Robotic cardiac surgery: Quo vadis?

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Man, how ignorant art thou in thy pride of wisdom.

—Mary Wollstonecraft Shelley, 1818

Just like other technologies, cardiac surgery also underwent important changes during the past decade: minimally invasive approach, endoscopic interventions, Heartport, off-pump coronary bypass (just to name a few). These changes were most significant because, contrary to those of the preceding years, they not only represented an expected linear progress but also uprooted some of our basic concepts we have learned, practiced, taught, and regarded as sacrosanct. Some of the first words we heard in the operating room as young apprentices were: “You must have adequate and wide exposure. Use your fingers as you use your eyes! Palpation is as important as is sight. To be able to do fine work, the heart has to be absolutely still.” Although none of the above innovations proved these basic postulates wrong, they have shown that we indeed can “get away” (most of the time) with things we thought we could not live without. Although with these new techniques we have definitely lost some of the safety and even effectiveness of our procedures, we were still both ethically and clinically justified because we got something important in return: shorter operating time, less surgical trauma, elimination of cardiopulmonary bypass, better cosmetic appearance, shorter hospitalization, whatever. It was a trade-off. If we learned the new technique well enough and we selected our patients appropriately, the balance was definitely positive.

With the passage of time, some of the innovations proved to be valuable tools; others, which did not meet expectations or because somebody invented a “better mousetrap,” were discarded.

Now we are again witnessing the introduction of a new technique: robotic cardiac surgery. Although clinical trials with cardiac robotics are now conducted only by a handful of institutions, there is no doubt that in significance this technology could outweigh any, if not all, technical modifications of contemporary cardiac surgery. If off-pump coronary surgery was a technical revolution, cardiac robotics is a technological coup d'état.

Robotic technology is not new; it has been with us since the early 1930s. Applied under appropriate circumstances, robots decreased costs, improved quality of goods, expedited production, and allowed human beings to avoid dangerous exposure. Where robotic technology proved to be impractical it was abandoned. Remember the fate of the “household robots,” which were supposed to fill in as maids or butlers? The few remaining examples are now exiled to kiddy shows.

To justify the introduction of this complex and certainly most expensive technology into our economically crisis-ridden cardiac surgical care, we must have clear, logical reasons. So far I have found none.

To state, however, that there is no place for robotic technology in health care would be definitely wrong. The tremendous value of automation, including robotics, is well proven in pharmaceuticals, clinical laboratory techniques, and imaging. Even in some areas of surgical practice, robotics may be very helpful. In neurosurgery, for example, robotics may not only be used as adjuncts in the millimeter-by-millimeter removal of brain tumors, but based on computed tomography or other imaging, a robot could be individually programmed to do the job almost by itself. In cardiac surgery, however, the situation is different, including the limitations imposed by anatomic and pathologic details, the necessity of a “split-second” standby team, and

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near-forbidding costs of the equipment itself. But for the sake of argument, let us accept a hypothetical situation, which may well occur in the not-so-distant future, that robotic technology is fully developed, all the technical “glitches” are gone, the learning curve is flattened out, and the purchase of a robot is only half as expensive as it is today.

Robotics will still have to be limited to patients with accessible lesions and who are in need of cardiopulmonary bypass as well. Even in those cases, what can a robot do better or faster than a surgeon with advanced conventional instrumentation? As it stands now, the most touted advantage of robotics is that it is “minimally invasive” and it may be performed through two or three “ports” without opening the chest. But, so can conventional endoscopic surgery!

If the future path of cardiac surgery indeed leads through three 1-inch holes instead of a thoracotomy, then so be it. But why do we have to interpolate a million-dollar robot between the surgeon and the endoscope? Shouldn't we rather concentrate time and resources on the perfection on “hands-on” endoscopic instrumentation instead of robotics?

An often heard argument in favor of cardiac robotics is that it may offer the advantage of “long-distance” operations (ie, highly trained specialists may provide services from home to less developed areas). This is bizarre. First of all, it is highly unlikely that the prerequisite of robotic cardiac surgery, the need of an “on-site” team to handle unexpected situations, will change. But even if robotic

technology would reach a stage when a standby team is not necessary anymore, it is hard to imagine a situation in which the hospital can afford a robotic operating room but not a surgeon.

I am somewhat hesitant to discuss any economical or ethical issues (the two are tightly interconnected) relative to cardiac robotics, but there are plenty of them. At the “dawn” of cardiac surgery open heart operations were done at a few elite centers. This greatly restricted patient access. Now we are well supplied with cardiac surgical facilities. In the United States alone about 1000 cardiac surgical facilities are performing close to 500,000 heart operations a year. If (in the unlikely situation) robotics proves superior to anything less, are we going to install 1000 robots or will there be two classes of service, one with and the other without robots? Will there also be two classes of surgeons, the “port-inserters” and the “long-distance robot operators”?

We did let the cardiac robotic genie out of the bottle; now we are obliged to ask some questions: Are we doing this “just because it could be done” or is it really advantageous for our patients? What are the costs? Can we afford it on a general scale? What are the professional and social implications? How may it change the education and structure of our profession? However, even if some or all of these inquiries may be answered affirmatively, the main question remains: What can cardiac robotics offer that other simpler and less expensive techniques cannot?