The Checklist

If something so simple can transform intensive care, what else can it do?

by Atul Gawande December 10, 2007

If a new drug were as effective at saving lives as Peter Pronovost's checklist, there would be a nationwide marketing campaign urging doctors to use it.

The damage that the human body can survive these days is as awesome as it is horrible: crushing, burning, bombing, a burst blood vessel in the brain, a ruptured colon, a massive heart attack, rampaging infection. These conditions had once been uniformly fatal. Now survival is commonplace, and a large part of the credit goes to the irreplaceable component of medicine known as intensive care.

It's an opaque term. Specialists in the field prefer to call what they do "critical care," but that doesn't exactly clarify matters. The non-medical term "life support" gets us closer. Intensive-care units take artificial control of failing bodies. Typically, this involves a panoply of technology—a mechanical ventilator and perhaps a tracheostomy tube if the lungs have failed, an aortic balloon pump if the heart has given out, a dialysis machine if the kidneys don't work. When you are unconscious and can't eat, silicone tubing can be surgically inserted into the stomach or intestines for formula feeding. If the intestines are too damaged, solutions of amino acids, fatty acids, and glucose can be infused directly into the bloodstream.

The difficulties of life support are considerable. Reviving a drowning victim, for example, is rarely as easy as it looks on television, where a few chest compressions and some mouth-to-mouth resuscitation always seem to bring someone with waterlogged lungs and a stilled heart coughing and sputtering back to life. Consider a case report in *The Annals of Thoracic Surgery* of a three-year-old girl who fell into an icy fishpond in a small Austrian town in the Alps. She was lost beneath the surface for thirty minutes before her parents found her on the pond bottom and pulled her up. Following instructions from an emergency physician on the phone, they began cardiopulmonary resuscitation. A rescue team arrived eight minutes later. The girl had a body temperature of sixty-six degrees, and no pulse. Her pupils were dilated and did not react to light, indicating that her brain was no longer working.

But the emergency technicians continued CPR anyway. A helicopter took her to a nearby hospital, where she was wheeled directly to an operating room. A surgical team put her on a heart-lung bypass machine. Between the transport time and the time it took to plug the inflow and outflow lines into the femoral vessels of her right leg, she had been lifeless for an hour and a half. By the two-hour mark, however, her body temperature had risen almost ten degrees, and her heart began to beat. It was her first organ to come back.

After six hours, her core temperature reached 98.6 degrees. The team tried to put her on a breathing machine, but the pond water had damaged her lungs too severely for oxygen to reach her blood. So they switched her to an artificial-lung system known as ECMO—extracorporeal membrane oxygenation. The surgeons opened her chest down the middle with a power saw and sewed lines to and from the ECMO unit into her aorta and her beating heart. The team moved the girl into intensive care, with her chest still open and covered with plastic foil. A day later, her lungs had recovered sufficiently for the team to switch her from ECMO to a mechanical ventilator and close her chest. Over the next two days, all her organs recovered except her brain. A CT scan showed global brain swelling, which is a sign of diffuse damage, but no actual dead zones. So the team drilled a hole into the girl's skull, threaded in a probe to monitor her cerebral pressure, and kept that pressure tightly controlled by constantly adjusting her fluids and medications. For more than a week, she lay comatose. Then, slowly, she came back to life.

First, her pupils started to react to light. Next, she began to breathe on her own. And, one day, she siply awoke. Two weeks after her accident, she went home. Her right leg and left arm were partially paralyzed. Her speech was thick and slurry. But by age five, after extensive outpatient therapy, she had recovered her faculties completely. She was like any little girl again.

What makes her recovery astounding isn't just the idea that someone could come back from two hours in a state that would once have been considered death. It's also the idea that a group of people in an ordinary hospital could do something so enormously complex. To save this one child, scores of people had to carry out thousands of steps correctly: placing the heart-pump tubing into her without letting in air bubbles; maintaining the sterility of her lines, her open chest, the burr hole in her skull; keeping a temperamental battery of machines up and running. The degree of difficulty in any one of these steps is substantial. Then you must add the difficulties of orchestrating them in the right sequence, with nothing dropped, leaving some room for improvisation, but not too much.

For every drowned and pulseless child rescued by intensive care, there are many more who don't make it—and not just because their bodies are too far gone. Machines break down; a team can't get moving fast enough; a simple step is forgotten. Such cases don't get written up in *The Annals of Thoracic Surgery*, but they are the norm. Intensive-care medicine has become the art of managing extreme complexity—and a test of whether such complexity can, in fact, be humanly mastered.

On any given day in the United States, some ninety thousand people are in intensive care. Over a year, an estimated five million Americans will be, and over a normal lifetime nearly all of us will come to know the glassed bay of an I.C.U. from the inside. Wide swaths of medicine now depend on the life support systems that I.C.U.s provide: care for premature infants; victims of trauma, strokes, and heart attacks; patients who have had surgery on their brain, heart, lungs, or major blood vessels. Critical care has become an increasingly large portion of what hospitals do. Fifty years ago, I.C.U.s barely existed. Today, in my hospital, a hundred and fifty-five of our almost seven hundred patients are, as I write this, in intensive care. The average stay of an I.C.U. patient is four days, and the survival rate is eighty-six per cent. Going into an I.C.U., being put on a mechanical ventilator, having tubes and wires run into and out of you, is not a sentence of death. But the days will be the most precarious of your life.