EDITORIAL

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Surgery of the 21st Century

Webster's dictionary defines a robot as "a machine that resembles a human and does mechanical, routine tasks on command."[1] Robots have been the stuff of science fiction novels for decades. But robotics is already part of our world. Robotic equipment has been put to profitable use in many fields of endeavor. Automobile manufacturing, space exploration, and maintenance of the nuclear arsenal are but a few examples. Robotic devices for use in general surgery have also now been developed. One such device (daVinci system, Intuitive Surgical, Palo Alto, CA) was approved for use in the United States in July, 2000. While not the first commercially available surgical robot (that distinction should probably go to the Orthopedic robotic device, Robodoc[2]), it is part of a family of budding robotic instruments in various stages of research and clinical use in the United States and around the world. Common to these devices are remote surgeon interfaces, which transmits the hand movements of the surgeon to robotic arms that enter the abdomen via laparoscopic ports and manipulate tissue. Thus, the above definition nearly describes the reality of these machines, although the tasks performed are under direct and continual "command" of the surgeon. In this issue of *Annals of Surgery*, Marescaux et al. report a series of 25 telerobotic laparoscopic cholecystectomies, performed in Strasbourg, France using the Zeus system (Computer Motion, Goleta, CA - not yet FDA approved in the USA). They proffer that their initial experience ". . .will pave the way for future definitive studies of computer integration of preoperative imaging studies with real-time, computer-assisted surgery." They report requirements for success that we have also discovered: The critical importance of port placement, the necessity of teamwork, and the need to understand details regarding system setup. Also reported are a number of perceived advantages, such as the ability to perform precise tissue manipulation.

Most surgeons would agree that robotics and/or computer assisted surgery will be a significant part of the future of surgery a decade from now, but few can articulate a vision for what that will look like, or how we will get there. The current generation of robotic surgical devices represents a starting point for this evolution. Surgeons not involved in the development of robotics will have legitimate questions about this emerging technology.

WHAT ARE THE ADVANTAGES OF THESE SYSTEMS?

The objective of these devices is not to replace surgeons, but to add technology to improve surgery. Laparoscopic surgery has hit a roadblock somewhere between the technical expertise required for a cholecystectomy and anti-reflux surgery. Only select surgeons are moving beyond these to more technically difficult operations. Robots offer the promise of improvements to laparoscopic surgery that will allow most surgeons to perform more difficult laparoscopic operations. They will also bring more difficult technical operations (now usually performed via incision) within the reach of laparoscopic surgery. Even more substantial advantages are likely to emerge in the future as technology advances. For example, 3-D CT imaging will be added to the already digitized image stream, so that the surgeon can "see" structures beneath the visual operative surface. Also, heart motion will be "gated", which will allow coronary artery bypass to be performed on the beating heart with robotic arms that move in parallel with the heart motion, while the surgeon sees a still heart.

SHOULD I GET INVOLVED?

Surgeons should become involved when they are convinced that the care of the patient will be enhanced, and not before. Any other involvement should take place as part of investigations that can determine both the appropriate role of these devices, and aid in their development. As with all new advances, robotics is likely to have some marketing value. Thus, there will be inappropriate economic pressure to become involved for some surgeons. Proficiency in laparoscopic surgery is indeed required. A feel for port placement, vectoring angles, and anatomy as viewed laparoscopically are obviously necessary. However, most of the learning curve involves the machines themselves, and not the operations. Training in the safe use of the device is an obvious prerequisite.

WHAT IS THE ROLE OF INDUSTRY?

Skeptics will view these machines as technology looking for an application, driven by the profit hungry medical/

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industrial complex. But the development of high technology surgery requires the participation of both industry and surgery, because neither group has the resources to accomplish these goals in isolation. Such cooperation is a new paradigm, first tested during the development of laparoscopic surgery.

WHAT ABOUT THE EXPENSE?

These machines cost approximately $1 million. While this sounds expensive for surgical equipment, most invasive radiology suites have equipment worth that much and a great deal more. Whether such an expense is justified is as yet undetermined.

Surgical robotics has arrived, and it is probably here to stay. The manuscript presented in this issue cracks open a door that leads to a bold new surgical world.

Welcome to the surgery of the 21st century.

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References

1. Webster's Universal College Dictionary, New York: Random House, Inc.; 1997.
2. Taylor RH, Joskowicz L, Williamson B, et al. Computer-integrated revision total hip replacement surgery: concept and preliminary results. Med Image Anal 1999; 3:301–19.