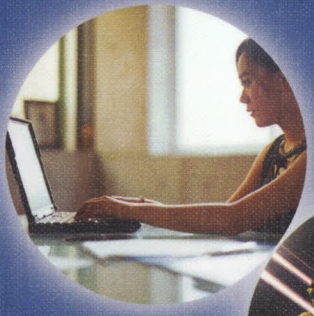
Tackling Tomorrow Today

Volume 2

America: Moving Ahead



Series Editor

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■ Essay Four ■

CARE TO BE A DOCTOR TOMORROW?

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By 2020, will doctors have become "knowledge navigators," helping patients made glassy-eyed by "health advice" Web sites judge what is gold and what is junk?[1] How likely is it that patients—you and I—will have switched from today's conventional care routines to alternative therapies, like chiropractic, acupuncture, and meditation? Will our family doctor even be needed as dramatic technological advances—with such strange names as pharmacogenomics and nanotechnology—gain the power to actually repair defective genes?

Seven trends are transforming a doctor's future (and ours, as well): globalization, the Internet revolution, the genetics revolution, the pharmacogenomics revolution, the nanotech revolution, alternative medicine, and aging. The first two are full-blown trends while the latter five are emerging and can create futures unrecognizable to us today.

GLOBALIZATION

This ongoing change can lead to faster access to news and technological breakthroughs elsewhere (true for doctors as well as patients). And it is a direct challenge to the idea of universal coverage. Whether for ideological reasons (privatization or market forces are represented as more efficient and better able to meet customers' needs) or for cost reasons (aging of the population, medicalization of illnesses), universal health care, as achieved in advanced OECD (Organization for Economic Cooperation and Development) nations, is under serious threat.

THE INTERNET REVOLUTION

Working in tandem with globalization, indeed, accelerating this process is the dot-com revolution. While currently Web-based, it will probably soon lead to always-on, wearable computers, or Web-bots. Emergent health-bots may take a robotic form or a more virtual form—either a robodoc or an always-present (24/7) doctors.com-type Web site.

As the Web develops, we can anticipate health-bots, or health coaches. They should be able to provide individualized, immediate feedback; for example, letting us know the caloric intake of the pizza we just ate and the amount of exercise needed to burn it off. They will probably also let us know the makeup of each product we are considering purchasing, helping us to identify allergies and safeguarding us against them. Sensors may soon be developed that will be able to detect health problems through the smell of our breath, and alert doctors for early diagnosis and response.

These computer systems will be reflexive knowledge systems, endlessly learning more and more about us—our preferred and not so preferred internal and external environment. What is crucial is that these bots will be customized, immediate, and reflexive—that is, connected and learning, and individualized.

The health futurist Clement Bezold writes: "In 2010, our DNA profile will be part of our electronic medical record, and our genetically based proclivity to major diseases, including heart disease, will be known. There will be sophisticated, low-cost, noninvasive or minimally invasive biomonitoring devices; for example, a wristwatch device will provide accurate, ongoing information on your health status.

You will likely have powerful in-home expert systems, probably supplied by your health-care provider, which will not only aid diagnosis but also reinforce the pursuit of your chosen health goals. These expert systems, or electronic personal guides, will tailor the information to your knowledge level, interest level, and learning style, as well as those of your family members, each of whom would have a personal electronic

'health coach.' If you are genetically or otherwise inclined to heart disease, your coach will encourage specific preventive measures."[2]

The assumption here is that 50 percent of the variance of the causes of preventable premature death is due to behavior (20 percent is related to genes, 20 percent environment, and 10 percent medical care). It is this 50 percent that the health-bot—the health professional on a wrist—will help us manage. We can always take the devices off unless insurance companies require their continuous use for cheaper premiums.

Smarter consumers will undoubtedly check on medical research studies and be able to maneuver in a world of conflicting data and paradigms. This should make the job of general doctors easier. As smart cards and health-bots continue to evolve, their intelligence will probably reduce the frequency of, and need for, doctor visits, saving money spent on the health system.

Combined with the information and technology revolution, we may soon have the equivalent of hospitals on our wrists, actually, within our bodies. This should force general doctors to quickly become Internet-savvy, seeing it as a way to communicate with patients, especially younger patients raised on the Net—the "dot-com generation" now in the nation's high schools.

GENETICS

Geneticists argue that genes play a role much larger than 20 percent in explaining our well-being, and genomics and germ-line engineering are expected to have an ever-greater impact on our health. The first step is identifying diseases to which we are predisposed. Next is customized gene therapy (replacing a defective gene and, therefore, a disease-causing gene with a healthy one). Further ahead is body-part cloning (growing replica parts to replace faulty ones).

The revolution's *full* potential lies with germ-line engineering, which modifies or manipulates the human DNA, for example, by altering the DNA of an unborn child to eliminate

or decrease a predisposition toward a given disease. Germ-line engineering can also preselect ideal sperm and eggs for fertilization, thus affecting the germ lines of generations to come. At this stage, there appears to be few limits—with science fiction even too timid.

PHARMACOGENOMICS

Pharmacogenomics entail examining inherited variations in genes that dictate drug response. Doctors can then explore ways these variations can be used to predict whether you will have a good response to a drug, a terrible one, or no response at all.

At present we can be given medications that either don't work or have bad side effects. Pharmacogenomics would make possible a day when your doctor would know you could suffer a severe negative reaction to a particular medication after a simple and rapid test of your DNA. Or your doctor would know you would greatly benefit from a new drug on the market, with little likelihood of a negative reaction. Proponents do not see this as a minor gain but part of a major renaissance in medical practice.

Note should be taken of the belief that while "the science of pharmacogenomics will provide an increased level of accuracy in selecting specific drug therapy for individual patients, it will not replace the art of clinical judgment in practice because of the confluence of social, behavioral, economic, and environmental factors."[3]

NANOTECHNOLOGY

If nanotechnology delivers what it promises, our entire bodies will become a pharmaceutical factory, ready to detect, diagnose, and react to imbalances. Consider the claims of the Foresight Institute headed by Eric Drexler: "A mouthwash full of smart nanomachines could do all that brushing and flossing do and more, and with far less effort—making it more likely to be used. This mouthwash would identify and destroy pathogenic bacteria while allowing the harmless flora of the mouth to flourish in a healthy ecosystem."[4]

* Medical nanodevices could augment the immune system by finding and disabling unwanted bacteria and viruses.
* Medical nanodevices will be able to stimulate and guide the body's own construction and repair mechanisms to restore healthy tissue.
* Viruses can be eliminated by molecular-level cellular surgery. The required devices could be small enough to fit entirely within the cell, if need be.

In the United States, funding for nanotechnology has risen from $100 million in 1997 to $400 million in 2002; outside the United States, funding is approximately $1 billion. In November 2003, the U.S. Senate approved funding of $3.7 billion over four years for nanotech research.[5]

However, Professor Ken Donaldson of the University of Edinburgh warns: "Nanotechnology threatens to generate new hazards in the form of toxic molecules that can enter the lungs."[6] But the promises are dramatic.

In his book, *Nanomedicine*, Robert Freitas writes: "Once nanomachines are available, the ultimate dream of every healer, medicine man, and physician throughout recorded history will, at last, become a reality. Programmable and controllable microscale robots composed of nanoscale parts fabricated to nanometer precision will allow medical doctors to execute curative and reconstructive procedures in the human body at the cellular and molecular levels. Nanomedicine will employ molecular machine systems to address medical problems, and will use molecular knowledge to maintain and improve human health at the molecular scale ..."[7]

The Fred Hutchinson Cancer Research Center in Seattle is involved in a collaborative effort with Intel Corporation of Palo Alto, California, in which Intel will build a Raman Bioanalyzer System at the center, according to a press release.

"The instrument is normally used to detect microscopic imperfections in silicon chips. The cancer research center will beam the bioanalyzer's lasers onto medical samples, such as blood serum, to create images that reveal the chemical

structure of molecules, helping to analyze, diagnose and prevent cancer."[8]

"This collaboration is a unique and exciting interaction," said Lee Hartwell, director of the center. "Biologists have never before had such a method for studying the molecular structure of biology. This is true discovery-based research; we don't know what we will see or learn."[9]

Mihail Roco, senior adviser for nanotechnology at the National Science Foundation in the United States, says the hope is to eliminate all cancers by 2015 using nanotechnology: "This is not a dream but a vision based on a well-defined strategy."[10]

Continues Freitas: "Nanomedical physicians of the early twenty-first century will still make good use of the body's natural healing powers and homeostatic mechanisms, because, all else equal, those interventions are best that intervene least. But the ability to direct events in a controlled fashion at the cellular level is the key that will unlock the indefinite extension of human health and the expansion of human abilities."[11]

ALTERNATIVE MEDICINE

By this I mean the move toward alternative or complementary medicine, primarily drawing on Chinese and Indian traditions of meditation and acupuncture but also less accepted alternatives like homeopathy (from Germany).

The data are stunning. In the United States, a Harvard Medical School study reports that 64 percent of medical schools now offer elective courses in complementary medicine. One in every three American adults uses chiropractic, acupuncture, and homeopathy treatments. Many patients judge conventional medicine as ineffectual, too costly, and/or too centered on curing ills rather than helping people maintain good health. These patients appreciate doctors who tend to spend greater amounts of time with them and who customize therapy. Also, scientific studies by Dr. Dean Ornish support diet, lifestyle, stress management, and social inclusion as factors to reverse heart disease.[12]

AGING

While genomics, health-bots, and alternative therapies may make us healthier, the data generally do not look good for the aged. The average person is sick or disabled for nearly 80 percent of the extra years of life he or she gains as life expectancy rises. Health expenditures for those over age sixty-five are much higher than for the rest of the population. The World Health Organization estimates that by 2020 depression will be the leading cause of "disability adjusted life years," dramatically increasing the demands for psychiatric health services for young and old. The aged, particularly those removed from family and community, are especially prone to mental illnesses.[13]

SUMMARY: CAREER CHOICES

What, then, might a would-be doctor want to consider now about the likely future for medicine?

1) Doctors will have to augment their understanding of the Internet, becoming knowledge navigators. However, they will also have to focus on what technology cannot give—warmth, human understanding, and empathy—as well as what some alternative therapies cannot give either—tough, rigorous analysis.
2) Health-bots and the Internet are likely to reduce the profits on the mass-market health business, especially since the patient-in, patient-out system appears not to be what users want.
3) If you are thinking about becoming a doctor, you will want to find specific niches not being met by a doctors.com-like Web site, the alternative medical care system, or genomics. Or you may want to focus on specific demographic groups and find out what their needs are—the global teenager, or the aged, who will need extra care.

Generally doctors will need to ask: What level of technology are they familiar with? Can they become knowledge navigators? Can they use the new technologies to increase their own quality of life; using the Net for seamless administration, so that their hours can be more flexible? Can they enter into dialogue with complementary medicine or at least begin to listen carefully to patients' concerns about their treatment? General doctors will have to reinvent themselves, detailing what role they desire for themselves in the future.

NOTES

1 See www.metafuture.org for articles and books by Sohail Inayatullah.
2 See Clement Bezold, "Will Heart Disease Be Eliminated in Your Lifetime? The Best of Health Futures," *Futures Research Quarterly* (Summer 1995) and *The Future of Complementary and Alternative Approaches in U.S. Health Care*. Institute for Alternative Futures, 1998.
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4 www.foresight.org/Utf/Unbound_LBW/chapt_10.html. Accessed 16 November 2003.
5 www.nanobusiness.org/pgepolicy.html. Accessed 18 December 2003.
6 www.smalltimes.com. "Researcher Warns of Toxic Threat from Nanotechnology." Accessed 19 November 2003.
7 www.foresight.org/Nanomedicine/Respirocytes.html. Accessed 16 November 2003.
8 http://www.intel.com/pressroom/archive/releases/20031023corp_a.htm. Accessed 28 October 2003.
9 Ibid.
10 www.smalltimes.com. Steve Mitchell, "Nanomedicine Vital to Finding a Cancer Cure," UPI. Accessed 1 November 2003.
11 www.foresight.org/Nanomedicine/Respirocytes.html. Accessed 16 November 2003.

12 Clement Bezold, "Health Care Faces a Dose of Change," *The Futurist*, April 1999, 30–33.
13 www.who.org. See World Health Organization, *The Global Burden of Disease*, 1996.

DISCUSSION QUESTIONS+

* How should current resources be invested: Research for the future or treatments for the present?

* What is the "right" balance of private sector vs. government investment in these new technologies?

* What should the government expect for its investments?

* Why will globalization undermine universal health care?

* How could globalization encourage universal health care?

* What is the difference between health information and knowledge?

* Why/how could health-bots "save" money?

* Could more information/knowledge lead to more health-care costs?

* What are the implications of more access to health information for general education?

* Could health literacy or the lack thereof become a challenge for these new technologies?

* What are the ethical/moral challenges to access to greater health information?

* Who is responsible/liable for information quality?

* Given that genotype is not phenotype, what are the ethical/moral implications of genetic manipulation? That is, are there risks associated with manipulating genes/germ cells because they have a propensity, not a certainty, for affecting health?

* Should genetic enhancements be subsidized or only used to care for illnesses?

* What are the implications for society, technology as a whole, health, and other areas if one of these technologies proves to be a disaster?

* The article focuses on individual health. What about public health considerations and these technologies?

+ *Prepared by Daniel Shostak, a health-care futurist, at the request of the editor.*