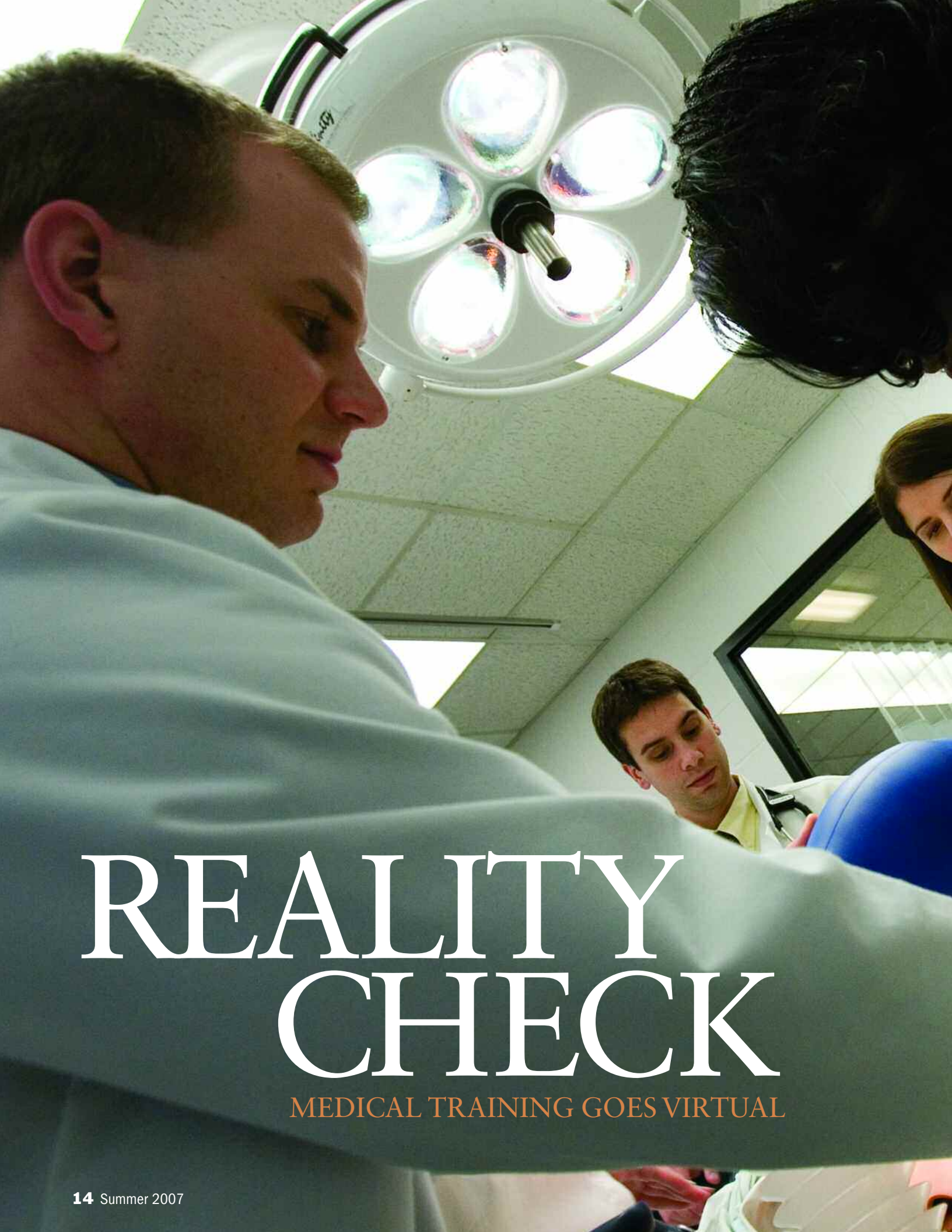
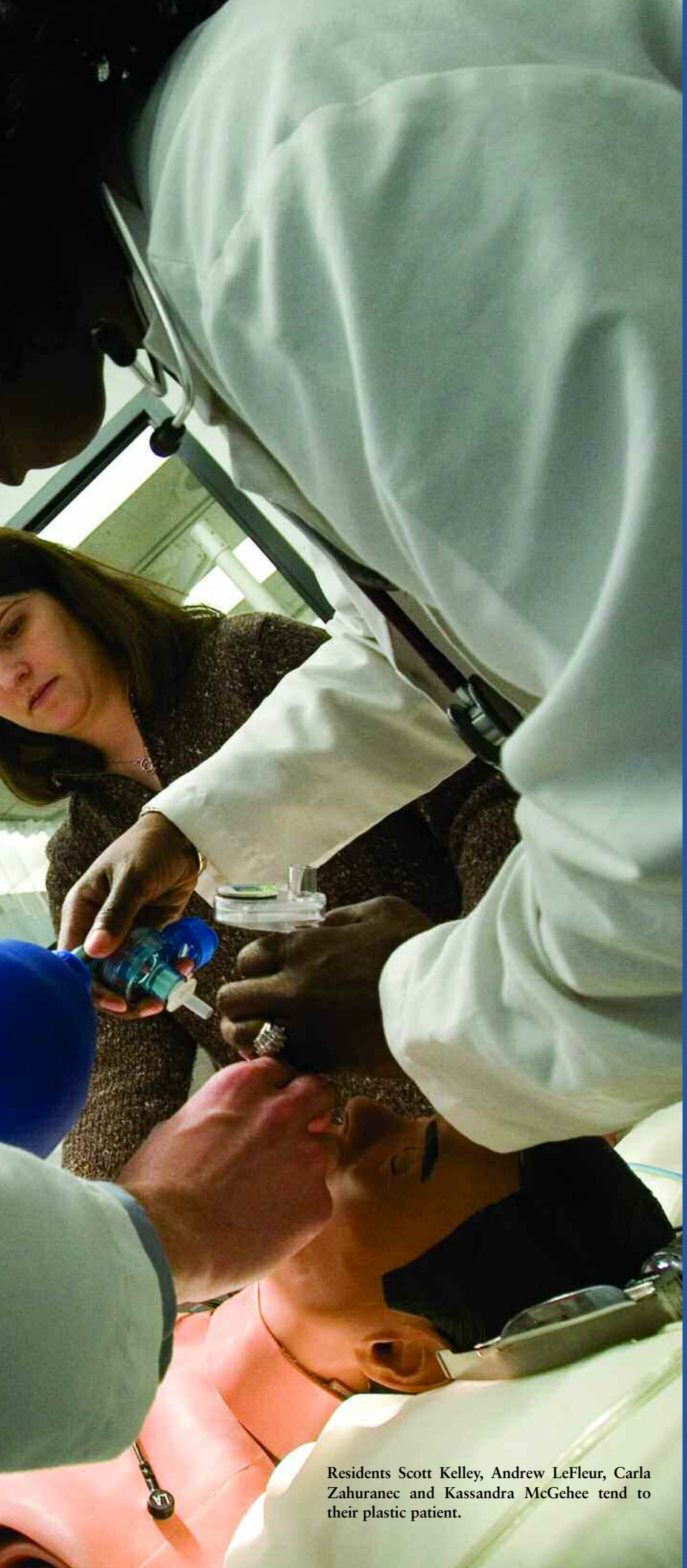


REALITY CHECK

MEDICAL TRAINING GOES VIRTUAL



Residents Scott Kelley, Andrew LeFleur, Carla Zahuranec and Kassandra McGehee tend to their plastic patient.

BY JAMES TOBIN
PHOTOS BY MARTIN VLOET

The plastic patient lying on his back in the Clinical Simulation Center at University Hospital may not be among the living, but he behaves as if he is. His eyelids blink. His chest rises and falls. And the four doctors hurrying to his side certainly are acting as if his life is at stake.

Overhead, a loudspeaker blurts: "Who do I give a report to? Dr. McGehee? I'm the EMS. I have this 50-year-old, inebriated, combative guy who, two hours ago, was a restrained driver in a head-on, car-versus-tree, motor-vehicle accident. He sustained a chest contusion, a three-centimeter left scalp laceration and compound fracture of the left femur. The airbag did deploy. There were no abdominal injuries. He has good pulses on the right but no palpable pulses in the left leg."

The patient needs exploratory surgery on his leg, the EMS technician on the loudspeaker says, but first the surgeons want him intubated — that is, a tube must be inserted in his throat to prepare him for the ventilator that will breathe for him during surgery. That's what these four residents in the Department of Family Medicine, led by Kassandra McGehee, M.D., a second-year, must do, and fast.

"All right," McGehee says. "Is he responsive?"

She leans over the mannequin.

"Sir? Sir?"

A new voice, loud and rough, comes through the loudspeaker: "Yea-ahh?"

"Hello, sir, we're going to take care of you, okay?"

"Ahh, great!" the voice bellows. "Hey, can you give me somethin' for my leg? My leg is killin' me. This is, like, the worst day ever …"

"Yes, we'll give you something for your leg," McGehee says. Then, to her colleagues: "Let's get him stable first." ➤

"In three short years, it's become almost indefensible for a hospital not to do this sort of training, because the face validity of it is so strong." —Paul Gauger, M.D.

Simulation has been part of the training of physicians since the first time a cadaver was opened for inspection. But in recent years, it has taken a quantum leap. In 2004, when the U-M opened its Clinical Simulation Center, only a few such facilities existed in all the U.S. Now, there are some 500. Taking their cue from aviation, and incorporating extraordinary new technology, medical educators are making simulation a central part of the learning experience. At the U-M, every resident logs time in the Sim Center, as the lab is called, and many practicing physicians are using it, too, to keep their skills sharp.

"Airline pilots have been doing this for decades," says James Cooke, M.D. (Residency 2000), an assistant professor of family medicine, whose voice sounds suspiciously like both the efficient EMS technician and the intoxicated patient just heard in the Sim Center. "They understand that you have to learn by doing and practicing. It's part of how we learn as human beings. We have to actually do these tasks to learn them."

And if you can learn on a patient who can't die, all the better.

The pioneers in this new era in medical simulation were anesthesiologists at the Stanford School of Medicine. In the late 1980s, seeing a need for better training in situations fraught with complexity and unpredictability, they developed a curriculum that drew heavily on training techniques designed for flight crews by NASA and the U.S. military. The Stanford educators used the earliest interactive patient simulators — that is, highly lifelike mannequins plus the software that runs them. Together, they replicate many features and functions of the human body, including its reactions to medications. Teaching units required students to work in teams on operating-room scenarios lasting up to an hour, with debriefing and discussion afterward. Soon, in laparoscopy and endoscopy, computerized simulations showed the enormous potential of virtual reality in medical training. By the early 2000s, technology was catching up with the pedagogical possibilities of simulation all across the medical disciplines.

"Medicine was 50 years behind in adopting it, but now it's taken off like wildfire," says Paul Gauger, M.D. (Residency 1998), an associate professor of surgery. "In three short years, it's become almost indefensible for a hospital not to do this sort of training, because the face validity of it is so strong."

Michigan was among the first to organize a simulation center shared by multiple departments. Gauger, along with James Woolliscroft, M.D. (Residency 1980), who is the Lyle C. Roll Professor of Medicine and now dean of the Medical School, and Larry D. Gruppen, Ph.D., chair of the Department of Medical Education, set up the Clinical Simulation Center in January 2004 as a cooperative involving 15 of the 17 departments in the Medical School. (Only pathology and dermatology, which can do their work only with actual human tissue, do not participate.) To direct the center, they hired Pamela Andreatta, Ed.D., a Californian with long experience in designing virtual reality training systems. She quickly equipped the center with state-of-the-art interactive mannequins (two adults and a child) and several virtual-reality simulators. She also began working with faculty to develop a broad array of teaching units.

One of the most active is Cooke, who led the simulation ramp-up in the Department of Family Medicine. Cooke studied how simulation was used in other medical schools and surveyed residents, who asked for more training in situations such as respiratory emergencies, advanced cardiac life support, and rapid intubation for patients in respiratory distress.

In a typical scenario in the Sim Center, Cooke sits in an elevated control booth, manning a microphone and a computer. He watches the residents through a one-way window. They can hear his voice playing various roles — EMS tech, nurse, clerk, patient — and he clicks his mouse in response to their orders, dispensing digital doses of medicine to the mannequin. He can let a scenario spin out without interfering. Or he can throw curveballs, clicking his mouse to create the kind of unexpected mayhem that inevitably complicates events in a real-life clinic — a respiratory failure here, a heart attack there.

Cooke and the residents can run through several scenarios in an afternoon. One week it might be sepsis, the next week shock, or heart arrhythmia, or colonoscopy.

Today, it's the tricky task of rapid intubation. This is an ideal skill for the Sim Center, because, as Andreatta says, it's "low-frequency but high-acuity." That means the average family physician won't often be called upon to intubate a patient, but when the need arises, she has to get it right. Repeated practice on a mannequin develops a skill that might be long in coming in the real world, simply for lack of practice.

"When the time hits when you need to intubate for the first time, anxiety is pretty much through the roof," Cooke says. "It's an incredibly nerve-racking way to learn something, and often it's not necessarily the safest for the patient."

Kassandra McGehee, Scott Kelley and Laura Distel prepare to intubate.

In the Sim Center, the residents are quickly running through their procedures. "Can we get him on the monitor?" McGehee asks. Laura Distel, M.D., a first-year, flips a switch. The monitor overhead blinks on, showing the patient's heart rate and oxygen level. The residents give lidocaine to stabilize the heart rhythm for surgery. The loudspeaker breaks in: "The surgeon was calling to see if they can get him back to the O.R."

McGehee says: "Well, he's stable, so let's get him intubated. Let's see. He's got his lidocaine. Let's give him Versed." This will put the patient to sleep for the uncomfortable process of having a tube stuck down his windpipe.

"Hey, doc!" the patient interrupts. "Is that gonna make my leg feel better? It's killin' me!"

"No," McGehee tells him, "but we've got to help you breathe first, and then we'll take care of your leg second."

Carla Zahuranec, M.D., a second-year, administers the drug. The patient's eyes close.

"Let's get his head down," McGehee says. They're about to intubate.

Scott Kelley, M.D., a second-year standing at the patient's head, grasps the chin, opens the mouth. He inserts a laryngoscope to hold the tongue out of the way, then peers inside. He sees the openings to two narrow tubes, millimeters apart. One is the trachea, leading to the lungs. The other is the esophagus, leading to the stomach. If he places the tube down the esophagus instead of the trachea, he could cause cardiac arrest, brain damage, even death. If he pushes it too far down the trachea, only one lung will work. He can damage the lining of the throat, the vocal cords, the lung itself, even the teeth. Kelley barely pauses, then inserts the tube.

On the instant, Distel attaches a breathing bag. She squeezes it rhythmically to push air into the lungs. "Chest is rising," she says.

McGehee applies her stethoscope to the chest. She detects sounds uncannily like human breathing, if a bit mechanical. "Breath sounds, bilateral," she says. Both lungs are working properly.

"All right," McGehee calls from below, "we can have chest X-ray come in."

"Chest X-ray's on their way back," says the loudspeaker. "Can we call for transport to the O.R.?"

"Yes, we can call for transport."

Up in the booth, unheard by the residents below, Cooke murmurs: "Beautiful. Absolutely beautiful." ➤

Before the simulation begins, James Cooke and Christine Kistler (right) orient residents to the equipment available in the Clinical Simulation Center.

The key to psychomotor development is repetitive practice. A resident can practice on a mannequin or a computer program again and again, with no risk to a human being, until the new skill becomes second nature.

The benefits of simulation in the medical curriculum are extending throughout the practice of medicine. All boil down to improvements in patient care. Residents are trained more thoroughly before they work with patients. Faculty members in clinic can spend more time helping residents with complex decision-making and less time on basic skills.

These begin with psychomotor skills — the mind-to-muscle actions that must come automatically, even in emergencies. The key to psychomotor development is repetitive practice. A resident can practice on a mannequin or a computer program again and again, with no risk to a human being, until the new skill becomes second nature.

"When you have a physician who knows the basics and has practiced the moves before they actually perform the procedures, the benefit is clear," Gauger says. "Yes, absolutely, we still need traditional training methods. But that initial, floundering effort doesn't need to happen."

Take a procedure as common as placing a central line in a patient's artery. Even a resident with a flawless knowledge of anatomy and extensive classroom preparation must develop an instinctive knowledge of several tactile sensations and manipulative skills — finding the right spot to insert the needle; the precise degree of pressure needed to insert the needle into the artery without piercing the opposite side; how to hold the needle in place while threading a wire through it and inserting a catheter. The tactile skills vary depending on whether the artery is femoral, jugular or subclavian, and they must be exercised in a sterile, crowded environment. The opportunities for a resident to try the task are few and far between, and if he makes a mistake, the consequences can be dire.

Yet with simulated skin and arteries astonishingly like the genuine article, the resident can place a central line again and again, until it's as easy and natural as riding a bike.

"When you're doing this on a patient your first time, and it's cumbersome, there's all sorts of room for problems," Andreatta says. "So the idea in the

Sim Center is to do that part before they get to a patient. Let's make sure that psychomotor skill set is automated, in a sense — that they have it down pat. Then, when they get to the patient-care environment, they're not thinking about their skills. They're thinking about the patient and the scenario at hand."

Simulation also allows residents to work out the kinks involved in medical teamwork — who takes charge, who stands where, how to communicate with maximum efficiency. Because scenarios in the Sim Center can be videotaped and recorded, then replayed immediately, instructors and residents can go back through the exercise, analyzing what went right or wrong. Sometimes a scenario is simply stopped in mid-course and started over. Or a mistake is allowed to play itself out. The "death" of an artificial patient may not be real, but residents say it teaches a powerful lesson.

Many begin Sim Center training with doubts. After all, they ask, how much good does it do to treat a patient whom you know, in the back of your mind, is really a machine?

"I was very skeptical when I first went into it," says Susan Bettcher, M.D., a second-year resident in family medicine. "I thought: 'Is this environment going to seem realistic?' But it really is a lot more realistic than I thought it would be."

"It can be easy to forget that it's not a real person," says Christine Kistler, M.D., a third-year in family medicine. "You don't want him to die. It can be really nerve-racking."

In fact, says Andreatta, the close observation of faculty, not to mention the videotaping, tends to induce a level of stress in residents comparable to what they go through in a clinic or hospital with human patients.

"It still makes your heart beat a little bit faster," Distel says. "You're being forced to speak in the moment, act on your feet. It's not a hand-written test."

James Cooke reviews a recording of the simulation with the residents involved, and discusses with them what went right and what went wrong.

James Cooke controls the patient's actions, provides his voice, and watches the residents' reactions from the observation room in the Clinical Simulation Center.

Up in the Sim Center booth, Kistler is sitting with Cooke as he runs through the intubation scenario. She suggests that he toss one of those curve balls to her less-experienced colleagues. "Let's throw in a tachycardia" — a racing heartbeat.

"Sure," Cooke says. He slides the mouse and clicks, cutting off the effects of the drug which had put the patient to sleep.

Below, the residents are thinking their intubated patient is ready for surgery. Then, on the monitor, the red digits indicating the heart rate leap.

McGehee sees it instantly. "Heart rate's 120," she says. "He's tachy."

Kelley looks down, sees the patient's eyes are open.

"Oh, he's awake. That's why he's tachy. So let's give him some Versed."

Up in the booth, off-mike, Cooke chuckles. "One second. Very nice."

The patient's eyes close. The heart rate drops to safety.

The voice on the loudspeaker asks: "Doctor, can I send transport back now?"

"Yes," McGehee says.

"Okay, they're on their way right now."

Kistler descends from the booth, applauding the competent performance of her resident colleagues. m

Editor's note: In June, the Clinical Simulation Center was awarded accreditation as a Level 1 Comprehensive Education Institute by the American College of Surgeons, one of only 13 such institutes in the nation.