

THE SCORE

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How childbirth went industrial.

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At 5 A.M. on a cool Boston morning not long ago, Elizabeth Rourke—thick black-brown hair, pale Irish skin, and forty-one weeks pregnant—reached over and woke her husband, Chris.

“I’m having contractions,” she said.

“Are you sure?” he asked.

“I’m sure.”

She was a week past her due date, and the pain was deep and viselike, nothing like the occasional spasms she’d been feeling. It seemed to come out of her lower back and wrap around and seize her whole abdomen. The first spasm woke her out of a sound sleep. Then came a second. And a third.

She was carrying their first child. So far, the pregnancy had gone well, aside from the exhaustion and nausea of the first trimester, when all she felt like doing was lying on the couch watching “Law & Order” reruns (“I can’t look at Sam Waterston anymore without feeling kind of ill,” she says). An internist who had just finished her residency, she had landed a job at Massachusetts General Hospital a few months before and had managed to work until this day. Rourke and her husband sat up in bed, timing the contractions by the clock on the bedside table. They were seven minutes apart, and they stayed that way for a while.

Rourke called her obstetrician’s office at eight-thirty in the morning, when the phones were turned on, but she knew what the people there were going to say: Don’t come to the hospital until the contractions are five minutes apart and last at least a minute. “You take the childbirth class, and they drill it into you a million times,” she says. “The whole point of childbirth classes, as far as I could tell, is to make sure you keep your butt out of the hospital until you’re really in labor.”

The nurse asked if the contractions were five minutes apart and lasted more than a minute. No. Had she broken her water? No. Well, she had a “good start.” But she should wait to come in. During her medical training, Rourke had seen about fifty births and had delivered four babies herself. The last one she had seen was in a hospital parking lot.

“The father had called, saying, ‘We’re delivering! We’re coming to the hospital, and she’s delivering!’ ” Rourke says. “So we were in the E.R. and we went running. It was freezing cold. The car came screeching up to the hospital. The door went flying open. And, sure enough, there the mom was. We could see the baby’s head. The resident running next to me got there a second before I did, and he puts his arms down, and the baby went—phhoom—straight into his arms in the middle of the parking lot. It was freezing cold outside, and I’ll never forget the steam pouring off the baby. It’s blue and crying and the steam was pouring off of it. Then we put this tiny little baby on this enormous stretcher and raced it back into the hospital.”

Rourke didn’t want to deliver in a parking lot. She wanted a nice, normal vaginal delivery. She didn’t even want an epidural. “I didn’t want to be confined to bed,” she says. “I didn’t want to be dead from the waist down. I didn’t want a urinary catheter to have to be put in. Everything about the epidural was totally unappealing to me.” She was not afraid of the pain. Having seen how too many deliveries had gone, she was mainly afraid of losing her ability to control what was done to her.

She had considered hiring a doula—a birthing coach—to stay with her through delivery. There are studies showing that having a doula can lower the likelihood that a mother will end up with a Cesarean section or an epidural. The more she looked into it, however, the more worried she became about being paired with someone annoying. She thought about delivering with a midwife. But, as a doctor, she felt that she would actually have more control working with another doctor.

By midday, her contractions hadn't really speeded up; they were still coming every seven minutes, maybe every six at most. She was finding it increasingly difficult to get comfortable. "The way it felt best was, strangely enough, to be on all fours," she recalls. So she just hung around the house like that—on all fours during the contractions, her husband close by, both of them nervous and giddy about their baby being on the way.

Finally, at four-thirty in the afternoon, the contractions began coming five minutes apart, and they set off in their Jetta, with the infant car seat installed in the back. When they reached the hospital admissions desk, Rourke was ready. The baby was on the way, and she was eager to bring it into the world as nature had intended. "I wanted no intervention, no doctors, no drugs," she says. "I didn't want any of that stuff. In a perfect world, I wanted to have my baby in a forest bower attended by fairy sprites."

Human birth is an astonishing natural phenomenon. Carol Burnett once told Bill Cosby how he could understand what the experience was like. "Take your bottom lip," she said, "pull it as far away from your face as you can, and now pull it over your head." The process is a solution to an evolutionary problem: how a mammal can walk upright, which requires a small, fixed, bony pelvis, and also possess a large brain, which entails a baby whose head is too big to fit through that small pelvis. Part of the solution is that, in a sense, all human mothers give birth prematurely. Other mammals are born mature enough to walk and seek food within hours; our newborns are small and helpless for months. Even so, human birth is a feat involving an intricate sequence of events.

First, a mother's pelvis enlarges. Starting in the first trimester, maternal hormones allow the joints holding the four bones of the pelvis together to stretch and loosen. Almost an inch of space is added. Pregnant women sometimes feel the different parts of their pelvis moving when they walk.

Then, when it's time for delivery, the uterus changes. During gestation, it's a snug, rounded, hermetically sealed pouch; during labor it takes on the shape of a funnel. And each contraction pushes the baby's head down through that funnel, into the pelvis. This happens even in paraplegic women; the mother does not have to do anything.

Meanwhile, the cervix—which is, through pregnancy, a rigid, inch-thick cylinder of muscle and connective tissue capping the end of the funnel—softens and relaxes. Pressure from the baby's head gradually stretches the tissue until it is paper-thin—a process known as "effacement." A small circular opening appears, and each contraction widens it, like a tight shirt being pulled over a child's head. Until the contractions pull the cervix open about four inches, or ten centimetres—the diameter of the child's head—the child cannot get out. So the state of the cervix determines when birth will occur. At two or three centimetres of dilation, a mother is still in "early" labor. Delivery is many hours away. At between four and seven centimetres, the contractions grow stronger, and "active" labor has begun. At some point, the amniotic sac breaks under the pressure, and the clear fluid surrounding the fetus gushes out. Contractile force increases further.

At between seven and ten centimetres of cervical dilation, the "transition phase," contractions reach their greatest intensity. The contractions press the baby's head into the vagina and the narrowest part of the pelvis's bony ring. The pelvis is usually wider from side to side than front to back, so it's best if the baby emerges with the temples lined up side to side with the mother's pelvis. The top of the head comes into view. The mother has a mounting urge to push. The head comes out, then the shoulders, and suddenly a breathing, wailing child is born. The umbilical cord is cut. The placenta separates from the uterine lining, and, with a slight tug on the cord and a push from the mother, it is extruded. The uterus spontaneously contracts into a clenched ball of muscle, closing off its bleeding sinuses. Typically, the mother's breasts immediately let down colostrum, the first milk, and the newborn can latch on to feed.

That's if all goes well. At almost any step, though, the process can go wrong. For thousands of years, childbirth was the most common cause of death for young women and infants. There's the risk of hemorrhage. The placenta can tear, or separate, or a portion may remain stuck in the uterus after delivery and then bleed torrentially. Or the uterus may not contract after delivery, so that the raw surfaces and sinuses keep bleeding until the mother dies of blood loss. Sometimes the uterus ruptures during labor. Infection can set in. Once the water breaks, the chances that bacteria will get into the uterus rise with each passing hour. During the nineteenth century, people started to realize that doctors often spread bacteria, because they examined more infected patients than midwives did and failed to wash their contaminated hands. Bacteria routinely invaded and killed the fetus and, often, the mother with it. Puerperal fever was the leading cause of maternal death in the era before antibiotics. Even today, if a mother doesn't deliver within twenty-four hours after her water breaks, she has a forty-per-cent chance of becoming infected.

The most basic problem is "obstruction of labor"—not being able to get the baby out. The baby may be too big, especially when pregnancy continues beyond the fortieth week. The mother's pelvis may be too small, as was frequently the case when lack of vitamin D and calcium made rickets common. The baby might arrive at the birth canal sideways, with nothing but an arm sticking out. It could be a breech, coming butt first and getting stuck with its legs up on its chest. It could be a footling breech, coming feet first, but then

getting wedged at the chest with the arms above the head. It could come out head first but get stuck because the head is turned the wrong way. Sometimes the head makes it out, but the shoulders get stuck behind the pubic bone of the mother's pelvis.

These situations are dangerous. When a baby is stuck, the umbilical cord, the only source of fetal blood and oxygen, eventually becomes trapped or compressed, causing the baby to asphyxiate. Mothers have sometimes labored for astonishing lengths of time, unable to deliver, and died with their child in the process. In 1817, for example, Princess Charlotte of Wales, King George IV's twenty-one-year-old daughter, spent fifty hours in active labor with a nine-pound boy. His head was in a sideways position, and too large for Charlotte's pelvis. When he finally emerged, he was stillborn. Six hours later, Charlotte herself died, from hemorrhagic shock. She was King George's only legitimate child. The throne passed to his brother, and then to his niece—which is how Victoria became queen.

Midwives and doctors had long sought ways out of such disasters, and the history of obstetrics is the history of these efforts. The first reliably life-saving invention for mothers was called a *crochet*, or, in another variation, a *cranioclast*: a sharp-pointed instrument, often with clawlike hooks, which birth attendants used in desperate situations to perforate and crush a fetus's skull, extract the fetus, and save the mother's life.

Many obstetricians made their names by devising methods to get both mother and baby through an obstructed delivery. In the *Lovset* maneuver for a breech baby with its arms trapped above the head, you take the baby by the hips and turn it sideways, then reach in, take an upper arm, and sweep it down over the chest and out. If a breech baby's arms are out but the head is trapped, you have the *Mauriceau-Smellie-Veit* maneuver: you place your finger in the baby's mouth, which allows you to pull forcefully while still controlling the head.

The child with its head out but a shoulder stuck—a “*shoulder dystocia*”—will asphyxiate within five to seven minutes unless it is freed and delivered. Sometimes sharp downward pressure with a fist just above the mother's pubic bone can dislodge the shoulder; if not, there is the *Woods corkscrew* maneuver, in which you reach in, grab the baby's posterior shoulder, and push it backward to free the child. With the *Rubin* maneuver, you grab the anterior shoulder and push it forward toward the baby's chest; and with the *McRoberts* maneuver you sharply flex the mother's legs up onto her abdomen and so lift her pubic bone off the baby's shoulder. Finally, there is the maneuver that no one wanted to put his name to but that through history has saved many babies' lives: you fracture the clavicles—the collar bones—and pull the baby out.

There are dozens of these maneuvers, and, though they have saved the lives of countless babies, each has a high failure rate. Surgery has been known since ancient times as a way to save a trapped baby. Roman law in the seventh century B.C. forbade burial of an undelivered woman until the child had been cut out, in the hope that the child would survive. In 1614, Pope Paul V issued a similar edict, and ordered that the child be baptized if it was still alive. But Cesarean section on a living mother was considered criminal for much of history, because it almost always killed the mother—through hemorrhage and infection—and her life took precedence over that of the child. (The name “*Cesarean*” section may have arisen from the tale that Caesar was born of his mother, Aurelia, by an abdominal delivery, but historians regard the story as a myth, since Aurelia lived long after his birth.) Only after the development of anesthesia and antisepsis, in the nineteenth century, and, in the early twentieth century, of a double-layer suturing technique that could stop an opened uterus from hemorrhaging, did Cesarean section become a tenable option. Even then it was held in low repute. And that was because a better option was around: the obstetrical forceps.

The story of the forceps is both extraordinary and disturbing, because it is the story of a life-saving idea that was kept secret for more than a century. The instrument was developed in the seventeenth century by Peter Chamberlen (1560-1631), the first of a long line of French Huguenots who delivered babies in London. It looked like a pair of big metal salad tongs, with two blades shaped to fit snugly around a baby's head and handles that locked together with a single screw in the middle. It let doctors more or less yank stuck babies out and, carefully applied, was the first technique that could save both the baby and the mother. The Chamberlens knew that they were onto something, and they resolved to keep the device a family secret. Whenever they were called in to help a mother in obstructed labor, they ushered everyone else out of the room and covered the mother's lower half with a sheet or a blanket so that even she couldn't see what was going on. They kept the secret of the forceps for three generations. In 1670, Hugh Chamberlen, in the third generation, tried and failed to sell it to the French government. Late in his life, he divulged it to an Amsterdam-based surgeon, Roger van Roonhuysen, who kept the technique within his own family for sixty more years. The secret did not get out until the mid-eighteenth century. Once it did, it gained wide acceptance. At the time of Princess Charlotte's failed delivery, in 1817, her obstetrician, Sir Richard Croft, was widely reviled for failing to use forceps. He shot himself to death not long afterward.

By the early twentieth century, the problems of human birth seemed to have been largely solved. Doctors could avail themselves of a range of measures to insure a safe delivery: antiseptics, the forceps, blood transfusions, a drug (ergot) that could induce labor and contract the uterus after delivery to stop bleeding, and even, in desperate situations, Cesarean section. By the nineteen-thirties, most urban mothers had switched from midwife deliveries at home to physician deliveries in the hospital.

But in 1933 the New York Academy of Medicine published a shocking study of 2,041 maternal deaths in childbirth. At least two-thirds, the investigators found, were preventable. There had been no improvement in death rates for mothers in the preceding two decades; newborn deaths from birth injuries had actually increased. Hospital care brought no advantages; mothers were better off delivering at home. The investigators were appalled to find that many physicians simply didn't know what they were doing: they missed clear signs of hemorrhagic shock and other treatable conditions, violated basic antiseptic standards, tore and infected women with misapplied forceps. The White House followed with a similar national report. Doctors may have had the right tools, but midwives without them did better.

The two reports brought modern obstetrics to a turning point. Specialists in the field had shown extraordinary ingenuity. They had developed the knowledge and instrumentation to solve many problems of child delivery. Yet knowledge and instrumentation had proved grossly insufficient. If obstetrics wasn't to go the way of phrenology or trepanning, it had to come up with a different kind of ingenuity. It had to figure out how to standardize childbirth. And it did.

Three-quarters of a century later, the degree to which birth has been transformed by medicine is astounding and, for some, alarming. Today, electronic fetal-heart-rate monitoring is used in more than ninety per cent of deliveries; intravenous fluids in more than eighty per cent; epidural or spinal anesthesia in three-quarters; medicines to speed up labor (the drug of choice is no longer ergot but Pitocin, a synthetic form of the natural hormone that drives contractions) in half. Thirty per cent of American deliveries are now by Cesarean section, and that proportion continues to rise. Something has happened to the field of obstetrics—and, perhaps irreversibly, to childbirth itself.

An admitting clerk led Elizabeth Rourke and her husband into a small triage room. A nurse-midwife timed her contractions—they were indeed five minutes apart—and then did a pelvic examination to see how dilated Rourke was. After twelve hours of regular, painful contractions, Rourke figured that she might be at seven or eight centimetres. Instead, she was at two.

It was disheartening news: her labor was only just starting. The nurse-midwife thought about sending her home, but eventually decided to admit her to the labor floor, a horseshoe of twelve patient rooms strung around a nurses' station. For hospitals, deliveries are a good business. If mothers have a positive experience, they stay loyal to the hospital for years. So the rooms are made to seem as warm and inviting as possible. Each had recessed lighting, decorator window curtains, comfortable chairs for the family, individualized climate control. Rourke's even had a Jacuzzi. She spent the next several hours soaking in the tub, sitting on a rubber birthing ball, or walking the halls—stopping to brace herself with each contraction.

By ten-thirty that night, the contractions were coming every two minutes. The doctor on duty for her obstetrician's group performed a pelvic examination. Her cervix was still only two centimetres dilated: the labor had stalled.

The doctor gave her two options. She could have active labor induced with Pitocin. Or she could go home, rest, and wait for true labor to begin. Rourke did not like the idea of using the drug. So at midnight she and her husband went home.

No sooner was she home than she realized that she had made a mistake. The pain was too much. Chris had conked out on the bed, and she couldn't get through this on her own. She held out for two and a half more hours, just to avoid looking foolish, and then got Chris to drive her back. At 2:43 A.M., the nurse scanned her in again—she was still wearing her bar-coded hospital identification bracelet. The obstetrician reexamined her. Rourke was nearly four centimetres dilated. She had progressed to active labor.

But at this point she had been having regular contractions for twenty-two hours, and was exhausted from sleeplessness and pain. She tried a narcotic called Nubain to dull the pain, and when that didn't work she broke down and asked for an epidural. An anesthesiologist came in and had her sit on the side of the bed with her back to him. She felt a cold wet swipe of antiseptic along her spine, the pressure of a needle, and a twinge that shot down her leg; the epidural catheter was in. The doctor injected a bolus of local anesthetic into the Silastic tubing, and the pain of the contractions melted away into numbness. Then Rourke's blood pressure dropped—a known side effect of epidural injections. The team poured fluids into her intravenously and gave injections of ephedrine to increase her and her baby's blood pressure. It took fifteen minutes to stabilize her blood pressure. But the monitor showed that the baby's heart rate remained normal the whole time, about a hundred and fifty beats a minute. The team dispersed and finally, around 4 A.M., Rourke fell asleep.

At 6 A.M., the obstetrician returned and, to Rourke's dismay, found her still just four centimetres dilated. Her determination to avoid medical interventions ebbed further, and a Pitocin drip was started. The contractions surged. At 7:30 A.M., she was six centimetres dilated. Rourke was elated.

Dr. Alessandra Peccei took over with the new day, and looked at the whiteboard behind the nursing station where the hourly progress of each room is recorded. On a typical morning, a mother in one room might be pushing; in another, a mother might be having her labor induced with medication; in still another, a mother might be just waiting, her cervix only partially dilated and the baby still high. Rourke was a "G2P0 41.2 wks pit+ 6/100/-2" on the whiteboard—a mother with two gestations, zero born (Rourke had had a miscarriage), forty-one weeks and two days pregnant. She was on Pitocin. Her cervix was six centimetres dilated and a hundred per cent effaced. The baby was at negative-two station, which is about seven centimetres from crowning, that is, from becoming visible.

Peccei went into Rourke's room and introduced herself as the attending obstetrician. Peccei, who was forty-two years old and had delivered more than two thousand babies, projected a comforting combination of competence and friendliness. She had given birth to her own children with a midwife. Rourke felt that they understood one another. Peccei waited three hours to allow Rourke's labor to progress. At 10:30 A.M., she reexamined her, and frowned. The cervix was still six centimetres dilated. The baby had not come down any further. Peccei felt along the top of the baby's head for the soft spot in back to get a sense of which way it was facing, and found it facing sideways. The baby was stuck.

Sometimes increasing the strength of the contractions can turn the baby's head in the right direction and push it along. So, using a gloved finger, Peccei punctured the bulging membrane of Rourke's amniotic sac. The waters burst, and immediately the contractions picked up strength and speed, but the baby did not budge. Worse, its heart rate began to drop with each contraction—120, 100, 80 the monitor went, taking almost a minute before returning to normal. It's not always clear what dips like these mean. Malpractice lawyers like to say that they are a baby's "cry for help." In some cases, they are. An abnormal tracing can signal that a baby is getting an inadequate supply of oxygen or blood—the baby's cord may be wrapped around its neck or getting squeezed off altogether. But usually, even when the heart rate takes a prolonged dive, lasting well past the end of a contraction, the baby is fine. A drop in heart rate is often simply what happens when a baby's head is squeezed really hard.

Dr. Peccei couldn't be sure which was the case. She turned off the Pitocin drip, to reduce the strength of the contractions. She gave Rourke, and therefore the baby, extra oxygen by nasal prong. She scratched at the baby's scalp to irritate it and confirmed that the baby's heart rate responded. The heart rate continued to drop during contractions, but it never failed to recover. After twenty-five minutes, the decelerations disappeared. Now what? Rourke had been in labor for thirty hours, and her baby didn't seem to be going anywhere.

There are a hundred and thirty million births around the world each year, more than four million of them in the United States. No matter what is done, some percentage will end badly. All the same, physicians have long had an abiding faith that they could step in and at least reduce that percentage. When the national reports of the nineteen-thirties proved that obstetrics had failed to do so, and that incompetence was an important reason, the medical profession turned to a strategy of instituting strict regulations on individual practice. Training requirements were established for physicians delivering babies. Hospitals set firm rules about who could do deliveries, what steps they had to follow, and whether they would be permitted to use forceps and other risky interventions. Hospital and state authorities investigated maternal deaths for aberrations from basic standards.

These standards reduced the number of maternal deaths substantially. In the mid-thirties, delivering a child had been the single most dangerous event in a woman's life: one in a hundred and fifty pregnancies ended in the death of the mother. By the fifties, owing in part to the tighter standards, and in part to the discovery of penicillin and other antibiotics, the risk of death for a mother had fallen more than ninety per cent, to just one in two thousand.

But the situation wasn't so encouraging for newborns: one in thirty still died at birth—odds that were scarcely better than those of the century before—and it wasn't clear how that could be changed. Then a doctor named Virginia Apgar, who was working in New York, had an idea. It was a ridiculously simple idea, but it transformed obstetrics and the nature of childbirth. Apgar was an unlikely revolutionary for obstetrics. For starters, she had never delivered a baby—not as a doctor and not even as a mother.

Apgar was one of the first women to be admitted to the surgical residency at Columbia University College of Physicians and Surgeons, in 1933. The daughter of a Westfield, New Jersey, insurance executive, she was tall and would have been imposing if not for her horn-rimmed glasses and bobby-pinned hair. She had a combination of fearlessness, warmth, and natural enthusiasm that drew people to her. When anyone was having troubles, she would sit down and say, "Tell Momma all about it." At the same time, she was exacting about everything she did. She wasn't just a talented violinist; she also made her own instruments. She began flying single-

engine planes at the age of fifty-nine. When she was a resident, a patient she had operated on died after surgery. “Virginia worried and worried that she might have clamped a small but essential artery,” L. Stanley James, a colleague of hers, later recalled. “No autopsy permit could be obtained. So she secretly went to the morgue and opened the operative incision to find the cause. That small artery had been clamped. She immediately told the surgeon. She never tried to cover a mistake. She had to know the truth no matter what the cost.”

At the end of her surgical residency, her chairman told her that, however good she was, a female surgeon had little chance of attracting patients. He persuaded her to join Columbia’s faculty as an anesthesiologist, then a position of far lesser status. She threw herself into the job, and became the second woman in the country to be board-certified in anesthesiology. She established anesthesia as its own division at Columbia and, eventually, as its own department, on an equal footing with surgery. She administered anesthesia to more than twenty thousand patients during her career. She even carried a scalpel and a length of tubing in her purse, in case a passerby needed an emergency airway—and, apparently, employed them successfully more than a dozen times. “Do what is right and do it now,” she used to say.

Throughout her career, the work she loved most was providing anesthesia for child deliveries. But she was appalled by the poor care that many newborns received. Babies who were born malformed or too small or just blue and not breathing well were listed as stillborn, placed out of sight, and left to die. They were believed to be too sick to live. Apgar believed otherwise, but she had no authority to challenge the conventions. She was not an obstetrician, and she was a female in a male world. So she took a less direct, but ultimately more powerful, approach: she devised a score.

The Apgar score, as it became known universally, allowed nurses to rate the condition of babies at birth on a scale from zero to ten. An infant got two points if it was pink all over, two for crying, two for taking good, vigorous breaths, two for moving all four limbs, and two if its heart rate was over a hundred. Ten points meant a child born in perfect condition. Four points or less meant a blue, limp baby.

The score was published in 1953, and it transformed child delivery. It turned an intangible and impressionistic clinical concept—the condition of a newly born baby—into a number that people could collect and compare. Using it required observation and documentation of the true condition of every baby. Moreover, even if only because doctors are competitive, it drove them to want to produce better scores—and therefore better outcomes—for the newborns they delivered.

Around the world, virtually every child born in a hospital had an Apgar score recorded at one minute after birth and at five minutes after birth. It quickly became clear that a baby with a terrible Apgar score at one minute could often be resuscitated—with measures like oxygen and warming—to an excellent score at five minutes. Spinal and then epidural anesthesia were found to produce babies with better scores than general anesthesia. Neonatal intensive-care units sprang into existence. Prenatal ultrasound came into use to detect problems for deliveries in advance. Fetal heart monitors became standard. Over the years, hundreds of adjustments in care were made, resulting in what’s sometimes called “the obstetrics package.” And that package has produced dramatic results. In the United States today, a full-term baby dies in just one out of five hundred childbirths, and a mother dies in one in ten thousand. If the statistics of 1940 had persisted, fifteen thousand mothers would have died last year (instead of fewer than five hundred)—and a hundred and twenty thousand newborns (instead of one-sixth that number).

There’s a paradox here. Ask most research physicians how a profession can advance, and they will talk about the model of “evidence-based medicine”—the idea that nothing ought to be introduced into practice unless it has been properly tested and proved effective by research centers, preferably through a double-blind, randomized controlled trial. But, in a 1978 ranking of medical specialties according to their use of hard evidence from randomized clinical trials, obstetrics came in last. Obstetricians did few randomized trials, and when they did they ignored the results. Careful studies have found that fetal heart monitors provide no added benefit over having nurses simply listen to the baby’s heart rate hourly. In fact, their use seems to increase unnecessary Cesarean sections, because slight abnormalities in the tracings make everyone nervous about waiting for vaginal delivery. Nonetheless, they are used in nearly all hospital deliveries. Forceps have virtually disappeared from the delivery wards, even though several studies have compared forceps delivery to Cesarean section and found no advantage for Cesarean section. (A few found that mothers actually did better with forceps.)

Doctors in other fields have always looked down their masked noses on their obstetrical colleagues. Obstetricians used to have trouble attracting the top medical students to their specialty, and there seemed little science or sophistication to what they did. Yet almost nothing else in medicine has saved lives on the scale that obstetrics has. Yes, there have been dazzling changes in what we can do to treat disease and improve people’s lives. We now have drugs to stop strokes and to treat cancers; we have coronary-artery stents, artificial joints, and mechanical respirators. But those of us in other fields of medicine don’t use these measures anywhere near as reliably and as safely as obstetricians use theirs.

Ordinary pneumonia, for instance, remains the fourth most common cause of death in affluent countries, and the death rate has actually worsened in the past quarter century. That's in part because pneumonias have become more severe, but it's also because we doctors haven't performed all that well. Research trials have shown that patients who are hospitalized with pneumonia are less likely to die if the right antibiotics are started within four hours of their arrival. But we pay little attention to what happens in practice. A recent study has shown that forty per cent of pneumonia patients do not get the antibiotics on time. When we do give the antibiotics, twenty per cent of patients get the wrong kind.

In obstetrics, meanwhile, if a strategy seemed worth trying doctors did not wait for research trials to tell them if it was all right. They just went ahead and tried it, then looked to see if results improved. Obstetrics went about improving the same way Toyota and General Electric did: on the fly, but always paying attention to the results and trying to better them. And it worked. Whether all the adjustments and innovations of the obstetrics package are necessary and beneficial may remain unclear—routine fetal heart monitoring is still controversial, for example. But the package as a whole has made child delivery demonstrably safer and safer, and it has done so despite the increasing age, obesity, and consequent health problems of pregnant mothers.

The Apgar score changed everything. It was practical and easy to calculate, and it gave clinicians at the bedside immediate information on how they were doing. In the rest of medicine, we measure dozens of specific things: blood counts, electrolyte levels, heart rates, viral titers. But we have no measure that puts them together to grade how the patient as a whole is faring. It's like knowing, during a basketball game, how many blocked shots and assists and free throws you have had, but not whether you are actually winning. We have only an impression of how we're performing—and sometimes not even that. At the end of an operation, have I given my patient a one-in-fifty chance of death, or a one-in-five-hundred chance? I don't know. I have no feel for the difference along the way. "How did the surgery go?" the patient's family will ask me. "Fine," I can only say.

The Apgar effect wasn't just a matter of giving clinicians a quick objective read of how they had done. The score also changed the choices they made about how to do better. When chiefs of obstetrics services began poring over the Apgar results of their doctors and midwives, they started to think like a bread-factory manager taking stock of how many loaves the bakers burned. They both want solutions that will lift the results of every employee, from the novice to the most experienced. That means sometimes choosing reliability over the possibility of occasional perfection.

The fate of the forceps is a revealing example. I spoke to Dr. Watson Bowes, Jr., an emeritus professor of obstetrics at the University of North Carolina and the author of a widely read textbook chapter on forceps technique. He started practicing in the nineteen-sixties, when fewer than five per cent of deliveries were by C-section and more than forty per cent were with forceps. Yes, he said, many studies did show fabulous results for forceps. But they only showed how well forceps deliveries could go in the hands of highly experienced obstetricians at large hospitals. Meanwhile, the profession was being held responsible for improving Apgar scores and mortality rates for new-borns everywhere—at hospitals small and large, with doctors of all levels of experience.

"Forceps deliveries are very difficult to teach—much more difficult than a C-section," Bowes said. "With a C-section, you stand across from the learner. You can see exactly what the person is doing. You can say, 'Not there. There.' With the forceps, though, there is a feel that is very hard to teach." Just putting the forceps on a baby's head is tricky. You have to choose the right one for the shape of the mother's pelvis and the size of the child's head—and there are at least half a dozen types of forceps. You have to slide the blades symmetrically along the sides, travelling exactly in the space between the ears and the eyes and over the cheekbones. "For most residents, it took two or three years of training to get this consistently right," he said. Then a doctor must apply forces of both traction and compression—pulling, his chapter explained, with an average of forty to seventy pounds of axial force and five pounds of fetal skull compression. "When you put tension on the forceps, you should have some sense that there is movement." Too much force, and skin can tear, the skull can fracture, a fatal brain hemorrhage may result. "Some residents had a real feel for it," Bowes said. "Others didn't."

The question facing obstetrics was this: Is medicine a craft or an industry? If medicine is a craft, then you focus on teaching obstetricians to acquire a set of artisanal skills—the Woods corkscrew maneuver for the baby with a shoulder stuck, the Lovset maneuver for the breech baby, the feel of a forceps for a baby whose head is too big. You do research to find new techniques. You accept that things will not always work out in everyone's hands.

But if medicine is an industry, responsible for the safest possible delivery of millions of babies each year, then the focus shifts. You seek reliability. You begin to wonder whether forty-two thousand obstetricians in the U.S. could really master all these techniques. You notice the steady reports of terrible forceps injuries to babies and mothers, despite the training that clinicians have received. After Apgar, obstetricians decided that they needed a simpler, more predictable way to intervene when a laboring mother ran into trouble. They found it in the Cesarean section.

Just after seven-thirty, in the thirty-ninth hour of labor, Elizabeth Rourke had surgery to deliver her baby. Dr. Peccei had offered her the option of a Cesarean eight hours before, but Rourke refused. She hadn't been ready to give up on pushing her baby out into the world, and, though the doctor doubted that Rourke's efforts would succeed, the baby was doing fine on the heart monitor. There was no harm in Rourke's continuing to try. The doctor increased the Pitocin dose gradually, until it was as high as the baby's heart rate allowed. Despite the epidural, the contractions became fiercely painful. And there was progress: by 3 P.M., Rourke's cervix had dilated to eight centimetres. The contractions had pushed the baby forward two centimetres. Even Peccei began to think that Rourke might actually make the delivery happen.

Three hours later, however, the baby's head was no lower and was still sideways; Rourke's cervix hadn't dilated any further. When Dr. Peccei offered her a Cesarean again, she accepted, gratefully.

The Pitocin drip was turned off. The contraction monitor was removed. There was just the swift tock-tock-tock of the fetal heart monitor. Peccei introduced a colleague who would do the operation—Rourke had been in labor so long she'd gone through three shifts of obstetricians. She was wheeled to a spacious, white-tiled operating room down the hall. Her husband, Chris, put on green scrubs, a tie-on mask, a bouffant surgical cap, and blue booties over his shoes. He took a chair next to her at the head of the operating table and placed his hand on her shoulder. The anesthesiologist put extra medication in her epidural and pricked at the skin of her belly to make sure that the band of numbness was wide enough. The nurse painted her skin with a yellow-brown antiseptic. Then the cutting began.

The Cesarean section is among the strangest operations I have seen. It is also one of the most straightforward. You press a No. 10 blade down through the flesh, along a side-to-side line low on the bulging abdomen. You divide the skin and golden fat with clean, broad strokes. Using a white gauze pad, you stanch the bleeding points, which appear like red blossoms. You slice through the fascia covering the abdominal muscle, a husk-like fibrous sheath, and lift it to reveal the beefy red muscle underneath. The rectus abdominis muscle lies in two vertical belts that you part in the middle like a curtain, metal retractors pulling left and right. You cut through the peritoneum, a thin, almost translucent membrane. Now the uterus—plum-colored, thick, and muscular—gapes into view. You make a small initial opening in the uterus with the scalpel, and then you switch to bandage scissors to open it more swiftly and easily. It's as if you were cutting open a tough, leathery fruit.

Then comes what still seems surreal to me. You reach in, and, instead of finding a tumor or some other abnormality, as surgeons usually do when we go into someone's belly, you find five tiny wiggling toes, a knee, a whole leg. And suddenly you realize that you have a new human being struggling in your hands. You almost forget the mother on the table. The infant can sometimes be hard to get out. If the head is deep in the birth canal, you have to grasp the baby's waist, stand up straight, and pull. Sometimes you have to have someone push on the baby's head from below. Then the umbilical cord is cut. The baby is swaddled. The nurse records the Apgar score.

After the next uterine contraction, you deliver the placenta through the wound. With a fresh gauze pad, you wipe the inside of the mother's uterus clean of clots and debris. You sew it closed with two baseball-stitched layers of stout absorbable suture. You sew the muscle fascia back together with another suture, then sew the skin. And you are done.

This procedure, once a rarity, is now commonplace. Whereas before obstetricians learned one technique for a foot dangling out, another for a breech with its arms above its head, yet another for a baby with its head jammed inside the pelvis, all tricky in their own individual ways, now the solution is the same almost regardless of the problem: the C-section. Every obstetrician today is comfortable doing a C-section. The procedure is performed with impressive consistency.

Straightforward as these operations are, they can go wrong. The child can be lacerated. If the placenta separates and the head doesn't come free quickly, the baby can asphyxiate. The mother faces significant risks, too. As a surgeon, I have been called in to help repair bowels that were torn and wounds that split open. Bleeding can be severe. Wound infections are common. There are increased risks of blood clots and pneumonia. Even without any complication, the recovery is weeks longer and more painful than with vaginal delivery. And, in future pregnancies, mothers can face serious difficulties. The uterine scar has a one-in-two-hundred chance of rupturing in an attempted vaginal delivery. There's a similar risk that a new baby's placenta could attach itself to the scar and cause serious bleeding problems. C-sections are surgery. There is no getting around it.

Yet there's also no getting around C-sections. We have reached the point that, when there's any question of delivery risk, the Cesarean is what clinicians turn to—it's simply the most reliable option. If a mother is carrying a baby more than ten pounds in size, if she's had a C-section before, if the baby is lying sideways or in a breech position, if she has twins, if any number of potentially difficult situations for delivery arise, the standard of care requires that a midwife or an obstetrician at least offer a Cesarean section. Clinicians are increasingly reluctant to take a risk, however small, with natural childbirth.

I asked Dr. Bowes how he would have handled obstructed deliveries like Rourke's back in the sixties. His first recourse, as you'd expect, would have included forceps. He had delivered more than a thousand babies with forceps, he said, with a rate of neonatal injury as good as or better than with Cesarean sections, and a far faster recovery for the mothers. Had Rourke been under his care, the odds are excellent that she could have delivered safely without surgery. But Bowes is a virtuoso of a difficult instrument. When the protocols of his profession changed, so did he. "As a professor, you have to be a role model. You don't want to be the cowboy who goes in to do something that your residents are not going to be able to do," he told me. "And there was always uncertainty." Even he had to worry that, someday, his judgment and skill would fail him. These were the rules of the factory floor. To discourage the inexpert from using forceps—along with all those eponymous maneuvers—obstetrics had to discourage everyone from using them. When Bowes finished his career, in 1999, he had a twenty-four-per-cent Cesarean rate, just like the rest of his colleagues. He has little doubt that he'd be approaching thirty per cent, like his colleagues today, if he were still practicing.

A measure of how safe Cesareans have become is that there is ferocious but genuine debate about whether a mother in the thirty-ninth week of pregnancy with no special risks should be offered a Cesarean delivery as an alternative to waiting for labor. The idea seems the worst kind of hubris. How could a Cesarean delivery be considered without even trying a natural one? Surgeons don't suggest that healthy people should get their appendixes taken out or that artificial hips might be stronger than the standard-issue ones. Our complication rates for even simple procedures remain distressingly high. Yet in the next decade or so the industrial revolution in obstetrics could make Cesarean delivery consistently safer than the birth process that evolution gave us.

Currently, one out of five hundred babies who are healthy and kicking at thirty-nine weeks dies before or during childbirth—a historically low rate, but obstetricians have reason to believe that scheduled C-sections could avert at least some of these deaths. Many argue that the results for mothers are safe, too. Scheduled C-sections are certainly far less risky than emergency C-sections—procedures done quickly, in dire circumstances, for mothers and babies already in distress. One recent American study has raised concerns about the safety of scheduled C-sections, but two studies, one in Britain and one in Israel, actually found scheduled C-sections to have lower maternal mortality than vaginal delivery. Mothers who undergo planned C-sections may also (though this remains largely speculation) have fewer problems later in life with incontinence and uterine prolapse.

And yet there's something disquieting about the fact that childbirth is becoming so readily surgical. Some hospitals are already doing Cesarean sections in more than half of child deliveries. It is not mere nostalgia to find this disturbing. We are losing our connection to yet another natural process of life. And we are seeing the waning of the art of childbirth. The skill required to bring a child in trouble safely through a vaginal delivery, however unevenly distributed, has been nurtured over centuries. In the medical mainstream, it will soon be lost.

Skeptics have noted that Cesarean delivery is suspiciously convenient for obstetricians' schedules and, hour for hour, is paid more handsomely than vaginal birth. Obstetricians say that fear of malpractice suits pushes them to do C-sections more frequently than even they consider necessary. Putting so many mothers through surgery is hardly cause for celebration. But our deep-seated desire to limit risk to babies is the biggest force behind its prevalence; it is the price exacted by the reliability we aspire to.

In a sense, there is a tyranny to the score. Against the score for a newborn child, the mother's pain and blood loss and length of recovery seem to count for little. We have no score for how the mother does, beyond asking whether she lived or not—no measure to prod us to improve results for her, too. Yet this imbalance, at least, can surely be righted. If the child's well-being can be measured, why not the mother's, too? Indeed, we need an Apgar score for everyone who encounters medicine: the psychiatry patient, the patient on the hospital ward, the person going through an operation, and the mother in childbirth. My research group recently came up with a surgical Apgar score—a ten-point surgical rating based on the amount of blood loss, the lowest heart rate, and the lowest blood pressure that a patient experiences during an operation. We still don't know if it's perfect. But all patients deserve a simple measure that indicates how well or badly they have come through—and that pushes the rest of us to innovate.

"I watched, you know," Rourke says. "I could see the whole thing in the surgical lights. I saw her head come out!" Katherine Anne was seven pounds, fifteen ounces at birth, with brown hair, blue-gray eyes, and soft purple welts where her head had been wedged sideways deep inside her mother's pelvis. Her Apgar score was eight at one minute and nine at five minutes—nearly perfect. Her mother had a harder time. "I was a wreck," Rourke says. "I was so exhausted I was basically stuporous. And I had unbearable pain." She'd gone through almost forty hours of labor and a Cesarean section. Dr. Peccei told her the next morning, "You got whipped two ways, and you are going to be a mess." She was so debilitated that her milk did not come in.

"I felt like a complete failure, like everything I had set out to do I failed to do," Rourke says. "I didn't want the epidural and then I begged for the epidural. I didn't want a C-section, and I consented to a C-section. I wanted to breast-feed the baby, and I utterly failed to breast-feed." She was miserable for a week. "Then one day I realized, 'You know what? This is a stupid thing to think. You have a totally gorgeous little child and it's time to pay more attention to your totally gorgeous little child.' Somehow she let me put all my regrets behind me." ♦