

The Velluvial Matrix
Stanford Medical School Commencement
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Greetings to the graduating class of 2010. Thank you for inviting me back to this gorgeous place where I'd gone to college and worked in this school's laboratories—and even, in my sophomore dormitory, met my wife. But most of all thank you for letting me be part of this special occasion.

To take your place in those folding chairs, you have trod a long road. Many of you have worked for four solid years—or five, or six, or nine. And we are here to declare that, as of today, the twelfth of June, 2010, you officially know enough stuff to be called a graduate of the Stanford School of Medicine. You are Doctors of Medicine, Doctors of Philosophy, Masters of Science. It's been certified. Each of you is now an *expert*. Congratulations.

So why—in your heart of hearts—does it not quite feel that way?

The experience of a medical and scientific education is transformational. It is like moving to a new country. At first, you don't know the language, let alone the customs and concepts. But then, almost imperceptibly, that changes. Half the words you now routinely use, you did not know existed when you started: words like arterial blood gas, nasogastric tube, microarray, logistic regression, NMDA receptor, velluvial matrix.

Okay, I made that last one up. But the velluvial matrix sounds like something you should know about, doesn't it? And that's the problem. I will let you in on a little secret. You *never* stop wondering if there is a velluvial matrix you should know about.

Since I graduated from medical school, my family and friends have had their share of medical issues arise, just as you and your family will. And inevitably, they turn to the medical graduate in the house for advice and explanation. I remember one time when a friend came with a question.

"You're a doctor now," he said. "So tell me: where exactly is the solar plexus?"

I was stumped. It was not anywhere in the textbooks.

"I don't know," I finally confessed.

"What kind of doctor are you?" he said.

I didn't feel much better equipped when my wife had two miscarriages, or our first child was born with part of his aorta missing and we had to figure out what to do, or when my daughter had a fall with a

dislocated elbow that I failed to recognize, or when my wife tore a ligament in her wrist that I'd never heard of—her velluvial matrix, I think it was.

This is a deeper, more fundamental problem than we acknowledge. The truth is that the volume and complexity of the knowledge we need to master in medicine and science has grown exponentially beyond our capacity as individuals. Worse, the fear is that the knowledge has grown beyond our capacity as a society. When we talk about the uncontrollable explosion in the costs of health care in America, for instance, about the reality that we in medicine are gradually bankrupting the country, we're not talking about a problem rooted in economics. We're talking about a problem rooted in scientific complexity.

Half a century ago, medicine was neither costly nor effective. Since then, however, science has combated our ignorance. It has enumerated and identified, according to the international disease classification system, more than 13,600 diagnoses, 13,600 different ways our bodies can fail. And for each, we've discovered beneficial remedies—remedies that can reduce suffering, extend lives, and sometimes stop a disease all together. But those remedies now include more than 6,000 drugs and 4,000 medical and surgical procedures—and growing. Our job in medicine is make sure all of this capability is deployed, town by town, in the right way at the right time, without harm or waste of resources, for every person alive. And we're struggling. There is no industry in the world with 13,600 different service lines to deliver.

It should be no wonder that you have not mastered the understanding of them all. No one ever will. That's why we as doctors and scientists have become ever more finely specialized and super-specialized. If I can't handle 13,600 diagnoses, well maybe there are fifty of them I can handle—or just one I might focus my research upon. The result, however, is that we each find ourselves to be specialists worried almost exclusively about our particular niche and not the larger question of whether we as a group are making the whole system of care better for people.

I think we were fooled by penicillin. When penicillin was discovered in 1929, it suggested that treatment of disease could be simple—an injection that could miraculously cure a breathtaking range of infectious disease. Maybe there'd be an injection for cancer and another one for heart disease. It made us believe that discovery was the only hard part. Execution would be easy.

But this could not be further from the truth. Diagnosis and treatment of most conditions require complex steps and considerations, and often multiple people and technologies. The result is that more than forty percent

of patients with common conditions like coronary artery disease, stroke, or asthma receive incomplete or inappropriate care in our communities. And the country is also struggling mightily with the costs. By the end of the decade, at the present rate of cost growth, the price of a family insurance plan will rise to \$27,000. Health care will go from ten percent to seventeen percent of labor costs for business, and workers' wages will have to fall. State budgets will have to double to maintain current health programs. And then there is the frightening federal debt we will face. By 2025, we will owe more money than our economy produces. One side says war spending is the problem, the other says it is the economic bailout plan. But take both away and you've made almost no difference. Our deficit problem—far and away—is the soaring and seemingly unstoppable cost of health care.

We in medicine have watched all this with mainly bafflement—even indifference. This is just what good medicine is like, we're tempted to say. But we'd be ignoring the evidence otherwise. For health care is not practiced the same way across the country. There is remarkable variability in the cost and quality of care. Two communities in the same state with the same levels of poverty and health can differ by more than fifty percent in their Medicare costs. There is a bell curve for cost and quality, and it is frustrating—but also hopeful. For those getting the best results—the hospitals and doctors measured to be at the top of the curve for patient outcomes—are not the most expensive. They are sometimes among the least.

Like politics, all medicine is local. The systems of care we are in matter. One essential characteristic of medicine is it requires the successful function of systems—assemblages of people and technologies. Among our most profound difficulties is making them work. If I want to give my patients the best care possible, not only must I do a good job but a whole collection of diverse components must somehow mesh together effectively. Health care is like a car that way. In both cases, having great components is not enough.

We've been obsessed in medicine with having great components—the best drugs, the best devices, the best specialists—but we've paid little attention to how to make them fit together well. Don Berwick of the Institute for Healthcare Improvement has noted how wrongheaded this is. "Anyone who understands systems will know immediately that optimizing parts is not a good route to system excellence," he says. He gives the example of a famous thought experiment of trying to build the world's greatest car by assembling the world's greatest car parts. We connect the engine of a Ferrari, the brakes of a Porsche, the suspension of a BMW, the body of a

Volvo. “What we get, of course, is nothing close to a great car; we get a pile of very expensive junk.”

Nonetheless, in medicine, that’s exactly what we have done.

Earlier this year, I received a letter from a patient named Duane Smith. He was a thirty-four-year-old assistant grocery store manager when he had a terrible head-on car collision that left him with a broken leg, pelvis, and arm, both lungs collapsed, and uncontrolled internal bleeding. The members of his hospital’s trauma team went swiftly into action. They stabilized his fractured leg and pelvis. They put tubes in both sides of his chest to re-expand his lungs. They gave him blood and got him to an operating room fast enough to remove the ruptured spleen that was the source of his bleeding. He required intensive care and three weeks of hospital recovery to get through all this. The clinicians did almost every single thing right. Mr. Smith told me he remains deeply grateful to this day for the people who saved him.

But they missed one small step. They forgot to give him the vaccines that every patient who has his spleen removed requires, vaccines against three bacteria that the spleen usually handles. Maybe the surgeons thought the critical care doctors were going to give the vaccines, and maybe the critical care doctors thought the primary care physician was going to give them, and maybe the primary care physician thought the surgeons already had. Or maybe they all forgot. Whatever the case, two years later he was on a beach vacation when he picked up an ordinary strep infection. Without the vaccines, the infection spread rapidly throughout his body. He survived but it cost him all his fingers and all his toes.

It was, as he summed it up in his note, the worst vacation ever.

When Duane Smith’s car crashed, he was cared for by good, hardworking people. They had every technology available to them. But they did not have an actual system of care. And the most damning thing is that no one learned a thing from this. The story of this man made no difference to anyone. For we have since had the exact same story occur in Boston with an even worse outcome. And I am certain it has happened here, too. Indeed, I would bet you that, across this country, we miss the basic, unglamorous step of vaccination in probably half of emergency splenectomy patients.

Why does this happen? Why does anyone receive suboptimal care? After all, society could not have given us people with more talent, more dedication, and more training than the people we have in medical science—than you. I think the answer is: we have not grappled with the fact that the complexity of science has changed medicine fundamentally. This can no longer be a profession of craftsmen individually brewing plans for whatever

patient comes through the door. We must be more like engineers building a mechanism whose parts actually fit together, whose workings are finely tuned and tweaked for ever better performance in providing aid and comfort to human beings.

You come into medicine and science at a time of radical transition. You have met the older doctors and scientists who tell the pollsters that they wouldn't choose their profession if they were given the choice all over again. But you are the generation that was wise enough to ignore them. For what you are hearing is the pain of people experiencing an utter transformation of their world. Doctors and scientists are now being asked to recognize a new understanding of what great medicine requires. It is not just the focus of an individual artisan-specialist, however skilled and caring. And it is not just the discovery of a new drug or operation, however effective it may seem in an isolated trial. Great medicine requires the innovation of entire packages of care—with medicines and technology and clinicians designed to fit together seamlessly, monitored carefully, adjusted perpetually, and shown to produce ever better service and results for people at the lowest possible cost for society.

When you are sick, this is what you want from medicine. When you are a taxpayer, this is what you want from medicine. And when you are a doctor or medical scientist, this is the work you want to be part of. It is work with a different set of values from the ones medicine has traditionally had: values of teamwork instead of individual autonomy, ambition for the right process, not just the right technology, and perhaps above all humility—for we need the humility to recognize that under conditions of complexity, no technology will be infallible and no individual will be either. There is always a velluvial matrix to know about.

You are graduating from a special place. And you are joining a special profession. Doctors and scientists, we are all in the survival business, but we are also in the mortality business. Our successes will always be leavened by the limits to knowledge and human capability, by the unstoppable of suffering and death. Meaning comes from our each finding ways to help people and communities make the most of what is known and cope with what is not.

This will take science. It will take art. It will take innovation. It will take ambition. And it will take humility. But the fantastic thing is: this is what you get to do.

I've tried to think of how to sum up our task. All I could come up with is: To do cool stuff that lasts. So here is my wish for you, the 2010

graduating class of the Stanford School of Medicine: May you do cool stuff that lasts.