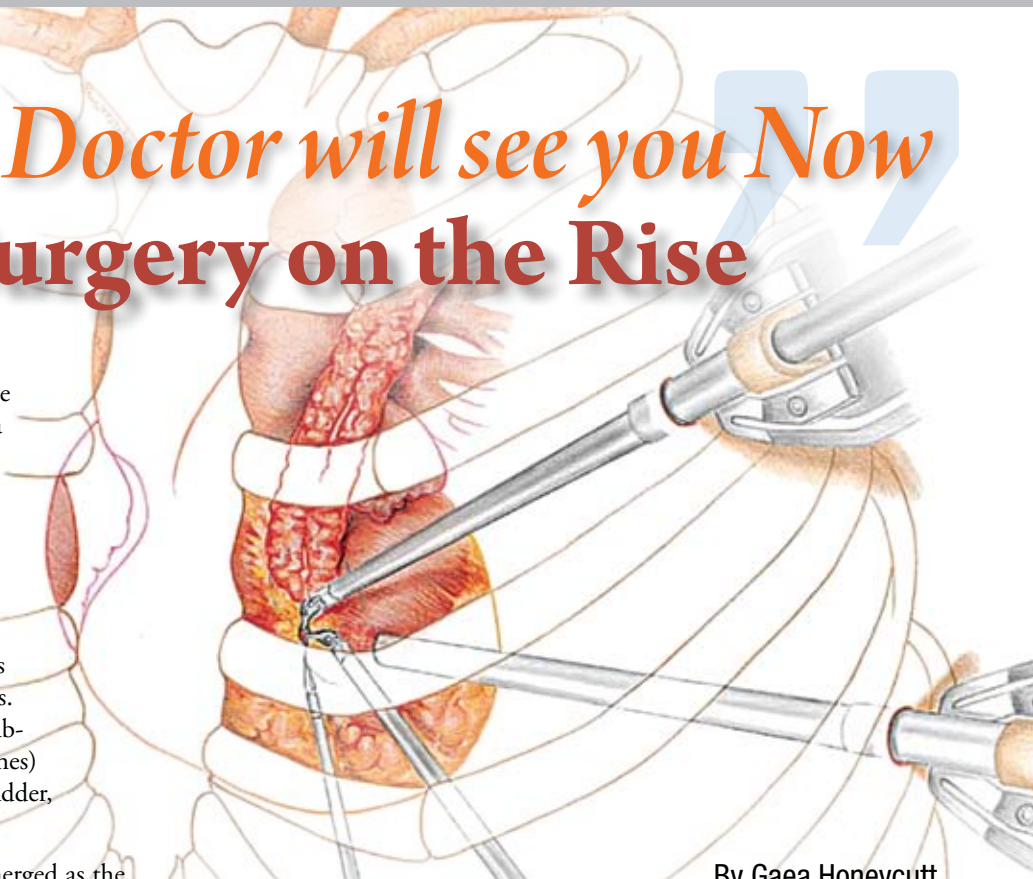
The (Robot) Doctor will see you Now

Robotic Surgery on the Rise

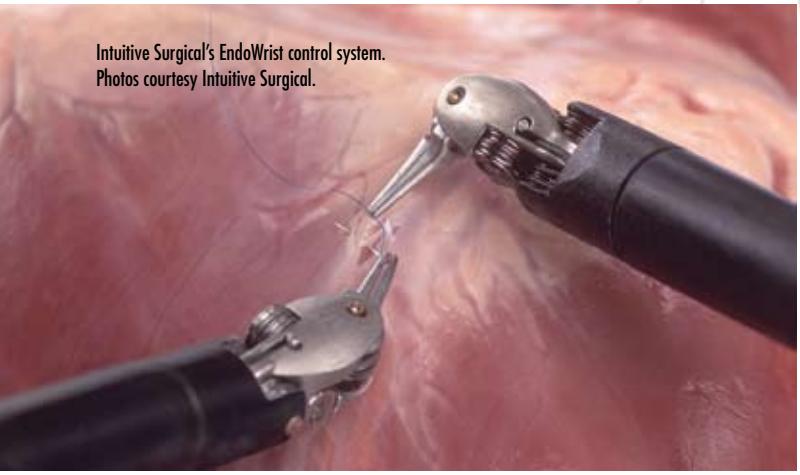


By Gaea Honeycutt

Imagine the absolute best medical care available where it's most needed ... the frontlines of a battlefield, an isolated rural community or an overburdened, understaffed public hospital in the middle of a metropolis.

Almost two decades ago, doctors began performing the first laparoscopic surgeries. Then the new frontier, minimally invasive laparoscopic surgery allowed doctors to perform a range of procedures using small, 1–2 centimeter (.4-.8 inch) incisions. Where previously a patient had to undergo an abdominal incision up to 30 centimeters (12 inches) long in order for the surgeon to reach the gallbladder, the patient now had only a few small incisions.

Just a decade ago, robotically assisted surgery emerged as the newest frontier of minimally invasive surgery, with robotically assisted pelvic surgery becoming a highly sought advantage among competing hospitals. Stanford Research Institute (now SRI) pioneered what is now the only soft tissue surgical unmanned robot available and approved by the U.S. Food and Drug Administration (FDA)—the da Vinci Surgical System, built by Sunnyvale, Calif.-based Intuitive Surgical.



Intuitive Surgical's EndoWrist control system.
Photos courtesy Intuitive Surgical.

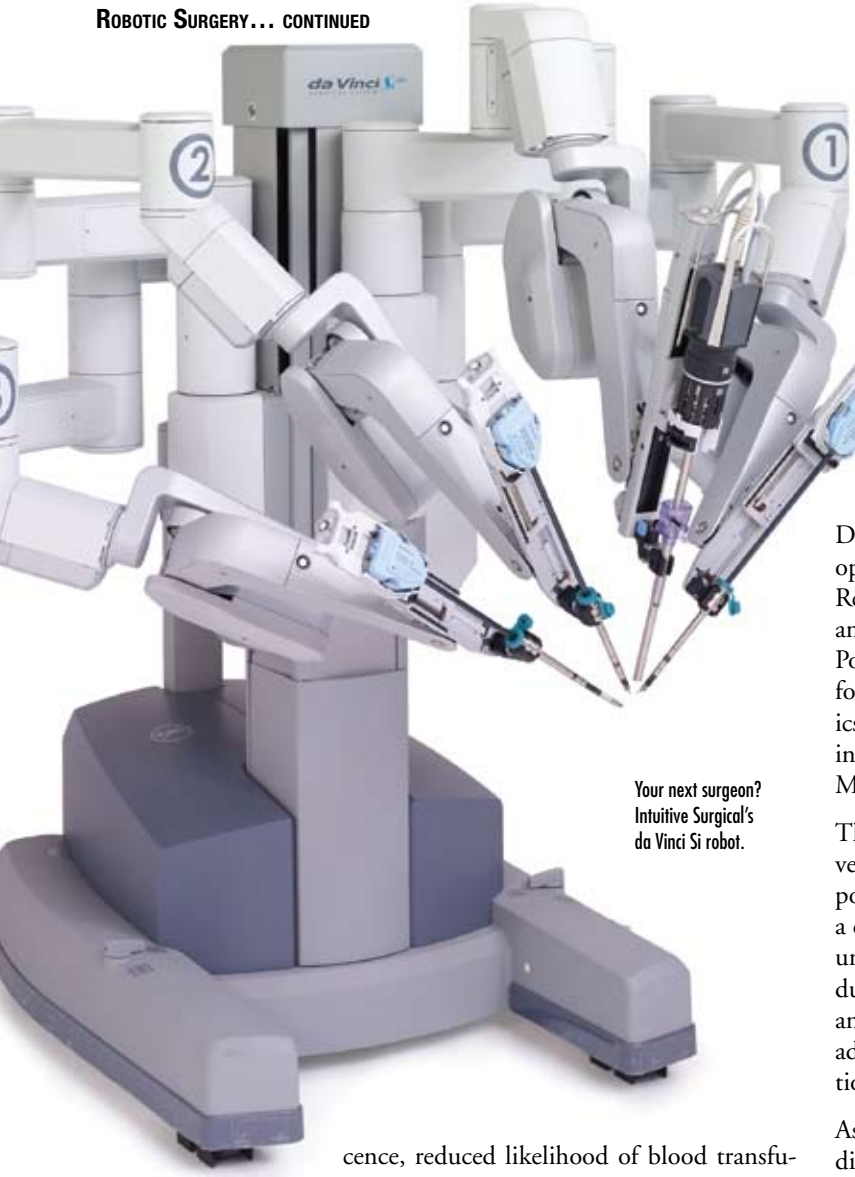
Today, the benefits of robotically assisted surgery surpass even the advances of laparoscopy. Dr. Eric J. Kuhn of the Urology Group at Good Samaritan Hospital in Cincinnati, Ohio, marvels at the progress.

"Surgery used to require two days in intensive care [followed by additional days in recovery]. By the mid-90s, it was just three days recovery. And now we have them out in less than 24 hours," he says.

Using a virtual interface, the da Vinci Surgical System is used to perform dozens of procedures, including prostate cancer removal, hysterectomy, single-valve cardiac surgery, and throat surgeries. The core technology features a three-dimensional, immersive stereo display with up to 10x magnification. With an ergonomically designed console station, surgeons sit comfortably while using an interface that replicates the motions of surgery. EndoWrist instrumentation allows a broad range of freedom of motion and 540 degrees of rotation. The robot stand is positioned next to the patient, with instruments over the body. A few feet away, the surgeon operates sensitive hand and finger tools akin to video game controls while cameras inside the patient relay real time data over fiber optic cables.

Intuitive Surgical's second-generation da Vinci robot added high definition and digital zoom, a motorized patient cart, high-speed fiber optics, extended reach, and multi-source video display with touch screen. Recently released, the da Vinci Si increases dexterity, provides higher quality 3D high-definition images and incorporates a dual console for endoscope exchange between surgeons.

The benefits of robotically assisted surgery include shorter convales-



Your next surgeon? Intuitive Surgical's da Vinci Si robot.

cence, reduced likelihood of blood transfusion, less pain and greater precision. But even better is the ability for surgeons to lessen the negative impact of surgery while achieving better results in complex procedures.

"That's really where the robot has found its strength," says Dr. Ronney Abaza, director of Robotic Urologic Surgery at The Ohio State University Comprehensive Cancer Center—James Cancer Hospital and Solove Research Institute. "Prostatectomy is complex surgery. There are competing goals. You want to remove the prostate but maintain the structures around it responsible for continence and potency. There's a very fine line in trying to maintain the tissues around the prostate."

Robotically assisted surgery is already sparking innovation among doctors. Dr. Ash Tewari, Director of Robotic Prostatectomy at the New York Presbyterian Hospital—Weill Cornell Medical Center, has developed the first and only real-time, cellular-level imaging technology used in conjunction with robotic prostatectomy, allowing the surgeon to see malignant cells and eliminate them while preserving the healthy tissue. Tewari also developed methodologies to improve urologic procedures.

"A neural hammock helps maintain the nerves surrounding the prostate, total reconstruction for urologic control, and an internal splint" that eliminates the need for a catheter, he says.

Military Roots

The development of robotically assisted surgery originated with SRI's research into the military applications of telesurgery in the 1980s. A former military doctor, Kuhn notes that the battlefield environment presents challenges.

"I think when it comes to the devastating trauma on the front lines of battle, you're still going to need medics and medical personnel," he says. "When you have massive bleeding, you lose visualization with a robot." He predicts, "Certainly there may be a surgeon in a central location doing surgery remotely, [but] it's not going to be the type of surgical robot we're using now."

Development of military applications continues, including the development of SRI's Trauma Pod. Funded by the U.S. Defense Advanced Research Projects Agency (DARPA) and the U.S. Army's Telemedicine and Advanced Technology Research Center (TATRC), the Trauma Pod has completed Phase 1 trials. The mobile robotic surgery platform is a collaboration with the University of Texas, General Dynamics Robotic Systems, Oak Ridge National Labs, University of Washington, Intuitive Surgical, Robotic Surgical Technologies, Integrated Medical Systems, GE Research and Multidimensional Imaging.

The Trauma Pod was conceived as a combination military delivery vehicle and robotic operating room. Injured soldiers would be transported from the battlefield to the autonomous operating room. From a centralized location outside the battle zone, surgeons would use an unmanned interface to assess the patient and perform medical procedures. SRI has completed the initial phase, automating scrub nurse and circulating nurse functions using semi-autonomous robots. In addition, tele-surgeons have performed complex surgeries on simulation mannequins.

As funding becomes available, SRI will launch Phase 2, developing diagnostic and intervention capabilities.

"We'll be focused on figuring out internal injuries in the head or the rest of the body," says Pablo Garcia, principal engineer in the Engineering Systems Division. "A lot of the tools that are out there are very limited. They don't allow you to make decisions in the first few minutes of injury, which is very critical."

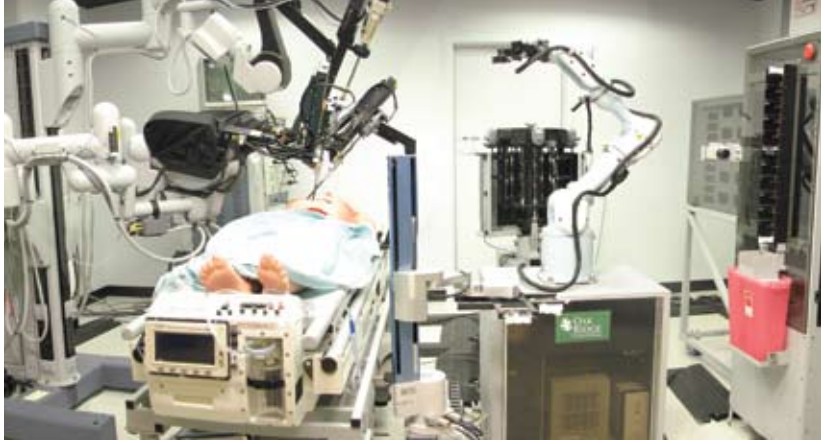
Philip von Gugenberg, director of Business Development, adds, "we will also continue the technology development and enhancing the functionality achieved in the first phase of the work."

Popular Robots

Robotically assisted surgery is popping up all over the U.S., Europe and Asia. According to Nora Distefano, market development specialist at Intuitive Surgical, "As of March 31, 2009, there have been 1,171 unit shipments worldwide—863 in the United States, 211 in Europe and 97 in the rest of the world."

Dr. Fernando J. Bianco, chief of Urology and Robotic Surgery at Mt. Sinai Medical Center in Miami, Fla., estimates, "Ninety percent of the cases I do today are done robotically. Five years ago, it would have been less than 10 percent."

More people have access to minimally invasive surgery, but this pro-



SRI's Trauma Pod, now under development.

liferation has its pros and cons. Aside from the fact that a da Vinci system is not cheap—roughly $1.5 million, plus maintenance and replacement instruments—there are other challenges. The learning curve is steep. Open surgery is very different than maneuvering through the body using the robotic approach. No longer able to rely on tactile feedback, surgeons must place greater reliance on eyesight and mastering controls.

"What we tend to see is that younger surgeons learn the robotic [method] faster than older surgeons. It's probably because they grew up using video games and learning the hand-eye coordination," says Dr. Winifred Hayes, founder and CEO of Hayes, Inc., a health technology research and consulting firm.

Although there's some compensation in the form of shorter hospital stays and smaller surgical teams in the operating room, a hospital must create a center of excellence to make the robot pay off. "If you only do 50-100 cases, it's not going to be cost efficient and you're not going to make the money," says Dr. David Samadi, chief of the Division of Robotics and Minimally Invasive Surgery at Mount Sinai Hospital in New York.

Samadi also notes, "The only downfall is, that like anything else, the technology can fall into the hands of people who should not be using it. You have a lot of robotic surgeons who are not well trained, but can take a prostate out." Abaza agrees, "Proficiency comes probably somewhere between 50 to 100 procedures. Expertise would come around 250 or more procedures."

The Future of Surgery?

Now imagine the best medical care delivered through your nose. Or your navel. No incisions, little pain and less recovery time. And, more precise surgery with greater visibility from a completely different location. That's the future of robotically assisted medicine.

"Let's say you have a patient in a rural area with a heart condition, but no expert nearby. There's the potential for a surgeon who's far away to do the procedure using a robot," says Hayes.

"Most interesting is the concept of virtuality," says Dr. Pier Giulianotti, professor of surgery at Illinois University. "The imaging can be enriched and empowered by data from other sources— ultrasound, x-ray and other things discovered in the future." Guilianotti sees endless possibilities, "and you're not only working on imaging, but simulation. You can simulate the surgery days before. You can alter the approach and practice even before the surgery."

Ohio State University's Abaza says, "obviously, the parts will get smaller ... we may see robots that can be dropped into abdomen and driven around."

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