may be made of these pages soaked in water and driveway salt from Ace Hardware. (Most health-insurance plans may or may not cover the cost of the salt, excluding delivery.)

Other large drug manufacturers, while not willing to go quite as far, still substantially follow the Flammia Brothers' program. The fact that life is beyond us has been firmly established by now. All the information is in, and no real dispute remains. But with the temporary absence of lasting remedies, and looking to a future when they won't be necessary, the manufacturers' consortium suggests that consumers send them money in cash or check, no questions asked. Major health organizations have unanimously endorsed this goal. Originally, the consortium explained that the companies might need the money to develop a new generation of drugs narrowly focused on curing many previously uncured problems. More recently, however, they have backed off of that.

Why we were brought into the world in the first place only to suffer and die is an area of research in which much remains to be done. Like other problems thought impossible in the past, this one, too, will someday be solved. Then anybody afflicted with questions like "Why me?,” "What did I do to deserve this?,” "How did I get in this lousy mess?,” and so on could be given a prescription, maybe even through diagnostic services provided online. The possibilities are exciting. At the same time, we must not underestimate our adversary, life itself. Uncomfortable even at good moments, difficult and unfair usually, and a complete nightmare much too often, life will stubbornly resist betterment, always finding new ways of being more than we can stand.

**ATUL GAWANDE**

**The Learning Curve**

FROM THE NEW YORKER

The patient needed a central line. "Here's your chance," S., the chief resident, said. I had never done one before. "Get set up and then page me when you're ready to start."

It was my fourth week in surgical training. The pockets of my short white coat bulged with patient printouts, laminated cards with instructions for doing CPR and reading EKGs and using the dictation system, two surgical handbooks, a stethoscope, wound-dressing supplies, meal tickets, a penlight, scissors, and about a dollar in loose change. As I headed up the stairs to the patient's floor, I rattled.

This will be good, I tried to tell myself: my first real procedure. The patient — fiftyish, stout, taciturn — was recovering from abdominal surgery he'd had about a week earlier. His bowel function hadn't yet returned, and he was unable to eat. I explained to him that he needed intravenous nutrition and that this required a "special line" that would go into his chest. I said that I would put the line in him while he was in his bed, and that it would involve my numbing a spot on his chest with a local anesthetic, and then threading the line in. I did not say that the line was eight inches long and would go into his vena cava, the main blood vessel to his heart. Nor did I say how tricky the procedure could be. There were "slight risks" involved, I said, such as bleeding and lung collapse; in experienced hands, complications of this sort occur in fewer than one case in a hundred.

But, of course, mine were not experienced hands. And the disasters I knew about weighed on my mind: the woman who had died
within minutes from massive bleeding when a resident lacerated her vena cava, the man whose chest had to be opened because a resident lost hold of a wire inside the line, which then floated down to the patient's heart; the man who had a cardiac arrest when the procedure put him into ventricular fibrillation. I said nothing of such things, naturally, when I asked the patient's permission to do his line. He said, "OK."

I had seen S. do two central lines; one was the day before, and I'd attended to every step. I watched how she set out her instruments and laid her patient down and put a rolled towel between his shoulder blades to make his chest arch out. I watched how she swabbed his chest with antiseptic, injected lidocaine, which is a local anesthetic, and then, in full sterile garb, punctured his chest near his clavicle with a fat three-inch needle on a syringe. The patient hadn't even flinched. She told me how to avoid hitting the lung ("Go in at a steep angle," she'd said. "Stay right under the clavicle"), and how to find the subclavian vein, a branch to the vena cava lying atop the lung near its apex ("Go in at a steep angle. Stay right under the clavicle"). She pushed the needle in almost all the way. She drew back on the syringe. And she was in. You knew because the syringe filled with maroon blood. ("If it's bright red, you've hit an artery," she said. "That's not good.") Once you have the tip of this needle poking in the vein, you somehow have to widen the hole in the vein wall, fit the catheter in, and snake it in the right direction — down to the heart, rather than up to the brain — all without tearing through vessels, lung, or anything else.

To do this, S. explained, you start by getting a guide wire in place. She pulled the syringe off, leaving the needle in. Blood flowed out. She picked up a two-foot-long twenty-gauge wire that looked like the steel D string of an electric guitar, and passed nearly its full length through the needle's bore, into the vein, and onward toward the vena cava. "Never force it in," she warned, "and never, ever let go of it." A string of rapid heartbeats fired off on the cardiac monitor, and she quickly pulled the wire back an inch. It had poked into the heart, causing momentary fibrillation. "Guess we're in the right place," she said to me quietly. Then to the patient: "You're doing great. Only a few minutes now." She pulled the needle out over the wire and replaced it with a bullet of thick, stiff plastic, which she pushed in tight to widen the vein opening. She

then removed this dilator and threaded the central line — a spaghetti-thick, flexible yellow plastic tube — over the wire until it was all the way in. Now she could remove the wire. She flushed the line with a heparin solution and sutured it to the patient's chest. And that was it.

Today, it was my turn to try. First, I had to gather supplies — a central-line kit, gloves, gown, cap, mask, lidocaine — which took me forever. When I finally had the stuff together, I stopped for a minute outside the patient's door, trying to recall the steps. They remained frustratingly hazy. But I couldn't put it off any longer. I had a page-long list of other things to get done: Mrs. A needed to be discharged; Mr. B needed an abdominal ultrasound arranged; Mrs. C needed her skin staples removed. And every fifteen minutes or so I was getting paged with more tasks: Mr. X was nauseated and needed to be seen; Miss Y's family was here and needed "someone" to talk to them; Mr. Z needed a laxative. I took a deep breath, put on my best don't-worry-I-know-what-I'm-doing look, and went in.

I placed the supplies on a bedside table, undid the patient's gown, and laid him down flat on the mattress, with his chest bare and his arms at his sides. I flipped on a fluorescent overhead light and raised his bed to my height. I paged S. I put on my gown and gloves and, on a sterile tray, laid out the central line, the guide wire, and other materials from the kit. I drew up five cc's of lidocaine in a syringe, soaked two sponge sticks in the yellow-brown Betadine, and opened up the suture packaging.

S. arrived. "What's his platelet count?"

My stomach knotted. I hadn't checked. That was bad: too low and he could have a serious bleed from the procedure. She went to check a computer. The count was acceptable.

Chastened, I started swabbing his chest with the sponge sticks. "Got the shoulder roll underneath him?" S. asked. Well, no, I had forgotten that, too. The patient gave me a look. S., saying nothing, got a towel, rolled it up, and slipped it under his back for me. I finished applying the antiseptic and then draped him so that only his right upper chest was exposed. He squirmed a bit beneath the drapes. S. now inspected my tray. I girded myself.

"Where's the extra syringe for flushing the line when it's in?" Damn. She went out and got it.

I felt for my landmarks. Here? I asked with my eyes, not wanting
to undermine the patient’s confidence any further. She nodded. I numbed the spot with lidocaine. (“You’ll feel a stick and a burn now, sir.”) Next, I took the three-inch needle in hand and poked it through the skin. I advanced it slowly and uncertainly, a few millimeters at a time. This is a goddamn needle, I kept thinking. I couldn’t believe I was sticking it into someone’s chest. I concentrated on maintaining a steep angle of entry, but kept spearing his clavicle instead of slipping beneath it.

“Ow!” he shouted.

“Sorry,” I said. S. signaled with a kind of surging hand gesture to go underneath the clavicle. This time, it went in. I drew back on the syringe. Nothing. She pointed deeper. I went in deeper. Nothing. I withdrew the needle, flushed out some bits of tissue clogging it, and tried again.

“Ow!”

Too steep again. I found my way underneath the clavicle once more. I drew the syringe back. Still nothing. He’s too obese, I thought. S. slipped on gloves and a gown. “How about I have a look?” she said. I handed her the needle and stepped aside. She plunged the needle in, drew back on the syringe, and, just like that, she was in. “We’ll be done shortly,” she told the patient.

She let me continue with the next steps, which I bumbled through. I didn’t realize how long and floppy the guide wire was until I pulled the coil out of its plastic sleeve, and, putting one end of it into the patient, I very nearly contaminated the other. I forgot about the dilating step until she reminded me. Then, when I put in the dilator, I didn’t push quite hard enough, and it was really S. who pushed it all the way in. Finally, we got the line in, flushed it, and sutured it in place.

Outside the room, S. said that I could be less tentative the next time, but that I shouldn’t worry too much about how things had gone. “You’ll get it,” she said. “It just takes practice.” I wasn’t so sure. The procedure remained wholly mysterious to me. And I could not get over the idea of jabbing a needle into someone’s chest so deeply and so blindly. I awaited the X-ray afterward with trepidation. But it came back fine: I had not injured the lung and the line was in the right place.

Not everyone appreciates the attractions of surgery. When you are a medical student in the operating room for the first time, and you see the surgeon press the scalpel to someone’s body and open it like a piece of fruit, you either shudder in horror or gape in awe. I gaped. It was not just the blood and guts that entrapped me. It was also the idea that a person, a mere mortal, would have the confidence to wield that scalpel in the first place.

There is a saying about surgeons: “Sometimes wrong; never in doubt.” This is meant as a reproach, but to me it seemed their strength. Every day, surgeons are faced with uncertainties. Information is inadequate; the science is ambiguous; one’s knowledge and abilities are never perfect. Even with the simplest operation, it cannot be taken for granted that a patient will come through better off—or even alive. Standing at the operating table, I wondered how the surgeon knew that all the steps would go as planned, that bleeding would be controlled and infection would not set in and organs would not be injured. He didn’t, of course. But he cut anyway.

Later, while still a student, I was allowed to make an incision myself. The surgeon drew a six-inch dotted line with a marking pen across an anesthetized patient’s abdomen and then, to my surprise, had the nurse hand me the knife. It was still warm from the autoclave. The surgeon had me stretch the skin taut with the thumb and forefinger of my free hand. He told me to make one smooth slice down to the fat. I put the belly of the blade to the skin and cut. The experience was odd and addictive, mixing exhilaration from the calculated violence of the act, anxiety about getting it right, and a righteous faith that it was somehow for the person’s good. There was also the slightly nauseating feeling of finding that it took more force than I’d realized. (Skin is thick and springy, and on my first pass I did not go nearly deep enough; I had to cut twice to get through.) The moment made me want to be a surgeon—not an amateur handed the knife for a brief moment but someone with the confidence and ability to proceed as if it were routine.

A resident begins, however, with none of this air of mastery—only an overpowering instinct against doing anything like pressing a knife against flesh or jabbing a needle into someone’s chest. On my first day as a surgical resident, I was assigned to the emergency room. Among my first patients was a skinny, dark-haired woman in her late twenties who hobbled in, teeth gritted, with a two-foot-long wooden chair leg somehow nailed to the bottom of her foot. She explained that a kitchen chair had collapsed under her and, as
she leaped up to keep from falling, her bare foot had stomped down on a three-inch screw sticking out of one of the chair legs. I tried very hard to look like someone who had not got his medical diploma just the week before. Instead, I was determined to be nonchalant, the kind of guy who had seen this sort of thing a hundred times before. I inspected her foot, and could see that the screw was embedded in the bone at the base of her big toe. There was no bleeding and, as far as I could feel, no fracture.

"Wow, that must hurt," I blurted out idiotically.

The obvious thing to do was give her a tetanus shot and pull out the screw. I ordered the tetanus shot, but I began to have doubts about pulling out the screw. Suppose she bled? Or suppose I fractured her foot? Or something worse? I excused myself and tracked down Dr. W., the senior surgeon on duty. I found him tending to a car-crash victim. The patient was a mess, and the floor was covered with blood. People were shouting. It was not a good time to ask questions.

I ordered an X-ray. I figured it would buy time and let me check my amateur impression that she didn’t have a fracture. Sure enough, getting the X-ray took about an hour, and it showed no fracture — just a common screw embedded, the radiologist said, "in the head of the first metatarsal." I showed the patient the X-ray. "You see, the screw's embedded in the head of the first metatarsal," I said. And the plan? she wanted to know. Ah, yes, the plan.

I went to find Dr. W. He was still busy with the crash victim, but I was able to interrupt to show him the X-ray. He chuckled at the sight of it and asked me what I wanted to do. "Pull the screw out?" I ventured. "Yes," he said, by which he meant "Duh." He made sure I'd given the patient a tetanus shot and then showed me away.

Back in the examining room, I told her that I would pull the screw out, prepared for her to say something like "You?" Instead she said, "OK, Doctor." At first, I had her sitting on the exam table, dangling her leg off the side. But that didn’t look as if it would work. Eventually, I had her lie with her foot jutting off the table end, the board poking out into the air. With every move, her pain increased. I injected a local anesthetic where the screw had gone in and that helped a little. Now I grabbed her foot in one hand, the board in the other, and for a moment I froze. Could I really do this? Who was I to presume?

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Finally, I gave her a one-two-three and pulled, gingerly at first and then hard. She groaned. The screw wasn’t budging. I twisted, and abruptly it came free. There was no bleeding. I washed the wound out, and she found she could walk. I warned her of the risks of infection and the signs to look for. Her gratitude was immense and flattering, like the lion’s for the mouse — and that night I went home elated.

In surgery, as in anything else, skill, judgment, and confidence are learned through experience, haltingly and humilitatingly. Like the tennis player and the oboist and the guy who fixes hard drives, we need practice to get good at what we do. There is one difference in medicine, though: we practice on people.

My second try at placing a central IV line went no better than the first. The patient was in intensive care, mortally ill, on a ventilator, and needed the line so that powerful cardiac drugs could be delivered directly to her heart. She was also heavily sedated, and for this I was grateful. She’d be oblivious of my fumbling.

My preparation was better this time. I got the towel roll in place and the syringes of heparin on the tray. I checked her lab results, which were fine. I also made a point of draping more widely, so that if I flopped the guide wire around by mistake again, it wouldn’t hit anything unsterile.

For all that, the procedure was a bust. I stabbed the needle in too shallow and then too deep. Frustration overcame tentativeness and I tried one angle after another. Nothing worked. Then, for one brief moment, I got a flash of blood in the syringe, indicating that I was in the vein. I anchored the needle with one hand and went to pull the syringe off with the other. But the syringe was jammed on too tightly, so that when I pulled it free I dislodged the needle from the vein. The patient began bleeding into her chest wall. I held pressure the best I could for a solid five minutes, but still her chest turned black and blue around the site. The hematoma made it impossible to put a line through there anymore. I wanted to give up. But she needed a line and the resident supervising me — a second-year this time — was determined that I succeed. After an X-ray showed that I had not injured her lung, he had me try on the other side, with a whole new kit. I missed again, and he took over. It took him several minutes and two or three
sticks to find the vein himself, and that made me feel better. Maybe she was an unusually tough case.

When I failed with a third patient a few days later, though, the doubts really set in. Again, it was stick, stick, stick, and nothing. I stepped aside. The resident watching me got it on the next try.

Surgeons, as a group, adhere to a curious egalitarianism. They believe in practice, not talent. People often assume that you have to have great hands to become a surgeon, but it's not true. When I interviewed to get into surgery programs, no one made me sew or take a dexterity test or checked to see if my hands were steady. You do not even need all ten fingers to be accepted. To be sure, talent helps. Professors say that every two or three years they’ll see someone truly gifted come through a program — someone who picks up complex manual skills unusually quickly, sees tissue planes before others do, anticipates trouble before it happens. Nonetheless, attending surgeons say that what's most important to them is finding people who are conscientious, industrious, and boneheaded enough to keep at practicing this one difficult thing day and night for years on end. As a former residency director put it to me, given a choice between a Ph.D. who had cloned a gene and a sculptor, he'd pick the Ph.D. every time. Sure, he said, he'd bet on the sculptor's being more physically talented; but he'd bet on the Ph.D.'s being less "flaky." And in the end that matters more. Skill, surgeons believe, can be taught; tenacity cannot. It's an odd approach to recruitment, but it continues all the way up the ranks, even in top surgery departments. They start with minions with no experience in surgery, spend years training them, and then take most of their faculty from these same homegrown ranks.

And it works. There have been many studies of elite performers — concert violinists, chess grand masters, professional ice skaters, mathematicians, and so forth — and the biggest difference researchers find between them and lesser performers is the amount of deliberate practice they've accumulated. Indeed, the most important talent may be the talent for practice itself. K. Anders Ericsson, a cognitive psychologist and an expert on performance, notes that the most important role that innate factors play may be in a person's willingness to engage in sustained training. He has found, for example, that top performers dislike practicing just as much as others do. (That's why, for example, athletes and musicians usually quit practicing when they retire.) But, more than others, they have the will to keep at it anyway.

I wasn't sure I did. What good was it, I wondered, to keep doing central lines when I wasn't coming close to hitting them? If I had a clear idea of what I was doing wrong, then maybe I'd have something to focus on. But I didn't. Everyone, of course, had suggestions. Go in with the bevel of the needle up. No, go in with the bevel down. Put a bend in the middle of the needle. No, curve the needle. For a while, I tried to avoid doing another line. Soon enough, however, a new case arose.

The circumstances were miserable. It was late in the day, and I'd had to work through the previous night. The patient weighed more than three hundred pounds. He couldn't tolerate lying flat, because the weight of his chest and abdomen made it hard for him to breathe. Yet he had a badly infected wound, needed intravenous antibiotics, and no one could find veins in his arms for a peripheral IV. I had little hope of succeeding. But a resident does what he is told, and I was told to try the line.

I went to his room. He looked scared and said he didn't think he'd last more than a minute on his back. But he said he understood the situation and was willing to make his best effort. He and I decided that he'd be left sitting propped up in bed until the last possible minute. We'd see how far we got after that.

I went through my preparations: checking his blood counts from the lab, putting out the kit, placing the towel roll, and so on. I swabbed and draped his chest while he was still sitting up. S., the chief resident, was watching me this time, and when everything was ready I had her tip him back, an oxygen mask on his face. His flesh rolled up his chest like a wave. I couldn't find his clavicle with my fingertips to line up the right point of entry. And already he was looking short of breath, his face red. I gave S. a "Do you want to take over?" look. Keep going, she signaled. I made a rough guess about where the right spot was, numbed it with lidocaine, and pushed the big needle in. For a second, I thought it wouldn't be long enough to reach through, but then I felt the tip slip underneath his clavicle. I pushed a little deeper and drew back on the syringe. Unbelievably, it filled with blood. I was in. I concentrated on
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I am in my seventh year of training, of which three years have been spent doing research. Only now has a simple slice through skin begun to seem like the mere start of a case. These days, I'm trying to learn how to fix an abdominal aortic aneurysm, remove a pancreatic cancer, open blocked carotid arteries. I am, I have found, neither gifted nor maladroit. With practice and more practice, I get the hang of it.

Doctors find it hard to talk about this with patients. The moral burden of practicing on people is always with us, but for the most part it is unspoken. Before each operation, I go over to the holding area in my scrubs and introduce myself to the patient. I do it the same way every time. "Hello, I'm Dr. Gawande. I'm one of the surgical residents, and I'll be assisting your surgeon." That is pretty much all I say on the subject. I extend my hand and smile. I ask the patient if everything is going OK so far. We chat. I answer questions. Very occasionally, patients are taken aback. "No resident is doing my surgery," they say. I try to be reassuring. "Not to worry — I just assist," I say. "The attending surgeon is always in charge."

None of this is exactly a lie. The attending is in charge, and a resident knows better than to forget that. Consider the operation I did recently to remove a seventy-five-year-old woman's colon cancer. The attending stood across from me from the start. And it was he, not I, who decided where to cut, how to position the opened abdomen, how to isolate the cancer, and how much colon to take.

Yet I'm the one who held the knife. I'm the one who stood on the operator's side of the table, and it was raised to my six-foot-plus height. I was there to help, yes, but I was there to practice, too. This was clear when it came time to reconnect the colon. There are two ways of putting the ends together — handsewing and stapling. Stapling is swifter and easier, but the attending suggested I handsew the ends — not because it was better for the patient but because I had had much less experience doing it. When it's performed correctly, the results are similar, but he needed to watch me like a hawk. My stitching was slow and imprecise. At one point, he caught me putting the stitches too far apart and made me go back and put extras in between so the connection would not leak. At another point, he found I wasn't taking deep enough bites of tissue with the needle to ensure a strong closure. "Turn your wrist more," he told me. "Like this?" I asked. "Uh, sort of," he said.

In medicine, there has long been a conflict between the impera-
tive to give patients the best possible care and the need to provide novices with experience. Residencies attempt to mitigate potential harm through supervision and graduated responsibility. And there is reason to think that patients actually benefit from teaching. Studies commonly find that teaching hospitals have better outcomes than nonteaching hospitals. Residents may be amateurs, but having them around checking on patients, asking questions, and keeping faculty on their toes seems to help. But there is still no avoiding those first few unsteady times a young physician tries to put in a central line, remove a breast cancer, or sew together two segments of colon. No matter how many protections are in place, on average these cases go less well with the novice than with someone experienced.

Doctors have no illusions about this. When an attending physician brings a sick family member in for surgery, people at the hospital think twice about letting trainees participate. Even when the attending insists that they participate as usual, the residents scrabbling in know that it will be far from a teaching case. And if a central line must be put in, a first-timer is certainly not going to do it. Conversely, the ward services and clinics where residents have the most responsibility are populated by the poor, the uninsured, the drunk, and the demented. Residents have few opportunities nowadays to operate independently, without the attending docs scrubbing in, but when we do — as we must before graduating and going out to operate on our own — it is generally with these, the humblest of patients.

And this is the uncomfortable truth about teaching. By traditional ethics and public insistence (not to mention court rulings), a patient’s right to the best care possible must trump the objective of training novices. We want perfection without practice. Yet everyone is harmed if no one is trained for the future. So learning is hidden behind drapes and anesthesia and the elisions of language. And the dilemma doesn’t apply just to residents, physicians in training. The process of learning goes on longer than most people know.

I grew up in the small Appalachian town of Athens, Ohio, where my parents are both doctors. My mother is a pediatrician and my father is a urologist. Long ago, my mother chose to practice part-time, which she could afford to do because my father’s practice became so busy and successful. He has now been at it for more than twenty-five years, and his office is cluttered with the evidence of this. There is an overflowing wall of medical files, gifts from patients displayed everywhere (books, paintings, ceramics with biblical sayings, hand-painted paperweights, blown glass, carved boxes, a figurine of a boy who, when you pull down his pants, pees on you), and, in an acrylic case behind his oak desk, a few dozen of the thousands of kidney stones he has removed.

Only now, as I get glimpses of the end of my training, have I begun to think hard about my father’s success. For most of my residency, I thought of surgery as a more or less fixed body of knowledge and skill which is acquired in training and perfected in practice. There was, I thought, a smooth, upward-sloping arc of proficiency at some rarefied set of tasks (for me, taking out gallbladders, colon cancers, bullets, and appendixes; for him, taking out kidney stones, testicular cancers, and swollen prostates). The arc would peak at, say, ten or fifteen years, plateau for a long time, and perhaps tail off a little in the final five years before retirement. The reality, however, turns out to be far messier. You do get good at certain things, my father tells me, but no sooner do you master something than you find that what you know is outmoded. New technologies and operations emerge to supplant the old, and the learning curve starts all over again. “Three quarters of what I do today I never learned in residency,” he says. On his own, fifty miles from his nearest colleague — let alone a doctor who could tell him anything like “You need to turn your wrist more” — he has had to learn to put in penile prostheses, to perform microsurgery, to reverse vasectomies, to do nerve-sparing prostatectomies, to implant artificial urinary sphincters. He’s had to learn to use shock-wave lithotripters, electrohydraulic lithotripters, and laser lithotripters (all instruments for breaking up kidney stones); to deploy Double J ureteral stents and Silicone Figure Four Coil stents and Retro-Inject Multi-Length stents (don’t even ask); and to maneuver fiberoptic ureteroscopes. All these technologies and techniques were introduced after he finished training. Some of the procedures built on skills he already had. Many did not.

This is the experience that all surgeons have. The pace of medical innovation has been unceasing, and surgeons have no choice
but to give the new thing a try. To fail to adopt new techniques would mean denying patients meaningful medical advances. Yet the perils of the learning curve are inescapable—no less in practice than in residency.

For the established surgeon, inevitably, the opportunities for learning are far less structured than for a resident. When an important new device or procedure comes along, as happens every year, surgeons start by taking a course about it—typically a day or two of lectures by some surgical grandees with a few film clips and step-by-step handouts. You take home a video to watch. Perhaps you pay a visit to observe a colleague perform the operation—my father often goes up to the Cleveland Clinic for this. But there’s not much by way of hands-on training. Unlike a resident, a visitor cannot scrub in on cases, and opportunities to practice on animals or cadavers are few and far between. (Britain, being Britain, actually bans surgeons from practicing on animals.) When the pulse-dye laser came out, the manufacturer set up a lab in Columbus where urologists from the area could gain experience. But when my father went there the main experience provided was destroying kidney stones in test tubes filled with a urinelike liquid and trying to penetrate the shell of an egg without hitting the membrane underneath. My surgery department recently bought a robotic surgery device—a staggeringly sophisticated $980,000 robot, with three arms, two wrists, and a camera, all millimeters in diameter, which, controlled from a console, allows a surgeon to do almost any operation with no hand tremor and with only tiny incisions. A team of two surgeons and two nurses flew out to the manufacturer’s headquarters, in Mountain View, California, for a full day of training on the machine. And they did get to practice on a pig and on a human cadaver. (The company apparently buys the cadavers from the city of San Francisco.) But even this was hardly thorough training. They learned enough to grasp the principles of using the robot, to start getting a feel for using it, and to understand how to plan an operation. That was about it. Sooner or later, you just have to go home and give the thing a try on someone.

Patients do eventually benefit—often enormously—but the first few patients may not, and may even be harmed. Consider the experience reported by the pediatric cardiac-surgery unit of the renowned Great Ormond Street Hospital in London, as detailed in the British Medical Journal last April. The doctors described their results from 925 consecutive operations between 1978 and 1998 on babies with a severe heart defect known as transposition of the great arteries. Such children are born with their heart’s outflow vessels transposed: the aorta emerges from the right side of the heart instead of the left, and the artery to the lungs emerges from the left instead of the right. As a result, blood coming in is pumped right back out to the body instead of first to the lungs, where it can be oxygenated. The babies died blue, fatigued, never knowing what it was to get enough breath. For years, it wasn’t technically feasible to switch the vessels to their proper positions. Instead, surgeons did something known as the Senning procedure: they created a passage inside the heart to let blood from the lungs cross backward to the right heart. The Senning procedure allowed children to live into adulthood. The weaker right heart, however, cannot sustain the body’s entire blood flow as long as the left. Eventually, these patients’ hearts failed, and although most survived to adulthood, few lived to old age.

By the 1980s, a series of technological advances made it possible to do a switch operation safely, and this became the favored procedure. In 1986, the Great Ormond Street surgeons made the changeover themselves, and their report shows that it was unquestionably an improvement. The annual death rate after a successful switch procedure was less than a quarter that of the Senning, resulting in a life expectancy of sixty-three years instead of forty-seven. But the price of learning to do it was appalling. In their first seventy switch operations, the doctors had a twenty-five percent surgical death rate, compared with just six percent with the Senning procedure. Eighteen babies died, more than twice the number during the entire Senning era. Only with time did they master it: in their next hundred switch operations, five babies died.

As patients, we want both expertise and progress; we don’t want to acknowledge that these are contradictory desires. In the words of one British public report, “There should be no learning curve as far as patient safety is concerned.” But this is entirely wishful thinking.

Recently, a group of Harvard Business School researchers who have made a specialty of studying learning curves in industry de-
cided to examine learning curves among surgeons instead of in semiconductor manufacture or airplane construction, or any of the usual fields their colleagues examine. They followed eighteen cardiac surgeons and their teams as they took on the new technique of minimally invasive cardiac surgery. This study, I was surprised to discover, is the first of its kind. Learning is ubiquitous in medicine, and yet no one had ever compared how well different teams actually do it.

The new heart operation — in which new technologies allow a surgeon to operate through a small incision between ribs instead of splitting the chest open down the middle — proved substantially more difficult than the conventional one. Because the incision is too small to admit the usual tubes and clamps for rerouting blood to the heart-bypass machine, surgeons had to learn a trickier method, which involved balloons and catheters placed through groin vessels. And the nurses, anesthesiologists, and perfusionists all had new roles to master. As you’d expect, everyone experienced a substantial learning curve. Whereas a fully proficient team takes three to six hours for such an operation, these teams took on average three times as long for their early cases. The researchers could not track complication rates in detail, but it would be foolish to imagine that they were not affected.

What’s more, the researchers found striking disparities in the speed with which different teams learned. All teams came from highly respected institutions with experience in adopting innovations and received the same three-day training session. Yet, in the course of fifty cases, some teams managed to halve their operating time while others improved hardly at all. Practice, it turned out, did not necessarily make perfect. The crucial variable was how the surgeons and their teams practiced.

Richard Bohner, the only physician among the Harvard researchers, made several visits to observe one of the quickest-learning teams and one of the slowest, and he was startled by the contrast. The surgeon on the fast-learning team was actually quite inexperienced compared with the one on the slow-learning team. But he made sure to pick team members with whom he had worked well before and to keep them together through the first fifteen cases before allowing any new members. He had the team go through a dry run before the first case, then deliberately scheduled six operations in the first week, so little would be forgotten in between. He convened the team before each case to discuss it in detail and afterward to debrief. He made sure results were tracked carefully. And Bohner noticed that the surgeon was not the stereotypical Napoleon with a knife. Unbidden, he told Bohner, “The surgeon needs to be willing to allow himself to become a partner [with the rest of the team] so he can accept input.” At the other hospital, by contrast, the surgeon chose his operating team almost randomly and did not keep it together. In the first seven cases, the team had different members every time, which is to say that it was no team at all. And the surgeon had no prebriefings, no debriefings, no tracking of ongoing results.

The Harvard Business School study offered some hopeful news. We can do things that have a dramatic effect on our rate of improvement — like being more deliberate about how we train, and about tracking progress, whether with students and residents or with senior surgeons and nurses. But the study’s other implications are less reassuring. No matter how accomplished, surgeons trying something new got worse before they got better, and the learning curve proved longer, and was affected by a far more complicated range of factors, than anyone had realized.

This, I suspect, is the reason for the physician’s dodge: the “I just assist” rap; the “We have a new procedure for this that you are perfect for” speech; the “You need a central line” without the “I am still learning how to do this.” Sometimes we do feel obliged to admit when we’re doing something for the first time, but even then we tend to quote the published complication rates of experienced surgeons. Do we ever tell patients that, because we are still new at something, their risks will inevitably be higher, and that they’d likely do better with doctors who are more experienced? Do we ever say that we need them to agree to it anyway? I’ve never seen it. Given the stakes, who in his right mind would agree to be practiced upon?

Many dispute this presumption. “Look, most people understand what it is to be a doctor,” a health policy expert insisted when I visited him in his office not long ago. “We have to stop lying to our patients. Can people take on choices for societal benefit?” He paused and then answered his question. “Yes,” he said firmly.

It would certainly be a graceful and happy solution. We’d ask patients — honestly, openly — and they’d say yes. Hard to imagine, though. I noticed on the expert’s desk a picture of his child, born
just a few months before, and a completely unfair question popped into my mind. “So did you let the resident deliver?” I asked.

There was silence for a moment. “No,” he admitted. “We didn’t even allow residents in the room.”

One reason I doubt whether we could sustain a system of medical training that depended on people saying “yes, you can practice on me” is that I myself have said no. When my eldest child, Walker, was eleven days old, he suddenly went into congestive heart failure from what proved to be a severe cardiac defect. His aorta was not transposed, but a long segment of it had failed to grow at all. My wife and I were beside ourselves with fear — his kidneys and liver began failing, too — but he made it to surgery, the repair was a success, and although his recovery was erratic, after two and a half weeks he was ready to come home.

We were by no means in the clear, however. He was born a healthy six pounds plus, but now, a month old, he weighed only five and would need strict monitoring to ensure that he gained weight. He was on two cardiac medications from which he would have to be weaned. And in the longer term, the doctors warned us, his repair would prove inadequate. As Walker grew, his aorta would require either dilation with a balloon or replacement by surgery. They could not say precisely when and how many such procedures would be necessary over the years. A pediatric cardiologist would have to follow him closely and decide.

Walker was about to be discharged, and we had not indicated who that cardiologist would be. In the hospital, he had been cared for by a full team of cardiologists, ranging from fellows in specialty training to attendings who had practiced for decades. The day before we took Walker home, one of the young fellows approached me, offering his card and suggesting a time to bring Walker to see him. Of those on the team, he had put in the most time caring for Walker. He saw Walker when we brought him in inexplicably short of breath, made the diagnosis, got Walker the drugs that stabilized him, coordinated with the surgeons, and came to see us twice a day to answer our questions. Moreover, I knew, this was how fellows always get their patients. Most families don’t know the subtle gradations among players, and after a team has saved their child’s life they take whatever appointment they’re handed.

The Learning Curve

But I knew the differences. “I’m afraid we’re thinking of seeing Dr. Newburger,” I said. She was the hospital’s associate cardiologist in chief and a published expert on conditions like Walker’s. The young physician looked crestfallen. It was nothing against him, I said. She just had more experience, that was all.

“You know, there is always an attending backing me up,” he said. I shook my head.

I knew this was not fair. My son had an unusual problem. The fellow needed the experience. As a resident, I of all people should have understood this. But I was not torn about the decision. This was my child. Given a choice, I will always choose the best care I can for him. How can anybody be expected to do otherwise? Certainly, the future of medicine should not rely on it.

In a sense, then, the physician’s dodge is inevitable. Learning must be stolen, taken as a land of bodily eminent domain. And it was, during Walker’s stay — on many occasions, now that I think back on it. A resident intubated him. A surgical trainee scrubbed in for his operation. The cardiology fellow put in one of his central lines. If I’d had the option to have someone more experienced, I would have taken it. But this was simply how the system worked — no such choices were offered — and so I went along.

The advantage of this coldhearted machinery is not merely that it gets the learning done. If learning is necessary but causes harm, then above all it ought to apply to everyone alike. Given a choice, people wriggle out, and such choices are not offered equally. They belong to the connected and the knowledgeable, to insiders over outsiders, to the doctor’s child but not the truck driver’s. If everyone cannot have a choice, maybe it is better if no one can.

It is 2 P.M. I am in the intensive-care unit. A nurse tells me Mr. G.’s central line has clotted off. Mr. G. has been in the hospital for more than a month now. He is in his late sixties, from South Boston, emaciated, exhausted, holding on by a thread — or a line, to be precise. He has several holes in his small bowel, and the bilious contents leak out onto his skin through two small reddened openings in the concavity of his abdomen. His only chance is to be fed by vein and wait for these fistulae to heal. He needs a new central line.

I could do it, I suppose. I am the experienced one now. But ex-
perience brings a new role: I am expected to teach the procedure instead. “See one, do one, teach one,” the saying goes, and it is only half in jest.

There is a junior resident on the service. She has done only one or two lines before. I tell her about Mr. G. I ask her if she is free to do a new line. She misinterprets this as a question. She says she still has patients to see and a case coming up later. Could I do the line? I tell her no. She is unable to hide a grimace. She is burdened, as I was burdened, and perhaps frightened, as I was frightened.

She begins to focus when I make her talk through the steps—a kind of dry run, I figure. She hits nearly all the steps, but forgets about checking the labs and about Mr. G.’s nasty allergy to heparin, which is in the flush for the line. I make sure she registers this, then tell her to get set up and page me.

I am still adjusting to this role. It is painful enough taking responsibility for one’s own failures. Being handmaiden to another’s is something else entirely. It occurs to me that I could have broken open a kit and had her do an actual dry run. Then again, maybe I can’t. The kits must cost a couple of hundred dollars each. I’ll have to find out for next time.

Half an hour later, I get the page. The patient is draped. The resident is in her gown and gloves. She tells me that she has saline to flush the line with and that his labs are fine.

“Have you got the towel roll?” I ask.

She forgot the towel roll. I roll up a towel and slip it beneath Mr. G.’s back. I ask him if he’s all right. He nods. After all he’s been through, there is only resignation in his eyes.

The junior resident picks out a spot for the stick. The patient is hauntingly thin. I see every rib and fear that the resident will puncture his lung. She injects the numbing medication. Then she puts the big needle in, and the angle looks all wrong. I motion for her to reposition. This only makes her more uncertain. She pushes in deeper and I know she does not have it. She draws back on the syringe: no blood. She takes out the needle and tries again. And again the angle looks wrong. This time, Mr. G. feels the jab and jerks up in pain. I hold his arm. She gives him more numbing medication. It is all I can do not to take over. But she cannot learn without doing, I tell myself. I decide to let her have one more try.

My daughter, Olivia, who just turned three, has an imaginary friend whose name is Charlie Ravioli. Olivia is growing up in Manhattan, and so Charlie Ravioli has a lot of local traits: he lives in an apartment “on Madison and Lexington,” he dines on grilled chicken, fruit, and water, and, having reached the age of seven and a half, he feels, or is thought, “old.” But the most peculiarly local thing about Olivia’s imaginary playmate is this: he is always too busy to play with her. She holds her toy cell phone up to her ear, and we hear her talk into it: “Ravioli? It’s Olivia . . . It’s Olivia. Come and play? OK. Call me. Bye.” Then she snaps it shut and shakes her head. “I always get his machine,” she says. Or she will say, “I spoke to Ravioli today.” “Did you have fun?” my wife and I ask. “No. He was busy working. On a television” (leaving it up in the air if he repairs electronic devices or has his own talk show).

On a good day, she “bumps into” her invisible friend and they go to a coffee shop. “I bumped into Charlie Ravioli,” she announces at dinner (after a day when, of course, she stayed home, played, had a nap, had lunch, paid a visit to the Central Park Zoo, and then had another nap). “We had coffee, but then he had to run.” She sighs, sometimes, at her inability to make their schedules mesh, but she accepts it as inevitable, just the way life is. “I bumped into Charlie Ravioli today,” she says. “He was working.” Then she adds brightly, “But we hopped into a taxi.” What happened then? we ask. “We grabbed lunch,” she says.

It seemed obvious that Ravioli was a romantic figure of the big exotic life that went on outside her little limited life of parks and