At the heart of a surgical revolution

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Doctors from around the world are waiting in line to spend two days at the Brody School of Medicine at East Carolina University, the only place they can learn to use their new arms to perform heart valve surgeries.

The arms belong to an ambidextrous robot named da Vinci. With its motherboards, computer chips, pedals and levers, the da Vinci Surgical System is part of a quiet revolution in surgery. Through its tiny grasping clamps and ability to move like a human wrist, it is enabling surgeons to complete life-saving procedures while seated about six feet away from the patient at a computerized console.

While the race for technology rushes on, so does the run for publicity. When doctors from Duke, Harvard, Columbia-Presbyterian in New York and other institutions snare headlines for surgical breakthroughs, they fail to mention they trained at ECU.

No matter. They're still taking their lead from the Brody School of Medicine. Although barely into adolescence — the first class graduated in 1981 — the medical school is reshaping medical history by taking technology into the most inner reaches of the heart.

Bringing doctors up to speed is the job of alumnus Dr. L. Wiley Nifong, director of surgical robotics and surgical research for the Brody School of Medicine and a 1990 graduate of the school.

Nifong, who grew up on the banks of Lake Mattamuskeet in Hyde County, N.C., feels strong ties to the East and once hoped to make a difference here.

He never imagined he'd make a difference around the world.

A robot in my heart

Da Vinci is an enormous box fed by cables that directs a 7-foot tall, spider-like assembly of arms, hinges, lights and gears. Despite its bulk, the da Vinci Surgical System powers two small wrists that perform with the sensitivity of a human hand. Yet while it is remarkable, it is only an instrument, leaving the physician responsible for the perfect execution of each step of a complex operation.

The robotic system's name reflects the inspiration of the Renaissance innovator Leonardo da Vinci. Among physicians, da Vinci is known for his groundbreaking discoveries of heart anatomy; he gave the mitral valve its name after the peaked hat worn by church bishops.

The miracle of the robotic da Vinci is that it translates the surgeon's hand movements to miniature mechanical arms able to thread their way into a patient's heart and operate from the inside.

Traditional open-heart surgery requires surgeons to make an 8- to 10-inch incision by sawing through the sternum and opening the rib cage to gain access to the heart. This method is painful for patients and requires several weeks of recovery.

With the da Vinci Surgical System, surgeons make a 3-inch incision between ribs on the right side and two other incisions of less than a half-inch on the top of the chest before inserting the robotic arms. One arm holds a slender camera that projects 3-D images onto a monitor in front of the surgeon, seated at the console. The lens system magnifies filament-sized arteries and veins to the size of drinking straws. The other arms hold the instruments, whose mechanical wrists are operated by complex cables and can transmit the dexterity of the surgeon's forearms and wrist into the chest.

Seated at the computer console several feet from the operating table, the surgeon views the magnified, 3-D image and moves the robotic arms using two mechanical levers.

Da Vinci's robotic arms are steadier than the coolest surgeon's, eliminating tremor in the critical heart spaces where millimeters matter. The robotic wrist holds the curved needle while the surgeon moves it to reinforce the valve flap with sutures.

Minimally invasive, robotically assisted valve repairs mean patients avoid sternotomy. They recover faster and with less pain.

"The robotic arm has vision, accuracy, precision and dexterity that allow us to do a better operation," Nifong said. "It's the only way to operate inside the heart laparoscopically."

Years of diligence in developing the robotic arm have enabled ECU to lead successful studies for the U.S. Food and Drug Administration, under the leadership of Dr. W. Randolph Chitwood Jr., chairman of the department of surgery and chief of cardiac surgery. He is also director of the Heart Center of University Health Systems of Eastern Carolina.

Today, the ECU medical school is a leader in robotics and one of only a few sites training surgeons to use da Vinci for other procedures, such as appendectomies, hysterectomies and gastric surgery for obesity. The Brody School of Medicine is the only place in the world training physicians to perform the robotic heart valve operation.

Two da Vinci systems are in use at the medical center. One is at ECU's surgical training center and the other is used for operations at Pitt County Memorial Hospital. The units cost about $1.3 million each.

Heart murmur, leaky valve

Most people never hear of the mitral valve until they have a problem with it. But it's the workhorse of the heart valves, blocking the lower left chamber shut every second or so while freshly oxygenated blood rushes out to the rest of the body.

The valve, a veil of skin about 2 inches wide, also opens with each heartbeat to shepherd newly oxygenated blood into this chamber, or ventricle, from the lungs.

A working mitral valve prevents blood from seeping back into the upper left chamber, or atrium, from where it would have to be pumped out, again — inefficient for the heart and exhausting for the person.

Doctors detect mitral valve bulges or leaks when they hear a heart murmur, or a strange heart sound. Valve leakage can appear at birth or occur as a result of disease. Other malfunctioning valves occur when the skin becomes hardened by disease such as rheumatic fever.

Traditionally, the valve was replaced with a pig valve or other suitable substitute during an open-chest procedure that left patients with an incision several inches long closed by a row of staples down their chest.

“It’s a totally different operation than we were taught,” said Nifong, 40, assistant professor of cardiothoracic surgery. “Our incisions are smaller, only 4 centimeters. At first, you had to believe in the technology, but once you saw how well the patients did, you got the energy to keep pushing forward.”

In November 2002, the FDA granted full approval for da Vinci’s use inside the heart. Cardiac surgeons at ECU led the national multi-center clinical trial; Chitwood served as principal investigator, performing 51 mitral valve surgeries using the da Vinci system, more than any other cardiac surgeon in the world.

With the FDA approval, doctors across the nation have the green light for adopting robotics for heart valve surgeries. Soon, they will likely start performing other heart surgeries, such as to repair septal defects, or holes, between heart chambers.

A separate FDA trial is now studying da Vinci’s use for coronary artery bypass grafting,

or CABG. The ECU medical school is also participating in these studies.

The da Vinci Surgical System is made by Intuitive Surgical of Sunnyvale, Calif., a medical technology company. Other companies, convinced of robotics' strong future, are pursuing their own surgical robotic devices.

Intensive training

Nifong participates in about two robotic valve repairs a week, often in conjunction with training sessions for other heart surgeons. In any given week there's usually at least one U.S. or international surgical team in training at ECU's Minimally Invasive and Robotic Training Center. The center is in the Edward N. Warren Life Sciences Building, an angular, glass-fronted building connected to the medical school by a vast breezeway looking over the nearby heart center.

Nifong leads training sessions at ECU and also travels to the surgeons' home hospitals to oversee their first post-training valve procedures. Surgeons must complete a general cardiac training on da Vinci before they advance to valve training. The center also receives and transmits live broadcasts from the operating room via fiber optic cable and Internet connection.

A typical session takes two very intensive days that start in the operating room. Participants arrive in the OR at about 7:30 a.m. as the sedated patient is positioned at a 30-degree tilt, with the arm raised on a cushioned platform. Later, visiting surgeons watch as three small incisions, called ports, are made between the patient's ribs on the right side and right breast for the pencil-sized camera and robotic arms to enter the heart.

During the operation, blood is routed to a heart-lung machine through a leg artery, where it is oxygenated before being returned to the body.

A palette of special instruments, some developed at the School of Medicine, help make

this procedure possible. The Chitwood clamp, a long-handled instrument with a curved tip, stops the flow of blood into the heart at the aorta, the major blood supplier to the body.

“These instruments have to be angled a certain way so they don’t get in the way of the robotic arms. Plus, they have to reach into small areas,” said Penni J. Robinson, a research specialist at the surgery training center who’s also an ECU graduate (a master’s in nutrition ’99, focusing on biology, and a bachelor’s in cellular biology ’91). She manages the training schedule, prepares models and oversees the center’s day-to-day operation.

“With minimally invasive surgery, you have to adopt a laparoscopic frame of mind, using smaller tools and working at a computer monitor, as compared with the traditional ways, where everything is open and you use your hands,” she said. With da Vinci, “it’s exactly like having your own hands in that small space,” she said, adding that there are adjustments, such as learning to operate without tactile sensation.

In the afternoon, surgeons work on a fleshy plastic model resembling a heart, suturing the valve into place and reinforcing it with a polyester band. The second day, they may observe another operation or they may spend the day practicing on other models.

The center has developed life-like plastic models that reduce the need for cadavers or animal models, an effort Nifong piloted. When animal models are needed, surgeons can operate on pig hearts, obtained through agreements with area slaughterhouses.

“We’re able to take people through the training with inanimate objects,” said Nifong, an animal lover who once studied to become a veterinarian. “We’ve gone out of our way to lead others to do the same thing. To develop these models has taken a lot of work, but it’s important, and we’ve convinced others that there’s a need.”

From rural to robotics

It’s no accident that the century’s most significant innovation in mitral valve surgery is taking place in eastern North Carolina. That accomplishment and many others spring from the devoted efforts of those committed to creating a thriving medical center in Greenville, a dream once scoffed at by nearly everyone to the west. Despite strong opposition, leaders like the late Leo W. Jenkins, former chancellor of ECU, strove to establish a medical center that would help improve the lives of the farmers, fishermen and small business owners of this isolated part of the state.

Once approved, they gave the school a three-part mission: Teach and train more minority physicians, train doctors to provide primary, or basic health care, and raise the overall health of people in the region.

Early studies from that time revealed heart disease as one of the top threats to health here and in 1984, the medical school hired a new surgeon, W. Randolph Chitwood Jr., just out of an exacting 10-year residency at Duke University. He performed the first open-heart surgery in Greenville that year.

Over the years, he developed a passionate interest in heart valve repair and replacement, with a special focus on the mitral valve. In February 1999, Chitwood became the first American to perform a mitral valve repair using da Vinci, while in Germany. That followed by only months the first-ever robotically assisted heart procedure in Paris, which took place in May 1998.

Common interests

“Surgeons like doing things with their hands,” Nifong said. “We like the immediate gratification of doing something and immediately seeing a result.”

From a young age, Chitwood enjoyed tinkering with mechanical things and today is an avid photographer. For Nifong, it was an interest in building that led to cardiac surgery.

“A lot of times in general surgery, you are removing something. But in heart surgery,

we’re interested in reconstructing, repairing. I loved general surgery, but I was drawn to intense situations, with patients who are sicker,” Nifong said.

Nifong is used to competition and has excelled at every turn. Offered admission to medical schools at Duke, Chapel Hill and Wake Forest, he chose the ECU medical school. He is a member of Alpha Omega Alpha, the medical honor society, which invites only the highest achieving doctors as members. At his 1990 graduation, he received the Frank Longino Award from the Department of Surgery.

He chose ECU for its emphasis on personal involvement that applies to the teaching relationship, as well as to relationships with other doctors and patients.

“In medical school here, you really learn to communicate with the patients and the referring physicians,” Nifong said.

His responsibilities are even greater now that he is training others. But he stays realistic about his abilities and limitations. He has to.

“You should always be humble,” he said. “As soon as you lose that, something will happen. As soon as you think, ‘I can do anything,’ or if something appears too simple, then suddenly it will become terribly complex. I’ve seen it happen. That brings you back to the importance of what you are doing.”

Nifong also maintains his intense focus by imagining how he would feel if one of his family members needed surgery. He remembers the lessons he learned at the School of Medicine, where primary care — and respectful, compassionate communication with patients — is paramount. “It becomes a very hands-on experience,” he said.

After receiving his medical degree at ECU, Nifong completed a general surgery residency at the University of Rochester in New York and a three-year cardiothoracic surgery fellowship at Wake Forest University.

“I got to see the old-timey, conventional operations, so I could see the ways people benefited from laparoscopic,” he said. “That’s how I became interested in it. When I was looking for a job, we just meshed,” Nifong said of Chitwood. “We built our relationship over the next couple of years.”

Home, at heart

While translating monumental surgical advancements to this generation’s best doctors takes him around the world, Nifong cherishes his ties to the East. Clearly modest about his accomplishments, he admits he’s worked hard for them.

Coming from a county with no incorporated townships, he spent summers helping his father in his family’s heavy construction business and, later, assisted in the veterinarians’ offices where he followed his love of animals. He graduated magna cum laude with a bachelor’s degree in poultry science from North Carolina State University, intending to become a veterinarian.

When he decided on medicine as a career, he began as a night orderly, staffing the emergency room between 11 p.m. and 7 a.m. In medical school, he frequently shadowed private practice physicians on weekends and holidays.

Nifong married his high-school sweetheart, Daphne, almost 20 years ago. They have two children, Caroline, 7 and Timothy, 5.

His childhood among neighbors and wildlife in Hyde County has remained a part of his life. “I think that having a family environment, being dependent on other people and on your close friends, is important,” he said. “It makes a person more sensitive.”

Advancements on the horizon

In January, ECU hosted Dr. Lucia Torracca, a cardiac surgeon from St. Raphael Hospital in Milan, Italy. Already proficient with the da Vinci system after two years of

using it, she wanted to refresh her training on mitral valve repair.

Robotic-assisted surgery is very popular in Europe, she said.

“We have had a very interesting response,” she said. “People are not afraid.”

While Torracca appreciates the advancement, she eagerly waits for the next generation of robotics to appear. “I’m excited, but I know there are still some limitations and difficulties we have to work on. We are only at the beginning,” she said.

Dr. Roxanne V. Newman, a cardiac surgeon from Fargo, N.D. who also trained at ECU with Nifong, agrees.

“I think the next two to three years will be spent on developing and improving,” she said. “Then it’s going to skyrocket, and it will be like calculators and computers. When you look at those two examples, you can imagine how rapidly the technology can accelerate.”

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