

Creating the educated surgeon in the 21st century

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Abstract

In this J. Roland Folse Invited Lecture in Surgical Education, given before the Association for Surgical Education, a resident considers two challenges for surgery and surgical training: the increasing importance of less invasive technologies, and the growing awareness of the importance of “systems” in care. As less invasive technologies evolve, the role of surgeons is being fundamentally challenged. Two alternative models of adaptation to technological change exist: the breast surgery model, in which surgeons restrict their role to providing open operative interventions, versus the neurosurgery model, in which surgeons adopt even noninvasive technologies in order to continue to manage diseases that might need open intervention. The neurosurgery model appears preferable but poses difficulties for the existing structure of surgical training. Evidence that surgical outcomes are critically dependent on entire teams of personnel, and not merely individual surgeons, may require changes in surgical training, as well. © 2001 Excerpta Medica, Inc. All rights reserved.

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Thank you for inviting me here. It is a rare thing to ask someone still in training for his thoughts about the appropriateness and direction of that training. I am honored that you have asked me. I am also aware, however, that this is a hazardous plank I've been asked to venture out onto. Telling this audience about how to improve surgical education is like giving Tiger Woods tips about his long game. But here goes anyway.

I decided that my best approach would be to puzzle through two overarching issues in surgical training with you: first, what we're trying to accomplish when we educate surgeons, and second, whether current approaches in training fit these goals. As we do this, I think it will become apparent that a troubling and fundamental conflict is developing in surgical education—one between the desire to create technical experts and the desire to create surgeons with a larger vision of what they do.

So let's start with the first question. What are we trying to accomplish when we educate surgeons? The answer seems simple: We're trying to create good surgeons. But what exactly is a good surgeon? For that matter, what is a surgeon?

What is a surgeon?

I turned for an answer to the usual source: the dictionary. I actually used two dictionaries—a 1913 Webster's and a 1998 Webster's. And I found a curious thing. Each one had a different definition. Here's how the 1913 Webster's [1] defined “surgeon”: “One whose profession or occupation is to cure diseases or injuries of the body by manual operation.” Now here's how the 1998 Webster's [2] defined “surgeon”: “A medical specialist who practices surgery,” which it further defines as “a branch of medicine concerned with diseases and conditions requiring or amenable to operative or manual procedure.” The change is subtle but important. The focus shifts over time from a specialty defined by “manual operation” to one defined by concern with the diseases that *might* need operation. This is, the more I think about it, a crucial difference. For it is the difference between whether we aim to create technicians or we aim to create doctors.

A technician, my 1998 edition says, is “a specialist in the details of a subject or occupation.” A technician is taught to do, say, breast operations. A doctor, however, should be taught to manage breast cancer.

This is where the conundrum arises. Surgical disease is no longer exclusively surgical. And when the science has moved beyond the confines of the operating room, we have been hesitant to follow. Who can blame us? We love to

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operate, to heal with cold steel. But the result, I've noticed as a resident, is that the profession seems increasingly stuck, uncertain whether the goal is to train technicians of the knife or specialists of disease. As medical care has become more and more multidisciplinary, I've detected two models of surgical training to cope with that reality. One I'll call the "breast surgery model" and the other I'll call the "neurosurgery model."

The breast surgery model sticks with the traditional operative paradigm. Residents learn primarily to master surgical techniques—biopsy, axillary node dissection, mastectomy—and to make decisions about who deserves which of them. The science, however, now requires the use of other, ever more various technologies—hormone therapies, genetic diagnostics, new chemotherapies, percutaneous sentinel node biopsy, and other new radiologic techniques. Much of the expertise with these new technologies has evolved in other specialties. So the model that has developed is one of joint, multidisciplinary care of breast cancer patients. We take our place alongside oncologists, radiation therapists, and radiologists, and see ourselves as providing mainly invasive therapy and diagnostics. (Even then we don't provide all of it. Radiologists are doing more and more core biopsies, for example. If a recent *New England Journal* article has it right, oncologists may begin doing bone marrow aspiration for staging [3]. And new therapies are in development to treat breast cancers with radiofrequency ablation instead of excision.) In the breast surgery model, we are the specialists of a technique, and the resulting risk is that we become technicians. Already we find ourselves playing a diminished role in deciding what the best approach for a particular patient is. Increasingly oncologists are taking on that role, in some cases, even deciding what, if any, surgical intervention is needed.

Contrast that with the neurosurgery model. Neurosurgical trainees are taught, first and foremost, to be experts of neurosurgical disease: brain tumors, cerebral aneurysms, and so forth. At my hospital, they rotate through neurology and neuroradiology. They learn to use a variety of techniques: craniotomies, stereotactic radiation, intrathecal chemotherapy, MRT-guided radioablation, open and closed biopsy. And this has allowed them to act as advocates, not of particular techniques, but of the best therapy for a patient's disease. Whether today or in the future, if a patient has a brain tumor, you can count on a neurosurgeon being able to direct the full range of management.

In general surgical training, the current approach follows the breast surgery model. You learn the knife and everything you can do with it. It is true that requirements have been added to spend time learning endoscopy and critical care management. But these are tacked onto what remains a conventional vision of the surgeon. A professor of mine once defined surgery for me as "cut 'n' cure." But what happens when curing no longer involves just cutting—or much cutting at all? There is a case for saying that surgeons should just stick to cutting, that if breast cancer treatment,

for example, is going to involve bone marrow aspiration, percutaneous node biopsy, radioablation, but excision only half the time, then surgeons ought to take a shrunken role. This has an appealing purity. What brings most people to become surgeons is the opportunity to actually go inside people and make them better for it.

But.

I don't know if any of you have read Tom Wolfe's [4] brilliant account of the beginnings of the U.S. space program, *The Right Stuff*. More than a history, it is a sociologic study of test pilots and the first astronauts—who these men were that they took on a nearly one in four chance of dying in accidents. Wolfe documents a curious, and I think instructive, rupture among the test pilots in the early 1960s when NASA approached them looking for men to become the first astronauts. The top pilots—the Chuck Yeagers—thought the space plans were ridiculous. This isn't a job for pilots, they said. This is a job for monkeys in tin cans. It only confirmed matters when the Russians' first "manned" launch *was* a monkey in a tin can. Where's the skill? Where's the fun? So when the pilots Pete Conrad, Gus Grissom, Alan Shepard, and John Glenn stepped forward for Project Mercury, they were nobodies. Only later did it emerge how difficult and heroic their task was, how much it required "the right stuff." And in the meantime piloting, if you think about it, has become a technicians' job. There are no Chuck Yeagers anymore.

Surgeons have generally been more careful not to become excessively narrow in our vision. Is there that much difference between a two-millimeter incision for a percutaneous approach and a five-millimeter incision for a laparoscopic approach to an anatomic problem? As technology changes surgery, we are forced to ask who we are—and decide whether we are willing to reshape ourselves or not.

Vascular surgery fellowships have recently begun to change in recognition that vascular surgery is not going to be what it once was. More and more fellowships make a point of including training in interventional radiology techniques. The fellows at my hospital, for example, now do up to 20% of their AAA cases using percutaneous placement of endografts, and at a few others places, they do up to three quarters of them this way. Some observers have argued that cardiac surgery will take a similar turn.

As surgery becomes increasingly minimally invasive, the lines between interventional radiology and surgery, endoscopy and surgery, robotics and surgery, pharmaceuticals and surgery will blur. And the range of skills required to manage surgical disease will expand. If the surgeon is to be more than a technician, surgical training should not be confined to learning operative care. It needs to involve learning the far broader base of skills required for managing the diseases we care for.

This suggestion may entail far-reaching changes in surgical training and philosophy. The resident learning to manage hepatobiliary disease, for example, may need to become qualified in laparoscopy, robotics, endoscopy, ra-

radioablation techniques, and gene therapy. No one wants residents to stop training to develop a full range of operative skills, but there is a tension with the desire to ensure they finish with a sure area of expertise. To accomplish this in a 5-year program, we may need to introduce tracks—one for surgeons going into general GI surgery, for example, and one for those going into other specialties. The science and technology is too vast to train everyone to do everything. And the emphasis on operation over disease management in both training and practice has led surgeons to cling to purely technical procedures that could have easily been given up to technicians—central venous lines, for example—while letting our ability to manage surgical disease slip.

What is a surgeon? Well, they are not just for cutting anymore.

What is a good surgeon?

If it's hard to define what a surgeon is, you can imagine how hard it is to decide what a *good* surgeon is, let alone how to train one. I think when we talk about “good surgeons” what we mean are surgeons who provide humane care with the best possible results. For the better part of the 20th century, we have operated with a certain idea of how such care comes about, a kind of theory of good surgery. Good surgery, we have surmised, has three components: (1) technical skill, (2) safe judgment, and (3) high moral performance (meaning conscientiousness and dedication) [5]. Surgical residency and surgical culture have evolved with precisely this thinking in mind. For the sake of good patient care, we seek to ensure that surgeons have all three characteristics. But many of you here are already raising concerns about how well training does this. I will further suggest that our theory of good surgery may not be entirely right, that good surgery may rest on other, less-recognized dimensions.

The dominant concern here at this conference follows from the relatively unstructured nature of training in surgery, and speaking only from my narrow inside view, the concern seems appropriate. Residency still largely relies on the wonderful, time-honored, throat-constricting method of learning-by-doing on-the-job training, as it were. It has worked for decades. But as many of you here have helped to show, its flaws are increasingly apparent.

First, the technical ability and judgment skills of senior surgical residents remains highly variable and largely unmeasured, whether one speaks of handling tissues and instruments, doing laparoscopy, or selecting patients for surgery [6]. And with the advent of laparoscopy and other minimally invasive technologies, skills are becoming more complex, not less [7].

Second, the typical general surgery resident finishes training without a complete set of skills in general surgery

[8]. We have, for example, little or no experience in esophagectomy, liver resection, gastric surgery, or laparoscopic operations more difficult than a cholecystectomy.

Third, the opportunity for learning in the operating room is shrinking. Pressure on time and cost are the main reasons. I also find that the acuity of the hospital floor patients we manage diverts our focus and opportunity for practice. Learning naturally takes second place to patient needs.

At the same time, the evidence that well-designed, formal training programs for development of skills and judgment can do better is growing. In a series of studies, Dr. Reznick's group in Toronto has demonstrated the feasibility in a residency of bench and wet laboratory training in essential technical skills and the transferability of improvements to performance in a human cadaver model [9,10]. Likewise, the Rossers at Yale have shown that concentrated didactic training in laparoscopy can improve skills in both residents and established surgeons [7]. Anesthesiologists have also pioneered the use of operating room simulators to improve crisis management skills [11]. But these approaches have yet to penetrate widely.

It seems clear that we are not taking advantage of what we know about how people acquire top level skills. Malcolm Gladwell [12], a *New Yorker* writer, recently wrote an article on “The Physical Genius” about Wayne Gretzky, Yo Yo Ma, and the UCSF neurosurgeon Charlie Wilson. Culling the scientific literature on performance, he found that success depended on three factors.

One was individual ability. This was not simply hand-eye coordination, speed, or any other physical attribute. It was as much, if not more, what he called, “a practical-minded obsession with the possibility and consequences of failure.” As coaches, maestros, and surgical attendings know, this is hard to cultivate. Either you have it or you don't. The sociologist Charles Bosk [13] interviewed neurosurgical residents who had resigned or been fired and found that they believed they hardly ever made mistakes. Successful residents, on the other hand, mulled over their mistakes routinely. When selecting residents, we are still unable to ferret out such differences [14].

Another requirement for success was practice, practice, practice. And there were critical aspects to successful practice. It involved repetitive performance of specific tasks, rather than general training in a changing variety of tasks. It involved breaking down complex procedures into component parts to be learned. And it involved immediate feedback on performance with early opportunities to try and try again. Only focused, repetitive practice resulted in high-level performance. Yet that is precisely what we do not often provide in surgical training [6]. Until the chief year in residency, the variety of services and procedures a resident participates in changes too frequently to allow one to try and try again.

Greatness

There was yet another characteristic that scholars recognized in the very highest level performers—one we talk less about: imagination. The ability to improvise, to cope skillfully with novel situations, requires vision, which takes years to develop. In his article, Gladwell describes one beautiful moment when Wayne Gretzky, in a 1981 game against the St. Louis Blues, stood behind the St. Louis goal with the puck at his feet, the opposition at all sides. He seemed hemmed in. Suddenly he lifted the puck onto the blade of his stick and bounced it off the back of the goalie in front of him into the net for a goal. *That* is vision—he saw a possibility where others saw none—and whether it's hockey or surgery, developing such vision takes not just experience but a certain orientation of mind. You have to reach the point that you can see the thing—the operative field in surgery—whole and see the possibility for artistry. It takes, in essence, a love of the game, a fulfillment from it.

We tend to assume that residents have this love of surgery. But the affinity can be killed and, if this happens, it has terrible consequences for the quality of future surgeons. I think this is not well recognized. I also think precisely this is happening.

My father is a surgeon and like many surgeons of his generation he speaks of residency as one of the high points of his life. You do not hear residents or recent graduates speak this way of surgical training. Today, residency is merely endured. I hear a great and dangerous bitterness between the generations on this point. I hear fellow residents complain about the hours and treatment as mere work-horses. And I hear more and more attending surgeons, even senior residents, lament that residents “are not as dedicated as they used to be.” There are reasonable arguments on both sides. On the one hand, pay and call schedules are far better than they were. On the other hand, the acuity of patients is greater and residents are often older than they were, with their families already started.

But I think these arguments are beside the point. What made my father's residency so wonderful was that there was camaraderie and a great sense of purpose. And the reason comes back to my original distinction between a doctor and a technician. He spoke to the patients and their families in advance of surgery, came to have a sense of what was at stake, often even decided whether and what surgery would be done. He could not help but feel personally invested throughout their course. He was the doctor, not a technician, and he knew that meant something important.

Today I meet patients briefly, to sign forms in pre-op hold, if at all before surgery. I rarely make major decisions about the surgery. Afterwards, they wake up groggy, delirious, irritable. And after a day or two or five, when they've really begun to come to, I write the scripts and they are gone. My experience is a technician's experience. Perhaps 35 years apart, my father and I might have done the very same colectomy, but if I am doing something important, the

sense is far more abstract for me than it was for him. We can fix the hours all we want, but unless we find a way to revive the relationship between resident and patient, and thus the dedication and purpose that fuel imagination, then the quality will not be what it was, let alone what we want it to be.

Individuals and systems in surgery

So when we step back and judge residency programs against our theory of good surgery—that is, in terms of producing surgeons of proficient skill, safe judgment, and high moral performance—we see possibilities for doing better. What's more, there is now a substantial body of evidence suggesting our theory, and therefore our training, may be too narrow. Good surgery appears to be far more complicated than we've assumed.

Starting with Hal Luft and Alain Enthoven's landmark 1979 paper [15] published in the *New England Journal of Medicine*, it has been widely observed that surgical outcomes improve with hospital volume in a broad variety of operations. This is seen with cardiac bypass surgery [16,17], biliary tract surgery [15], total hip replacements [17], abdominal aortic aneurysm repair [18], and so on. For many years, based on our traditional theory of good surgery, the assumption was that this volume effect simply reflected the greater experience of surgeons at high-volume hospitals. But over time it has become apparent that this is commonly not the case. Studies that looked at both hospital volume and the volumes of individual surgeons found that often only the hospital volume mattered. For example, in pancreatic surgery [19], AAA repair [20], colon resection [20], and child delivery [21], favorable outcomes independently correlated with hospital, but not surgeon, experience. Differences among systems mattered while differences among individuals did not.

This is apparently not always the case. For some operations, both hospital and surgeon seemed to matter—for example, in adult cardiac surgery [22] pediatric cardiac surgery [23], carotid endarterectomy [24] and partial gastrectomies [22]. At a low volume hospital, higher volume cardiac surgeons or gastric surgeons did significantly better than lower volume ones. But high volume surgeons at high volume hospitals did best. In yet other operations, only the surgeon's experience counted. In thyroid surgery [25] and rectal surgery [26] when studies considered both hospital volume and the surgeons' individual volumes, it was exclusively the surgeon's experience that mattered.

So how are we to put all this seemingly contradictory evidence together? There may be a straightforward and logical interpretation. And if it is right, it has important implications for how we train good surgeons.

The evidence seems to reveal few circumstances in which only the surgeon's experience matters. One sees it with thyroid and rectal surgery, but these are unusual in that they involve high technical complexity yet relatively un-

complicated patient management. The bulk of the risk of avoidable complications in such cases rests directly in the surgeon's hands. Ophthalmological procedures might be thought of as the paradigm example. In most cases, however, the surgeon and the team both have a wide margin for error (as with hernia repair or appendectomy) or else success requires high level team performance in the perioperative period (as with cardiac surgery, AAA repair, pancreatic surgery, and so on). When avoidable complications occur, it is usually because of malfunctions occurring along the whole system of care—not because of an individual surgeon's poor performance.

There is evidence for the vital importance of what we might call "system competence" in surgery. For example, Shukhri Khuri, the cardiac surgeon directing the VA's National Surgical Risk Study, led a team to visit the 10 VA hospitals with the highest surgical complication rates and the 10 with the lowest [27]. What he found was not differences in the training or experience of the surgeons but rather in the performance of the care systems. The key difference was in communications—whether there were regular meetings and good relations among nursing, medical, and surgical staffs involved in care, whether clear protocols were in use, and so on. Overall, the evidence is still fragmentary, but as surgery has become more complex, the central role of the performance of the system—meaning the teams, the technology, the infrastructure—has become increasingly obvious. There is reason to believe that advancement in system performance represents the next great frontier in advancing outcomes for surgical patients.

Yet training still proceeds as if outcomes were entirely within the surgeon's hands. It may be that this is what we want. If we are training technicians, perhaps it is okay if a surgeon only takes responsibility for what he or she directly does. But if we are not, if instead we want to train surgeons who take responsibility for providing patients with the best possible surgical care, then training needs to change in surprising ways. For it requires that surgeons learn not just how to operate but how to create good working systems of care.

A few residency programs have begun to recognize the increasing importance of leadership and administrative skills in surgery. But they have tended to see these skills as valuable only for a limited few on an alternative career path, rather than an integral part of surgery training for all. The usual approach is to let an occasional resident get an MBA during research time the same way one might let another work in an x-ray crystallography laboratory. Instead we ought to consider creating a routine rotation for all with genuine, graduated responsibility in administration—overseeing protocols and operations, establishing and maintaining databases on surgical performance, developing new initiatives to reduce error and improve outcomes. These aspects of system competence are critical parts of good surgery. If we are not to become mere technicians, we need to learn to deal with them and deal with them well.

Conclusion

I have outlined a tall order. Some may find it depressing, I suppose. It isn't surgery as it used to be. But no matter what we do, surgery won't be what it used to be. So in the future, the ideal training of surgeons, instead of surgical technicians, may involve several difficult tasks:

- Agreeing on what we will consider surgical disease—what we want within the realm of the surgeon.
- Refocusing training on acquiring the full range of skills needed to care for those diseases, perhaps even creating tracks for different areas of expertise.
- Establishing formalized training for the technical and judgment skills required.
- Restoring the place of residents in the full continuity of care.
- Teaching residents to have the systems management and leadership skills that will be key to future surgical progress.

This may seem a miscellany of topics in surgical education. But I have a core concern as we proceed into the unknown and ever-changing future. And that is that we understand who we are. We are doctors, not technicians. We must educate ourselves accordingly.

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