Technofutures Chapter: Future Health

The Top Ten Health Care Trends for the 21st Century
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1. Most hospitals, clinics, trauma centers, physicians, and patients will be connected to one large network enabling access to critical medical information.
2. Consumer health information, accessible over a variety of Net channels, will become the most in-demand content worldwide.
3. The medical industry will face an ethical and social dilemma over the disclosure of patient information.
4. Health-care professionals, available via remote Internet connections, will provide services to millions of people who were previously under-served.
5. Medicalbots, nonhuman intelligence agents, will dispense medical care to patients and doctors worldwide to save money and share expertise.
6. Advanced nano-biology and genetic technology will eliminate many diseases, accelerate healing, and increase longevity.
7. Bio-engineered food will help promote health and longevity.
8. A new generation of smart drugs, implants, and medical devices will enhance our health and performance.
9. Virtual-reality medical simulations will become the dominant mode of medical training.
10. Cyber-health care that is customized for us—designed to monitor, diagnose, educate, and intervene regardless of location or time—will be common.

Telemedicine On-Demand: Year 2003
It’s one in the morning, and Ann’s five-year-old daughter, Tyler, wakes up crying. She has a fever and is complaining about her ears. Ann logs on to her Home Health Watch Internet site and places a wireless thermometer over her ear, enabling her to send real-time clinical information to her online nurse practitioner. The Tele-Nurse analyzes the bio-data automatically with a direct access link to the 24-hour virtual lab. She prescribes a drug that Ann can get delivered from her local pharmacy in ten minutes. Since Tyler hates pills, the drug is an inhalant—one sniff per dose in her favorite scent, cherry. Information on-demand. Help when we need it. Welcome to the future of health care.

The health-care industry in the United States—next in size only to the defense industry—will represent a burgeoning $2.2 trillion dollar business in 2003. A whopping 14 percent of the U.S. Gross Domestic Product is spent on health care. Throughout the world, regardless of what nation or type of system, high costs and inefficiency plague people in need of treatment and health guidance. Some patients pay usurious fees for the best care, while others sit waiting for hours, weeks, even years for basic medical attention. Many more people in developing countries have
no consistent access to health care at all. This can change if leaders cautiously build tomorrow’s health-care system using the Power Tools of leading-edge technology. There is little wonder that health expenses are out of control. First of all, no health information systems architecture exists today. It is as if the information age has missed the health-care industry, and unless this is fixed, health care will be on the critical list. Data points throughout the health-care system—collection of patient information, storing medical images such as x-rays, physicians’ entries in patient records, billing—need to be brought together seamlessly. The impact of disparate information systems on health-care delivery is something we have all experienced to some degree. At least $300 billion could be saved just from switching from a paper-based system to a digital system for administration. This is one of numerous applications of new technology with the dual impact of cutting costs and improving service. It’s still resisted, though, out of an ingrained, almost superstitious, attachment to paper documents and other “old ways.”

Having advised the health-care industry over my career, I am concerned by the lack of vision with our leaders about unifying resources to deliver better services. But vision or no vision, they will have to change. Technology will force their hand. Consumers, free enterprise, and government will scurry toward the same goal: an efficient, cost-effective, and quality health-care system.

It is impossible to miss the potential. Breakthroughs in nanotech, robotics, biotechnology, and other tools of the telemedicine revolution can enhance quality, promote efficiency, and improve access for millions. Anyone who can see this potential, anyone who can understand the application of Power Tools to health care, can identify tremendous business opportunities today.

If we do not get health-care expenditures under control, by 2006 the U.S. will face a price tag of $4 trillion—much of it due to its 78 million aging baby boomers. There are few industries that need as much “healing” as medicine and health care, and massive doses of leading-edge technology are the best therapy. The following is a preview of what’s in store.

**Future Telemedicine**

What we call “telemedicine” today will be simply “medicine” tomorrow. The use of technology to deliver health care anytime, anywhere—the broad definition of telemedicine—will be the way things are done in the 21st century.

At first developed to serve our astronauts, then later valued mostly for supplementing care to people in remote and rural areas, telemedicine is today being integrated into urban health-care systems by forward-looking provider networks. A pioneer in this field is Boston-based Partners HealthCare (www.partners.com), which is testing videoconferencing, the Internet, and new digital imaging technologies in a bid to gain market share, cut costs, and improve quality of care to a large urban patient base.

One Partners program, emergency stroke management, involves connecting remote community emergency rooms to a central “hub” for specialist help in the utilization of anticoagulant agents. Certain anticoagulants have strict criteria for use, and ER doctors are often reluctant to use them without a second opinion.
Videoconferencing capabilities are being tapped for this particular project. Other urban telemedicine programs revolve around distance learning, home health care, and disease management.

**Virtual Patient Monitoring**
Home health care will become more efficient as remote patient monitoring over the Net is available. The homes of chronically ill patients—those the hospitals now call “revolving door patients” because of their repeated hospital visits—will be equipped with intelligence-enhanced “nurse-bots” for 24-hour duty. These medical assistants will be able to take vital signs and transmit them via small hand-held video teleconferencing devices to a central database. Their on-site actions will prevent the need for many trips to the emergency room. Physicians in another part of town, or another part of the world, will be instantly alerted if there’s a problem and use their mobile phone LCD monitor to view the patient and make emergency recommendations.

Other patients—perhaps those with asthma, diabetes, and other less-severe chronic problems—will rely on home health monitors that are simple to use, non-invasive, and relatively inexpensive. The Medical College of Georgia first launched trials with such monitors in 1994. These devices will easily monitor liver functions, ovulation cycles, levels of cholesterol, and more with results transmitted to a central health bank. Daily or weekly videoconferences with a nurse or doctor will become routine.

**Tele-Med Training: Year 2002**
The famous heart surgeon, Dr. Karinchy, in her operating room at Stanford University Medical Center, is guiding an intricate triple bypass operation thousands of miles away in a Singapore Hospital. Medical students from around the world from 50 medical schools are watching the procedure via videoconference over the Net as part of their resident training.

“Now with this technique, which I am only perfecting as of now, I have found a way to make more refined incisions by using a fiber-optic tipped scalpel that has on-board intelligence,” Dr. Karinchy describes.

“Does that mean that this process is more precise?” asked one of her students, Sanji, who is beamed in from India.

“Hi, Sanji, good to have you here today. Greater precision is one part of this new procedure, but speed is also a result of the smart targeting of the scalpel.”

Over 30 different languages and cultures are represented with simultaneous real-time translation customizing the exchange between Dr. Karinchy and her top-notch team. After a grueling five-hour operation, Dr. Karinchy answers questions from the local and remote locations. Her answers and the questions are captured and shared over superfast networks and e-mailed to all present.

“Remember that this course is worth six credits if you download the homework and e-mail it back before April 3. Visual simulations are required, so please don’t submit your work without them. Dr. Karinchy offline.”
Some of the residents later download the operation over the Net and simulate the teachers’ actions in order to learn her technique. Other students interact with other teachers and students over a groupware Net link where they can make notes and diagrams while they play back the operation in slow motion. The patients’ vital signs, displayed as information streaming across their screens, lets them monitor the operations’ progress. All of this information and the procedure can be redesigned, simulated differently, or stored for playing out different scenarios. The visualization of the surgical procedures enables the students to accelerate their education.

Net-Med Training
Even in the early days of telemedicine, it was clear to its pioneers that physician-to-physician communication was perhaps a more critical benefit than patient-to-physician contact. Real-time interactive tele-mentoring and medical training is far more efficient than books or journals. The education of medical students and the continuing education of physicians can be delivered very cost-effectively either by distributing lessons in real-time or filing them digitally over the Net for later review and study. The Mayo Clinic began experimenting with real-time specialist-to-specialist tele-mentoring in 1993 by connecting surgeons in the Rochester, Minnesota, hospital with those in their satellite facilities in Arizona and Florida. They did this with an expensive satellite link among the facilities, but now with relatively low-cost access to a global Internet, this kind of professional tele-connection will soon become a common occurrence. Why wouldn’t we want collaboration among the best experts if we’re undergoing a life-threatening procedure?

Networked Health: Year 2005
Larry’s had a long day and feels tired despite having taken an anti-fatigue pill called “Aware” to get through the last Internet videoconference on the company’s newest product. A happy hour beer-fest at the CyberLounge is tempting, but just after leaving the building, a sharp chest pain stops him cold. The pain finally subsides, and he quickly slips his Personal Health Record card into a slot on his cell phone, uttering the word, “Emergency.” Immediately, Larry is routed via the Internet to his health plan’s Clinical Emergency Center for a diagnosis. This involves answering a series of yes-or-no questions about the symptoms and vital signs asked by a CyberDoc computer. Larry places a finger on the screen where his biosignature converts his EKG signals and sends them instantly to the Emerg-Med Team via a virtual Net center many time zones away. The CyberDoc decides that Larry’s condition may be acute cardiac ischemia and dispatches a Clinic-Mobile to his exact location. En route to the nearest emergency care unit, a battery of tests, including another EKG, are performed and transmitted via a wireless device to a lab for interpretation. By the time the local Emerg-Med team reaches Larry, the doctor on duty has the results, along with a second opinion by a cardiac specialist 2,000 miles away.
Larry’s Personal Health Card has also provided his medical history and genetic predisposition to the on-duty doctor. The doc has authorized several categories of treatment for the condition—a partially clogged artery. The receptionist takes Larry to a video monitor, where he can see and talk to both physicians who have studied his condition. On the split screen, the duty doctor shows Larry holographic 3-D color images of the vessel blockage via a microscopic camera inserted into his bloodstream. The doctor recommends injecting an army of nanoscrubbers to clean out the arteries. Larry’s asked to rest while the physician takes a virtual tour of his bloodstream to code in the correct markers for making the non-invasive procedure a success. Once deployed and completed with their mission, the nanoscrubbers dissolve harmlessly.

The actual operation takes only eight minutes, and Larry’s discharged shortly afterwards. Before leaving, he’s given a customized holographic health disk with an analysis of what dietary or lifestyle changes are needed for him to avoid another such incident.

A wristband will unobtrusively monitor Larry’s condition for the next couple days, but he feels fine as he strolls out of the neighborhood care unit. In fact, he still has time to make happy hour. He just has to watch what he orders. His updated personal health record may warn him from ordering beverages that are not on his diet. Larry may hear this message: “Light Nutri-beer suggested—and only two servings.”

Consider how we will be able to deliver individual health-care solutions anywhere, at any time of day when all physicians, hospitals, HMOs, and clinics are connected to the same online site; we’ll call it “Global Health-Net.” Savvy companies will anticipate that and get ahead of the competition by matching specific patient needs with information resources available via the Net.

**Doctors’ Helpers**

The “Global Health-Net” will also have a prime, live-saving role in future disasters. Physicians and other front-line medical personnel will be equipped with lightweight mobile computing devices linked to the Net that can be hooked to their wrist, waist, or hard-hat. They will also have embedded artificial intelligence to enable practitioners to make more informed and faster decisions. A prototype of this kind of communications/computing device, nicknamed the “Dick Tracy Watch,” was developed in the early 1990s for the U.S. Army.

With an accompanying small “black box” of diagnostic instruments, medics will help an earthquake victim, for instance. They could quickly take the victim’s vital signs, do an x-ray of potentially damaged body parts, and transmit the tests for analysis to a telemedicine center specializing in disaster medicine. In turn, specialists at the center will transmit the solutions needed to the medics or doctors in the field to provide a virtual assist.

The future physician won’t use a pen for taking field notes. Natural voice recognition will quickly translate spoken instructions into text that is instantaneously sent to the
appropriate database and the patient’s health history. This will leave the physician’s hands free for patching up a wound.

**Smart Card Saves Life: Year 2003**

Milo is driving through a rainstorm in rural Spain on vacation near the sea shore when his car skids, hits a tree, and knocks him unconscious. Luckily, Pablo, the local physician, is able to access Milo’s personal code number from the back of the smart card in Milo’s wallet by using his Physicians’ Emergency Protocol (PEP). He quickly accesses the Net by saying “Code Blue, Code Blue” and an emergency access code. Milo’s health history is downloaded. He finds that Milo is allergic to penicillin and has a history of hypertension. He adjusts his treatment protocol accordingly. Milo’s life has just been saved.

Milo’s personal doctor and his Home Docbots are also alerted in case their consultation, or intervention, is needed.

**Health History on a Chip**

Critical life-saving information delivered when we need it, where we need it, will soon be common with small, robust storage devices—the next generation of the “smart card.” Such advances in health informatics, facilitated by the convergence of health care, computers, and networks, will have a comprehensive impact on consumer health.

Each of us will soon carry a personal health record “smart card” that contains all the relevant data about our health history on a tiny chip. In multimedia form, it will include our entire health record, including the drugs we’ve taken, operations we’ve had, medicines we’re allergic to, and diseases or conditions we’ve suffered. In addition, our genomic profile will be catalogued on our digital file. This information, critically important to our health, may be even more essential over time as new drugs and interventions born from unlocking the human genome will steadily become available after 2002. This smart card, hooked into the Net, can quickly alert us to new research on a mutant genetic trait we’ve inherited, or to a new “smart drug” to help cure memory lapses we’ve recorded.

Our health card acts as a tiny computer, another gateway to the Net, searching out information for our specific needs, and alerting the hospital or specialist when we need their services. It watches our health statistics and “knows” what we need when.

**Health Ethics Alert**

The ethical considerations of this scenario can be disturbing, which is one reason why there is currently such widespread reluctance to adopt some of this technology in its formative stages. Only the military in the U.S. and certain other nations have boldly gone forward in an effort to put medical records on a “smart card.” There will be so much personal health information available on such a device that it will be hard to believe that our rights to privacy will be fully protected. There will be abuses; there are now with a paper-based system—and paper is typically much easier to copy, deface, lose, and destroy than electronic records.
If one area cries out for change, it is the protection of health databases from unauthorized parties. And who are they? Do governments have the right to identify people with genes that are precursors for violent behavior? How about employers wanting to screen us before hiring to determine our cardiovascular potential? Does the public have a right to know a potential President's health and genomic history? This information will be virtually somewhere in our connected society. How and when we use this health data will determine employment directions, social policies, political elections, and relationships such as marriage, dating, and parenting. I cannot overemphasize the need for laws and policies to protect the privacy rights of individuals in the future. The exploitation of personal health information is one of the greatest threats to democracy and personal freedoms that we face. I urge those companies that don’t have privacy policies to form them now.

**Selling Privacy**
Smart companies will build new businesses around this privacy concern. Protecting and managing consumers’ health information will be a very profitable business model for the future. Numerous businesses will emerge that will stand between consumers and industry to protect personal rights to privacy. If we as a society do not heed the warnings here, these events may occur: First, irate consumers will pass laws to restrict the collection of their personal data. Next, consumers will decide to charge companies for the rights to have access to their personal data. With the emergence of genomics, information about people’s DNA, there is nothing more personal than our health data. How protection of it is handled by the private sector will affect law, politics, and commerce for decades to come.

**Leapfrog Technology**
Instant access to patient data is made possible by the emerging telecom infrastructure built for high-speed wireless transmissions of voice, data, and video in *real-time*—superfast transmissions when and where they’re needed. A telemedicine explosion will be triggered by the demands of emerging nations for the quality health care this infrastructure enables. This will create a short-term $100 billion opportunity in upgrading the electronic pipelines they need to be connected to the world’s medical expertise. This will be a vital step in creating peace, prosperity, and enhanced quality of life worldwide.
Many nations with inadequate telephone and communications infrastructures will be able to leapfrog technologies by installing satellite-based wireless networks, satellite transmission systems, and the latest Internet-configured computer-TVs. Very simply, the proliferation of these technologies will make them affordable. Singapore’s Telecommunications Authority leapfrogged by wiring the island with fiber optics, and instantly opened up a new world of telemedicine and electronic commerce. High-quality video and high-speed data transmissions, made possible by dedicated bandwidths and signal compression, will connect even the most rural sites to sophisticated clinical centers set up to do long-distance diagnoses and consultations.
Robo-Surgery
High-speed network communications will allow physicians around the world to do more than consult routinely with each other. Another outcome is that surgeons could use robotic techniques to operate on patients remotely. One scenario that is possible with current technology has the surgeon remotely guiding a robotic arm in real time, with the device filtering out any of the surgeon’s minor hand tremors. The benefit of such surgery is twofold: The best surgeons will perform the operations they do best with the assistance of remote robots, and unique and “perfect” operations could be viewed by medical students in different locations as part of their training.

Robotic and robotically-assisted surgeries can, in fact, be “perfect” because they can be programmed. Imagine a surgeon at Boston General Hospital’s telemedicine center using a virtual-reality environment to “walk through” a complicated organ transplant procedure that will take place the following day in Los Angeles. The surgeon can program his robotic assistant in Los Angeles to carry out the step-by-step operation while he watches in real-time on his video monitor. His colleagues at the University of Southern California are also monitoring the program and are ready to step in physically, if need be, should a problem arise. Bringing in doctors from Harvard and Tokyo University via teleconferencing could add new insight, as needed, for a delicate experimental procedure.

Voxel Digital Holography (www.voxel.com) routinely uses data collected by Computed Tomography (CT) and Magnetic Resonance (MR) scanners to produce true three-dimensional images. The life-size, transparent holograms, Voxgrams, literally extend out in space. Voxgrams enable a physician to interact in, around, and through an image as if it were a real specimen of anatomy, making “programming” an operation a feasible goal.

By using such tools, we will also go toward less invasive surgery. Laser Industries, Ltd., and Biosense, Inc., for example, are jointly developing a system for using a catheter-based navigation system to guide laser beams to heart muscles for the relief of angina and coronary artery disease. The system (www.sharplan.com) allows for the delivery of energy to selected sites on the inner side of the heart wall and may do away with the need for 300,000 coronary artery bypasses each year. Patients will benefit handsomely when telemedicine solutions involving robots, virtual reality, and computer-generated doctors reach the mainstream.

Cyberdocs
In the United States, medicine over the Net will be pervasive by 2008, and virtual “face-to-face” doctor-patient relationships will exist without the barrier of time and space. Sometimes, however, the doctor may be a computer, or cyberdoc.

Just as we have accepted other human-machine influences from voice mail to computers, we will come to not just accept, but also to demand and trust, cyberdocs. It is likely that consumers may get more help from an interactive, intelligent computer than a stressed-out human physician. This makes sense especially if we have a life-threatening illness and cannot afford human error.
Humans may no longer monopolize medicine after we develop robotic surgeons that are more precise than their human creators, and cybordocs that perform routine diagnostics with predictable precision. This will lead to cheaper care available to vastly more people in need. In fact, insurance companies may come to require that robodocs and cybordocs be used because their precision and reliability are higher than that of humans. The use of robotics or cybordocs will be a shock to many at first, but so was voice mail and shopping on the Net.

**CyberDoc Will See You Now: Year 2008**

Feeling ill? The on-duty doctor’s just a cyber-call away in the plugged-in health-care world of the near future.

Quickly, we are linked to CyberDoc—a powerful computer with a soothing voice whose office door is open 24 hours a day via our Net-linked smart card, our health history on a chip.

CyberDoc’s brain is an updated network of expert systems, agents, and neural networks linked to a data warehouse tied to the Internet. CyberDoc is a powerful telehealth associate that both diagnoses and treats patients, as well as teaches and coaches doctors.

We can contact CyberDoc at a local Telemedicine Kiosk, which has large videoconferencing screens, or simply dial in using our small wireless Personal Digital Assistant (PDA). Our smart card, along with a voice recognition security system, gives us access to all the medical information we need to stay healthy.

CyberDoc may decide to connect us to its human counterpart, Dr. Jacobs, who is vacationing at a beach in Rio. Dr. Jacobs can scan our condition on her mobile Digi-Phone screen and order additional tests, which can be instantly conducted at our telemed kiosk and transmitted to her. If something seems suspect, she can quickly get a second opinion from an on-duty medical specialist in Kuala Lumpur. Dr. Jacobs can be brought in if needed to review the results, but CyberDoc doesn’t think this is necessary.

Everything gets billed to our Singapore-based health maintenance organization (HMO), which the next day sends us a curt reminder that frequent-flyer points are awarded to consumers who go through personal health assistants with their medical complaints, rather than directly to expensive physicians. The HMO also offers a 15 percent discount on next year’s rates if we purchase the Cray Company of Switzerland’s new interactive broadcast channel for our home entertainment center.

We decline—and they offer us a PDA co-marketed by Pepsi. We rethink the “sweet–ened” offer.

**Health Empowerment**

We will demand that our cybordocs, robodocs, and real docs support a mass consumer emphasis on preventive medicine—a program of taking care of ourselves through lifestyle modification to prevent illness and preserve. It will spawn the creation of hundreds of new companies in the 21st century.

In 1998, over 20 million people searched the net for health and medical information. Hundreds, perhaps now even thousands, of Websites focus on health. By the year
2005, 100 million or more consumers will be online looking for ways to prevent illness and support their good health. We are hungry for information on which herbs to buy, how many vitamin supplements to take, and who makes the best energy drink.

Fitness will continue to grow as a subsegment of the “wellness” industry. One type of new service that health clubs of the future might offer are “Virtual Health Adventures” that add excitement to exercise. Through a blending of VR, holography, and interactive multimedia, we could be transported to exotic places or adventurous liaisons. One offering could be a realistic dinosaur hunt where we would burn calories and get our heart rate up to a healthy pace in a dramatic escape from a tromping tyrannosaurus. A real-time calorie-burning chart could show our progress. Health insurers will offer virtual cash and prizes for people to slim down, stop smoking, or reduce stress. There will be a variety of incentives for us to stay healthy. If dinosaur hunts are too dusty, we could sign up for a virtual whitewater raft trip down the treacherous Bolo, or a climb to the top of Mt. Everest. For something tamer and in the confines of our own homes, there’s always software that can bring us tennis lessons in our bedroom with Wimbledon champion André Agassi, or a weight-lifting workout with Arnold Schwarzenegger. The possibilities are endless. We’ll have to pay to play, but the end results will be worth it.

Net companies could match these adventure firms—or other types of service providers—with “bundled” packages for customers who are likely to buy and use these products to take more responsibility for their health.

Health Detectives
Predictive Programs containing advanced Artificial Intelligence agents will be a key part of prevention programs. For example, they will analyze patient information and accurately compute the probability of a cardiac condition. Injectable nano agents designed for us personally from our DNA sequence will automatically scout the bloodstream for cholesterol-producing agents and neutralize them—turning them into “friendlies” with no ill side effects.

**Smart Drugs**

“Smart drugs” will join the technologies that play a key role in wellness, as well as a desire for enhancement. Over the next ten years, “smart drugs” will include a new class of nutraceuticals—or mixtures of nutrients, vitamins, and synthesized chemicals. These techno-cocktails will enhance productivity, memory, physical performance, and even entertainment and pleasure. Their growing acceptance may even eliminate street drugs, replacing them with legal pharmaceuticals.

Smart drugs today represent an emerging billion-dollar market, mostly in Europe, and increasingly in Asia and the U.S. The potential of the industry is unlimited as biotech discovers and creates potent new energy boosters. Once these hybrid drugs are accepted, much as coffee is accepted as a stimulant today, they will shape the way we work, live, and play.

Part of this trend will inevitably include ways to “package ecstasy.” Anti-anxiety and antidepressant drugs are just the beginning. The idea of packaged pleasure in a pill will challenge the assumptions we have about leisure, work, and entertainment.
Pharma magic in the 21st century will necessitate a brand-new look at the influence of drugs on society. Will we need smart drugs to cope, manage, or even understand the future we are creating?

A high percentage of people using Prozac—an estimated 15 to 25 percent—do so to enhance their performance. They use it as a smart drug. Wouldn’t we all like to eliminate anxiety, work smarter, be more productive, and be more successful? The pharmaceutical companies hear us loud and clear. Better performance through biochemistry will be a multibillion industry in the stressful, competitive, and chaotic world of tomorrow.

Chemically improving ourselves will become the rage as 21st-century smart drugs help to realize new human potential. Slow performance will become abnormal and de classe. Some drugs derived from natural sources are today pointing in that direction (DMEA, Ondonstron, Nimoditie, Mila-cemide, Parcenten), but tomorrow’s techno-brews will do the job more predictably.

A recent discovery offers an excellent scenario for illustrating how to market such smart drugs. Supposedly, a component of green tea called ECGC may stop cancer by interfering with the way the disease invades cells and breaks down healthy tissue. An entrepreneur could buy a supply of green tea, isolate the ECGC, and then combine it with other known anti-cancer substances. The new tablet could be made chewable and marketed as “Cancer Fighter,” via the Internet, where it would be targeted to disease-specific groups.

Who wouldn’t want to take this anti-cancer cocktail to ward off disease? The $7 billion-a-year vitamin market fueled by over 100 million Americans alone is a strong indication of the power of this movement. I would forecast over a billion smart drug devotees ingesting over $2 trillion in instant health and performance products by 2003.

Medicine in the 21st century will not just be shaped by the convergence of “hard technologies,” but will be forever changed by a new class of drugs, substances, and nutrients that alter our health, performance, lifestyle, and behavior on-demand.

**Yuri’s Diet: Year 2007**

Yuri is a young Israeli medical student living in Tel Aviv who is concerned about his weight. He needs to lose 25 pounds, exercise, and get healthier. Finally, he decides to take action. Using his wireless videophone, he calls his Internet agent, Nanette, a Digitized Engineered Personality (DEP) who is bright, alert, and playful—characteristics chosen by Yuri.

Today, he asks Nanette to assemble a customized weight-reduction package that takes into account his rigorous academic schedule. He also asks her to scan the Net for available data related to his personal health records and to check for any bonus premiums of cybercash credits offered by his employer, HMO, government, or insurance company.

Nanette is configured for Max Intelligence Level 517. She also serves with a passion. Within three minutes, Nanette compiles a complete report, which she downloads to Yuri’s remote computer as an interactive holograph with music, graphics, and charts. It is also delivered in text to his smart card fax.
Among her findings is a cybercash credit program offered by McDonald's-Walmart Health Care, Inc. She registers him and will help him stay on track.
As a true DEP, Nanette is able to self-evolve, learn, and adapt based on the moods, behaviors, and actions of her creator. For example, she knows Yuri’s moods and limitations—such as being in denial about the reasons for his weight—and is able to integrate his responses to her in order to come up with solutions for achieving her prime directive, helping Yuri trim down. To this end, Nanette will navigate through all parts of Yuri’s life, and will, for example, actually lock the refrigerator after 5 P.M. if necessary. “I’m sorry, Yuri, snacking is not approved on your diet.” Food not on Yuri’s diet is no longer approved for purchase at the supermarket checkout. Ditto with cigarettes, which Yuri has vowed to quit as part of his new lifestyle. Nanette sends him this message each day: Veggies okay. Easy on meat and diary. Low and no fat is the ticket. Exercise is key.
In addition, Nanette offers encouraging reinforcement by assisting with finding research projects and hunting down discounts at Yuri’s favorite Italian clothing stores. She also builds a network of support with Yuri’s friends and relatives by letting them know his progress and how they can help him achieve the end goal. Nanette advises Goloy, Yuri’s mother, not to drop off any more chocolate chip cookies. She arranges regular tennis, running, and exercise partners and coaches to fit in with Yuri’s schedule.
Yuri made it clear that Nanette should be relentless in helping him fight the battle of the bulge. Yuri’s contract for these health changes cannot be canceled for six months, and he has to live with the consequences of Nanette’s zealousness.
The kicker comes when Nanette, unsatisfied with Yuri’s initial progress—his weight is still high as is his cholesterol—puts together a holographic “This is Your Life” health magazine that depicts his family history of weight-related health problems and early deaths. A lifeline for Yuri shows that unless he sticks to the program, he’s due to keel over at the age of 56.
Shocked by such in-your-face data, Yuri joins the gym recommended by Nanette, and quits avoiding the prescribed medications. He stops sneaking snacks and swears off nicotine. Before the six months are up, Yuri’s reached his goal, dropped his weight, and has to spend a bundle on slimmer, more fashionable clothes. He’s also got another problem—a sudden flock of admirers. This time, however, he decides not to call on Nanette. “Bring on the real,” he muses. Nanette “feels” rejection.

**Future Implants**
The makers of medical devices are also gearing up for the new millennium, with products to help people cope with physical problems and mental disorders. New surgically implanted devices, similar to the way a pacemaker works to keep the heart beating normally, are being developed to remedy the symptoms of epilepsy, Parkinson’s, tremors, chronic pain, incontinence, and sleep apnea. Researchers in this field believe a common thread to the disorders lies in the misfiring of the body’s...
nervous system. An up-and-coming company, Medtronic (www.medtronic.com), is pushing the envelope on this approach, but competition won’t be far behind. But implants may be where the action is in the future. Implants, injected microprocessors, bio-implants made from organic materials, and even DNA implants will be a thriving industry. Implants will be used to enhance memory for Alzheimer’s patients, replace limbs, retrofit nerves, and replace organs such as kidneys or eyes. Implants will also be used to enhance human performance.

Potential Future Implants
Brain implants for: improving and enhancing memory—enhancing intelligence—new languages and skills—increasing perception awareness
implants for legs and arms to strengthen or make them flexible
implants to replace organs, muscles, and limbs
implants for assisting fertility
implants for replacing eyes, ears, or noses; or enhancing sight, sound, smell, and taste
longevity implants to prolong health and eliminate disease (free-radical scavengers)

Genomic Medicine, the Conclusion: Year 2045

Android Selection
“I can choose any of these android bodies to download my mind into?” asks Ken.
“That’s it. We have five models to choose from, and we can simulate through our Virtual Reality console what you will look and feel like,” says Jeffrey.
“When all is over, does that make me an android or a cyborg?”
“Actually, when the transfer is complete, you will be classified as a Human Cyborg versus the Synthetic Humans that are all android or robots that have no human parts or human DNA.”
“How long will I live?”
“With the normal maintenance and upgrades, we’re projecting forever, or until you request termination.”
“Forever sounds fine,” Ken asserts. “What about the risks?”
“Oh, the usual. Accidents, insanity, war,” Jeffrey continues. “Of course, we are not expecting to try a full transfer for about ten more years, but I think we can keep you telemersed and harvest enough synthetic organs for you until then. How are those new eyes, nose, stomach, memory implants, and hearing implants working?”
“They’re fine, along with the bio-fab knees and new heart valves. Though sometimes when I cough, I still see reruns of I Love Lucy shows in my vision field.”
“That’s that new AT&T-AOL-INTEL M4 chip. I will download a patch to fix that pronto. Why didn’t you tell me about this?”
“Well, to tell you the truth, I am a big fan of Lucy, and I don’t really mind it,” Ken laughs.
“Okay, you love Lucy, too. Now let’s talk about the Cyber-Mind download.”
“So I can actually do a test run of the different android bodies to see how I like them? Cool.”
Jeffrey moves his hands to attach wireless electrodes to Ken’s head, and Ken is transported into a virtual scene where he selects an athletic-looking android called
Beta Adonis 3000 to embody. “Looks good. How does he perform?” Jeffrey, represented by a Virtual Jeffrey in the simulation, asks Ken. Ken is running up a virtual mountainside with the speed of a cheetah, while barely breaking a sweat. His android eyes see better than 20/20, and his hearing is very sensitive to the simulated forest around him. He is operating at optimum levels, exceeding human performance by 185 percent.

“Great. I’ll take it,” says Ken, terminating the simulation. “Tell me what’s under the hood.”

“Only the best that science can build and your money can buy. An Intel/TI Supercollider Penta 500 Hardware Bio-Engine and Picoflex skin smooth as a human’s.”

“No, I mean under the hood down there.”

“Oh, don’t worry. You will be fully functional in all areas for optimal sexual pleasure and sensory satisfaction, or you get your money back.”

“How about getting my mind back?”

“Sorry, Ken, that’s an extra we just cannot guarantee at this time.”

“Great,” says Ken, shaking his head and wondering what’s next.

**Future Health-Care Trends**

Applying the Four Power Tools to health care will put certain trends in motion. I believe that the following trends will be business-critical to the health-care system of the future. They represent challenges, but also competitive advantages for companies that want to build the next-generation health-care enterprise.

Holographic projection: The use of life-size transparent holographic images of the human body anatomy projected into a room or onto a virtual space online for physicians to interact with as if it were a real patient.

Augmented reality: Supplementing the real world by adding virtual objects so that goggle-wearing surgeons, for example, can “see through” a human body as they perform an autopsy.

Robotic surgeons: Performing operations with their movements controlled by a specialist at a remote site or preprogrammed for a specific task and monitored by a physician. Early successful trials were by Robodoc, of Integrated Surgical Systems, in Sacramento, California (www.robodoc.com), which focused on hip replacements.

Wetware: Emerges as computer-implanted technology allowing direct brain access to extend intelligence, skills, and memory. Embedded intelligence becomes as natural as breast implants.

Synthetic tissue growth: The growing of tissues and organs for human transplantation.

Neurogeneration: The repair and growth of spinal cords and complex organs.

Cloning banks: Repositories of an individual’s cells that can be grown into organs on-demand to replace diseased body parts and prolong life indefinitely.

Health data piracy: Black market sales of people’s’ health data. This will undoubtedly be a big illegal business in the near future.
Re-engineering Health Care
In one way, we’re back where we started in this chapter. I want to reiterate the desperate need for a unified health systems architecture, connecting consumers providers and suppliers into one integrated network that will optimize care, productivity, and communications. The Internet certainly could be a backbone for such an architecture. The connected health-care enterprise, public or private, will be where the greatest cost and quality efficiencies will originate in the future. Today the Tower of Babel of discrete systems that serve the health-care system breeds inefficiency and waste. Care is compromised, and costs continue to escalate. Systems must talk to systems, providers, and consumers.

Current Problems of the Health-Care System
Lack of information standards and systems
Lack of unified enterprise connectivity and communications
Antiquated stand-alone computer systems
Paper-dependent procedures, records, and files
Labor-intensive, human-dependent practices
Little access to medical information on-demand
Lack of electronic training and education
Little use of electronic channels for patient education, monitoring, and care-to-patient communications
No centralized electronic procurement of resources, services, and supplies
No standardized consumer health information
No standardized personal health record

Benefits of a 21st-Century Network Health Systems Architecture
Lower costs for providing better care
Greater security of records
Authorized access to complete patient information on demand
Real-time knowledge management, sharing, and exchange
Human resource savings
More efficient communications among patients, providers, and suppliers
Elimination of paper, waste, and redundancy
Real-time consumer network access to customized health information, health promotion, and prevention services

Designing a New Health Architecture
A new health architecture would bring together many different technologies to help people better communicate, share knowledge, and provide health care. The goal is to automate the complex administrative, clinical, and service components into one holistic network. Assuming in the U.S. that we could save $300 to $500 million from the deployment of a “Global Health-Net” model as proposed here, we could apply it to the improvement of health-care delivery quality.

Applications of a 21st-Century Network Health Systems Architecture
Net delivered education and training
Wireless unified messaging
Multimedia interactive patient files design and access
Workflow telecommunications between care providers
Groupware
Clinical electronic file transfer
On-demand knowledge access across the medical enterprise
Research and development findings available over the Net
Real-time lab data access on the Net
Videoconferencing and telemedicine procedures and education
Net-based patient billing
Net-based scheduling
Patient and physician communications over the Net
Net-available patient health education and disease prevention courses

Health Trendsetters
I have watched the evolution, or rather the devolution, of health care over 20 years: No force will enable and empower change as deeply or as fast as technology. Here are some of the key trends that forward-thinking companies have set in motion to take health care into a new age empowered by technology:
Ordering medication online will drive prices down and create a new competitive online market reaching millions (www.Drugstore.com).
Physician quality management, for patients who want to evaluate and determine specialty information about doctors, will drive competition as well as improve physician quality assurance (www.Digimed.com).
Health-care provider knowledge bases, such as www.physicansomonline.com, will enable customers to access provider information and make better decisions.
Electronic network procedures will eliminate the paper-based and labor-intensive procedures that create waste and inefficiency (www.healtheon.com; www.kintra.com; www.proxymed.com).
A fundamental shift in the health-care system is coming, and it is driven largely by changes in the Internet and e-business, the networking efficiencies of the new economy. This shift will present a cornucopia of new business opportunities for companies that can provide agile and tech-enabled solutions to health-care delivery problems. It is an exciting time to be in this market. Many new paths will open up in the next millennium for companies that want to teach this dinosaur to dance.