan.

Gaba believed that patient simulators could help doctors make faster diagnoses and master simple procedures, but he knew that they were unlikely to help improve communication in the O.R. He had watched a "Nova" program called "Why Planes Crash," which described a method known as "crew resource management," or C.R.M., which is used by commercial airlines and the military in pilot training. C.R.M. was developed by NASA in the late nineteen-seventies, on the theory that failure to avoid a crash could often be traced to poor communication in the cockpit. Gaba decided to adapt the method for anesthesiologists working in the O.R., where they must monitor a stream of data about a patient's vital organs and relay critical information to the surgeon and the nursing team. In 1989, working in part from a manual designed for the cockpit, Gaba designed a daylong course that he called ACRM, for Anesthesia Crisis Resource Management, and began training residents.

Gaba and I watched a videotape of an ACRM simulation conducted at the V.A. hospital affiliated with Stanford. The exercise took place in a room resembling an O.R., and involved a second-year anesthesiology resident, in the hot seat, and, performing parts that Gaba had scripted for them, two nurses and an experienced anesthesiologist. A Stan-like mannequin served as the patient, a young woman undergoing laparoscopic surgery—a minimally invasive technique in which slender instruments are inserted through small incisions in the abdomen—for a diseased appendix. A few minutes into the operation, after carbon dioxide had been pumped into the woman's abdomen to make room for the surgical instruments, her heart rhythm became abnormal and her blood turned acidic. As the anesthesiology resident tried to figure out why the patient was deteriorating, the surgeon, played by the senior anesthesiologist, spoke to him in a peremptory tone.

The resident said, "I'm having a little trouble with the ventilator—"

"I don't know what your problem is," the surgeon interrupted, "but I need a better view."

"I need to blow off more CO2," the resident retorted. "I'm getting a lot of PVCs right now." The monitor showed premature ventricular contractions, abnormal heartbeats that often precede cardiac arrest.

"Don't worry," the surgeon said.

The resident glanced nervously at the monitor. "If you want to proceed with the operation, then you have to open," he said to the surgeon. Cutting open the patient's abdomen would presumably release the carbon dioxide, help restore her blood's acid balance, and allow her heart to beat normally.

"No," the surgeon said.

"Please call my anesthesia colleague in right now and turn on the lights right now," the resident said in a tense voice. "Convert to an open procedure if you want to proceed with this case. I'm hand-ventilating right now—it's the only way I can get the CO2 off."

"Then what's the matter with your ventilator?" the surgeon asked.

The resident seemed confused for a moment. Then he glared at the surgeon. "Right now the patient is very unstable," he said. "I suggest you pack the wound."

"What do you mean? What's going on?" the surgeon replied. "I don't understand what your problem is."

Flustered by the surgeon's hostile behavior, the resident only belatedly arrived at a diagnosis: malignant hyperthermia, a severe and relatively rare reaction to certain anesthetic drugs that, if not treated immediately, can cause death.

Gaba has evaluated scores of anesthesiologists and O.R. teams in ACRM scenarios. About a third of the anesthesiologists and about a quarter of the O.R. teams failed to ask for help, did not accept help when it was offered, or did not work together effectively in a crisis. Frequently, there were communication problems of the sort I observed on the videotape—moments when, as Gaba put it, participants were "speaking into thin air, not clearly addressing a co-worker, or being imprecise about what they wanted done."

Gaba recently persuaded Stanford to make simulation training—both scripted scenarios and mannequin practice—a requirement for medical students, something that many schools, citing financial considerations, have resisted. "In aviation, simulation is a cost of doing business," Gaba said. "In medicine, you get your training while you are producing revenue, or on your own time."

In 2000, Dr. Richard Satava, who was then a surgeon at Yale Medical School, conducted a study with several colleagues to determine whether doctors who had practiced on surgical simulators performed better in the O.R. than doctors who had learned their skills under the apprenticeship system. Satava had been an Army combat surgeon for twenty-three years, and had worked at DARPA, the Defense Department's research-and-development arm. In 1987, with the help of Jaron Lanier, a pioneer of virtual-reality technology, he built one of the first surgical simulators: a computer terminal with video-game-style graphics, on which doctors could practice a number of laparoscopic procedures.

At Yale, Satava and his colleagues enlisted sixteen surgical residents to test the efficacy of a similar simulator, which he had persuaded the school to purchase. First, the researchers assessed the residents' psychomotor skills, including hand-eye coördination and ability to transpose mirror images. Then they randomly assigned the residents to either simulation training or conventional training in laparoscopic gallbladder removal. The residents who worked with the simulator practiced until they met the standard of competency set by specialists who routinely execute the procedure. All sixteen residents then performed the surgery on actual patients under the supervision of attending surgeons who did not know which kind of training the residents had received. The operations were videotaped, and reviewed independently by two senior investigators who also did not know how the residents had learned the procedure.

The residents had displayed similar psychomotor skills, but the two groups performed very differently in the O.R. Those who had trained on the simulator completed the operation, on average, twenty-nine per cent faster than those who had not. Moreover, the residents who had received standard surgical training were nine times more likely to hesitate during the operation, five times more likely to injure the gallbladder or burn surrounding tissues, and six times more likely to make other errors. Additional research has shown that simulator training significantly enhances performance of hernia repairs, nasal sinus procedures, and bronchoscopic examinations of the lungs.

Satava is now at the University of Washington, in Seattle, where he directs the Institute for Surgical Intervention and Simulation. Eventually, he says, simulators will be able to provide comprehensive medical training of the sort that a single doctor can't provide. "Every resident will do fifty Whipples"—a surgery for pancreatic cancer—"fifty lung resections, two hundred gallbladders, and two hundred colons, all virtually."

Before this can happen, however, medical mannequins need to become even more sophisticated than Stan. In 1998, a group of physicians at Massachusetts General Hospital, working with engineers from Mitsubishi, the Japanese electronics company, created a new type of simulator called VIST, for Vascular Intervention System Training. A rectangular box five feet long and made of molded plastic, VIST behaves as if it were composed of blood and tissue. Its software creates an illusion of internal anatomy so precise that a catheter threaded through a portal in the box and into a coronary artery will encounter torque and resistance just where it would in a human being and enables doctors to practice repairs of arteries in the heart, brain, kidneys, and abdomen. A computer tracks the physicians' movements and displays X-ray images of relevant vessels and surrounding body parts.

Dr. Steven Dawson, the director of simulation at CIMIT, a consortium that includes two Harvard hospitals and the Massachusetts Institute of Technology, is one of the physicians who developed VIST. When I visited his laboratory in Cambridge, in February, he had just returned from the White House, where he had given a presentation on medical simulation to an audience that included members of the Department of Defense, the Centers for Disease Control, and the C.I.A. Dawson says that he is often asked whether it is possible to "practice an operation on a simulator before performing it on my mother." Last May, at a medical conference in a hospital in Paris, French doctors showed how this can be done. Before the conference, a CAT scan was performed on an elderly woman who was to undergo coronary catheterization. The information on the scan was digitized and loaded into VIST's computer, where it appeared as a detailed image of the woman's cardiac anatomy. Two cardiologists, who were scheduled to perform the catheterization, were invited to practice the procedure on VIST. The doctors had trouble manipulating the catheter through some coronary vessels, and they complained that the simulator was not sufficiently realistic. After completing the practice session, the cardiologists went next door to the operating room and performed the catheterization on the patient while colleagues watched. "When they did Grandma, they had problems specifically where the physics-based simulator had presented them during the practice," Dawson said. "It just blew the audience away."

VIST provides an authentic simulation of the human vascular system. Dawson's group is now attempting to create a complete synthetic human, which will incorporate the respiratory and musculoskeletal systems as well. Dawson showed me the design labs next to his office, where the project is under way. On a wall in the main room was a marker board covered with complex mathematical equations. In an adjoining room, several partial skeletons lay on the floor, next to a pile of reproductions of human bones. On a table was a prototype for a shoulder: two metal rods connected to a circular metal cap. Dawson rotated the contraption through a series of arcs, imitating a pitcher in a windup. Elsewhere in the lab, synthetic skin was being made from a mixture of polyurethane and silicone.

Dawson invited me to try suturing a wound on CELTS, a Computer-Enhanced Laparoscopic Training System, which CIMIT completed in 2002. CELTS resembled a large metal lunchbox with a domed lid, in which there were two round holes for inserting surgical instruments. Projected on a video monitor nearby was an image of the box's contents: a mound of synthetic tissue and, planted in the top layer, at the edge of a large gash, a curved needle and suture thread.

In each hand, I gripped a laparoscopic instrument—a metal rod ending in a set of serrated jaws. Sewing tissue is a simple procedure, but I had never tried to do it laparoscopically. I slipped the instruments into the box, and the serrated jaws appeared on the monitor, where I could follow their movements, just as a laparoscopist does in the O.R. The needle was deep in the dermis, and it took me several seconds to capture it with the jaws. Then I had to learn how to hold the instrument at an angle that would allow me to move the needle cleanly through the tissue. This required a great deal of force; at first, I lost the needle in the thick skin. Finally, after much struggle, I saw the tip emerge from the wound.

All the while, the simulator was recording my movements and analyzing each error: the needle's arc of entry was insufficiently acute; the smoothness of its movement through the synthetic tissue was poor; and, of course, I had briefly lost the needle in the skin. I knew that when I finished the procedure a graph would appear on the monitor, comparing my performance with that of an expert. I decided to stop before CELTS gave me a failing grade.

The machine has yet to be adopted by a hospital or a medical school. Dawson told me that many surgeons are wary of the device, arguing that its value remains unproved. (CIMIT has also developed VIRGIL, a mannequin that spurts fake blood and is now being used by military physicians to simulate battlefield injuries.) "Have there been randomized prospective controlled trials to see if a parachute works?" Dawson asked. "Some things just make sense. But medicine is very conservative and very traditional."

Last August, the F.D.A. approved the use of a stent in the repair of carotid arteries. In its ruling, the agency stipulated that doctors wishing to perform the procedure must follow training guidelines set by the stent's manufacturers. These call for physicians to practice on a simulator until they obtain a level of proficiency comparable to that of an expert. The ruling was the first by the agency to endorse simulation training.

The stent procedure is extremely difficult to perform. The two carotid arteries, which are situated on either side of the neck, supply blood to the brain, and when one vessel becomes obstructed because of atherosclerosis the risk of stroke is extremely high. Treatment has typically involved an operation in which an incision is made directly in the diseased artery, and forceps are used to remove plaque deposits. Complications from the surgery include stroke and heart attack. Recent studies have shown that catheter-based approaches, in which a stent is inserted into the artery, are equally effective and have half the rate of complications.

In January, I watched Dr. Lawrence Garcia, an interventional cardiologist at Beth Israel Deaconess Medical Center, in Boston, perform the stent procedure on a seventy-eight-year-old man with diabetes and atherosclerosis. Although the patient had not experienced any neurological symptoms, his carotid arteries were obstructed, the one on his left side at ninety-nine per cent.

It took Garcia a little more than half an hour to repair the left artery. He threaded a metal stent through a catheter placed in the femoral artery in the patient's groin, up through the iliac artery and the aorta, and implanted it in the obstructed vessel. When he finished the operation, the blockage had been reduced by nearly ninety per cent, and circulation to the left side of the man's brain had been restored. He was discharged within twenty-four hours.

Garcia, who estimates that he has performed the procedure more than three hundred times, says that several kinds of physicians are competing to do it. In one group are doctors, typically cardiologists, who have been trained to use catheters to treat vascular disease, including carotid-artery obstructions. (Garcia belongs in this category.) In the second group are cardiologists who want to extend their range of expertise beyond the heart but lack sufficient training. Finally, there are surgeons who have little or no catheter experience but who realize that their professional survival may depend on their ability to place a stent rather than cut into a vessel. "As things have shifted toward more catheterbased procedures, their income is going to be threatened," Garcia said. Nevertheless, he added, "it is not a simple transition from surgery to catheter." He worries that simulation training can do only so much to help prepare physicians for the idiosyncrasies of human vascular anatomy, and believes that inexperienced doctors should, in addition, perform the procedure under the supervision of experts—a form of apprenticeship.

According to Dr. Daniel Jones, the chief of minimally invasive surgery at Beth Israel Deaconess, his hospital is the only one in the country to require surgical residents to demonstrate proficiency in simulated procedures in order to advance to the next year. The policy was instituted last year, after a campaign by Jones, who recently established a skills lab at the hospital which includes ten laparoscopic video trainers, a urological simulator, a gastrointestinal simulator, and two mannequins like Stan—one for use in anesthesia procedures, the other for trauma cases. When I visited Jones at his lab, he told me that he would like to extend simulation testing to medical students applying to the program. Though surgical skills can improve with practice, he said, medical schools shouldn't encourage students with poor hand-eye coördination or other severe limits in psychomotor ability. "If you can identify people who don't have it on the day of the interview, you will be doing them a big service—and a big service for others," he said. I thought of my experience with CELTS and agreed that some doctors may be better with their heads than with their hands.

Jones recently won approval from the chairman of his department to begin using simulators to assess the performance of senior faculty. Before the surgeons are evaluated, they are invited into the skills lab to practice. The goal is for everybody to pass, Jones said. But those who are unable to meet the department’s standards will be asked to leave.

While we were talking, one of the hospital’s senior surgeons appeared. He was scheduled to perform a difficult operation to remove an adrenal-gland tumor and wanted to practice his laparoscopic skills. The surgeon was clearly nervous about testing himself on the simulator in my presence, and asked that I not discuss his performance with his colleagues. About an hour later, however, he had successfully completed the tasks on the simulator, well within the recommended time period, and said that I was free to mention his performance to others.

“Every gray-haired doctor imagines being put in the hot seat,” Nancy Oriol told me. She mentioned a prominent physician at Harvard, who, after observing a simulation of a medical crisis, told her, “If that were me, I’d be in the corner screaming.” So far, Oriol has been unable to persuade the school to make simulation training a major requirement for students or faculty. “It is scary,” she said. “And it’s expensive. You need quality technicians. It’s new, and there aren’t that many people who know how to teach simulation. But what better way to learn medicine?”

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