

CHAPTER
16

Health@Everywhere— From Inpatient and Outpatient to Everywhere

“I will prescribe regimens for the good of my patients according to my ability and my judgment and never do harm to anyone.”

Hippocratic Oath

“Previous generations assumed that we would always rely on nonrenewable fossil fuels to meet our energy needs. They regarded environmental pollution as an inevitable by-product of economic development. And they assumed that we would always rely on medical professionals to supply all the health care we needed. They were wrong on all counts. But while we are now actively protecting our environment and developing sustainable energy resources, we are just beginning to understand that our present healthcare system is also becoming unsustainable.”

Thomas Ferguson, MD

Health@Everywhere starts with a look at the person-centered healthcare world of 2020 that takes integrative medicine to the next level. It discusses eHealthcare information technology systems and Medical

Informatics 20/20 solutions as they evolve from their existing focus on inpatient and outpatient services to anywhere a person may be: at work, home, or play. Health@Everywhere delivers an overview of critical developments needed to navigate effectively through the next several decades. This chapter concludes with a snapshot of the next-generation preventive care called “preemptive medicine” and a final fast forward view into the future. The following key areas are highlighted in this chapter:

- ***Person-Centered Health Care:*** powered by self-care and eHealth Advisor Live
- ***Cutting-Edge Medical Sciences:*** “-omics” (genomics, glycomics, proteomics, lipidomics, metabolomics, etc.), regenerative medicine, psychoneuroimmunology
- ***Complementary & Alternative Medicine (CAM) and EHRs***
- ***eHealthcare—TeleMedicine and More***
- ***Wearable Intelligence Technology Systems (WITS)***
- ***Smart eHealth Record Systems for People and Providers***
- ***Genetic Information Systems and Biorepositories***

Forces Driving the Need for Innovation and Collaboration

Meeting the needs of people in health care is becoming an ever-more challenging proposition as costs rise, reimbursement goes down, quality accountability goes up, and demands for new cures increase. Professionals, politicians, and patients are realizing that the current healthcare system, despite all its strengths, is broken and must be transformed.

Simply put, the current system must evolve from a doctor-centered production system to a person-centered, holistic, integrated system, supported by advanced health and medical informatics. The fact of the matter is that each of us is the primary healthcare provider for ourselves. In many ways, people are becoming their own “ConsumerMD,” supported by the information systems, technologies, and techniques that enable the self-care we have previously highlighted in this book. Over time, with the growth of eHealth and new forms of preemptive care, individual accountability for our health will grow beyond the role of the doctor.

From the perspective of the PERSON (or Person Centric Continuum of Care, as described in Figure 16-1), the leading challenges and drivers of change are:

- ***Explosion of Medical Science Knowledge and Technologies:*** Medical knowledge doubles every couple of years. Add to that the belief that technology can solve most of our problems and that technology development is an unstoppable force. This force is tempered by the current 15 to 20 years it may take to move a medical invention or technology from bench to bedside or anywhere a person might be.
- ***Human-Made Epidemic of Medical Errors:*** The rise of medical errors as a result of system complexity and other factors
- ***Threats of Disasters and Epidemics:*** Threat of natural or terrorist-driven disaster, outbreaks of avian flu or CA-MRSA, and other communicable diseases
- ***Rising Cost of Health Care:*** The ever-increasing costs of health care as percentage of United States GNP, in part due to global warming and dependency on nonrenewable energy sources for our lifestyle
- ***Live Long and Prosper:*** The fundamental demand that people be properly treated, cured, and live as long as possible
- ***Unlimited Demand, Finite Resources:*** The seldom articulated fact that health care is a periodic, unwanted purchase for which there are unlimited demands and finite resources
- ***The Internet and the Rise of Sophisticated Consumers:*** The Internet has delivered medical knowledge to the fingertips of any person connected. Online health and medical information is making people more aware and more empowered because they now have access to the brains
- ***Person-Directed Care:*** The shift of responsibility for healthcare costs onto the consumer within a complex medical care market, using the theory that people who are able to access more information will make better decisions
- ***No Access to Care:*** The reality that billions of people across the planet have no access to even the most basic of healthcare services
- ***No Access to Affordable Insurance:*** The fact that because 40 million or more Americans have no health insurance, many conditions are not addressed until it is more costly or too late

- ***Outdated and Uninformed Care:*** The fact that 50% of patients' treatment or diagnosis is not based on the most current medical evidence, and 20% to 30% of patients receive improper care
- ***Care for the Aging Population:*** A future cornerstone of many acute and chronic disease states for the baby boomers of the United States and other developed countries. Plus, given this group's view that they are ever-young, there will be a robust market for prevention and health maintenance products and services.
- ***Self-Care or "My Care":*** Self-care is and has been the largest provider of health care since the beginning of time. Only in the industrial age of medicine did the myth that "doctors knows best" become widespread. In the information age of medicine, the empowered person seeks help from appropriate professionals who act as coaches, facilitators, detectives, and healers.
- ***Here Come the Baby Boomers:*** One of the most important multifaceted driving forces is the aging of the societies of developed countries. In the United States, this is illustrated by the aging baby boomers, a generation that has radically shifted and altered history by their needs, choices, and preferences for the last 60 years. The first baby boomers turned 60 in 2006 and the last will be turning 60 around 2020. Yes, this age cohort is healthier but their needs for better health and quality medical care will define the next generation of healthcare services. The baby-boom generation is the first that realized that the establishment or the doctor doesn't always know best. This generation also realizes that maintaining health and overcoming illness requires an integrated, holistic approach.

Predicting the future is impossible, but these final chapters of the book highlight important technologies that will help empower people and allow them to become much more of their own primary healthcare provider. Wearable systems, nanotechnologies, embedded sensors, personal health records, and virtual eHealth Advisors will all contribute to this vision. Many of these Medical Informatics 20/20 inventions are in development and early diffusion, which in turn supports the increasing deployment of EHR systems leading to the realization of quality healthcare. The intent of this chapter is to enlighten you to possibilities and potentials. When we are enlightened, inspired, and informed, we can properly prepare ourselves and our organizations for the future.

Transforming into a Person-Centered Healthcare System

During the next 15 years, the consumer-directed movement of the early 21st century will evolve and fully recognize that in health care, people do more than consume a product. The healthcare industry will realize that people are not simply patients to be defined by their disease or condition. The healthcare industry will fully realize that healing and supporting optimum health depends on a person-centered philosophy that recognizes that people, not physicians, are their own true primary healthcare providers. There will also be a recognition that the whole person must be treated: mind, body, and spirit. Hopefully, we will finally create a sustainable healthcare system that delivers access to all and is in sync with a more healthy environmentally sustainable world.

As we continue to move forward and attempt to transform the system, we must remember that health care is a very personal “knowledge-based” service. Unfortunately, at this point in time, people and clinicians are finding that they are drowning in information. People and clinicians do not have the intelligent interfaces that deliver the information they really need when they need it. Over the next decade, the number and kind of healthcare coaches or “infomediaries” will expand rapidly. A current example of this is PinnacleCare (www.pinnaclecare.com), where a human health coach is supported by leading medical experts and online information resources, such as extensive knowledge databases, that can support a person undergoing complex medical care. This human coach helps a person navigate a complex medical field and also seek out and analyze the most advanced treatment options available that may be appropriate for an individual. (See the PinnacleCare example in Chapter 13.)

At the beginning of the 21st century, the field of health coaching and advocacy started to grow with humans being aided by computers, knowledge bases, and the Internet. The field of health coaching seeks to support people in finding and managing a complex system to get better care. Initially, health coaching was only available to people that could afford the membership fees, but advances in medical informatics, artificial intelligence, and mobile-anywhere services will ultimately allow anyone in need of these services to access them. In fact, the next decade will see health services, that in the past were provided only by human professionals, converted into easy-to-access, cost-effective, artificial intelligence programs

that are embedded in a PDA, iPod, Zune or some other mobile device in essence creating virtual eHealth advisors/nurses and support entities.

Over time, public health officials and doctors operating in this virtual world will become more sophisticated as they monitor people's health through data-mining of EHRs and monitoring of real-time physiological changes reported by wearable and embedded sensors. Using the knowledge gained from these sensors, a virtual health counselor (eHealth Advisor Live) will diagnose, treat, and recommend preventive measures. Automating the processes using thinking "mindware" (advanced anticipatory/predictive software)—and the continual ability of technology advancement to exponentially reduce the cost of hardware devices—will drive the costs of the virtual smart health counselor services down to affordability.

Over the next several decades, the direction of change will lead to the vision of the "Person-Centric Continuum of Support—Health@Everywhere 2020" illustrated in Figure 16-1. At the center is the person who seeks optimum health and effective treatment of acute or chronic conditions. This figure represents the evolution from the ConsumerMD described in Chapter 1. We anticipate that by 2020, a person (if they desire and their conditions demand it) will be surrounded by virtual and

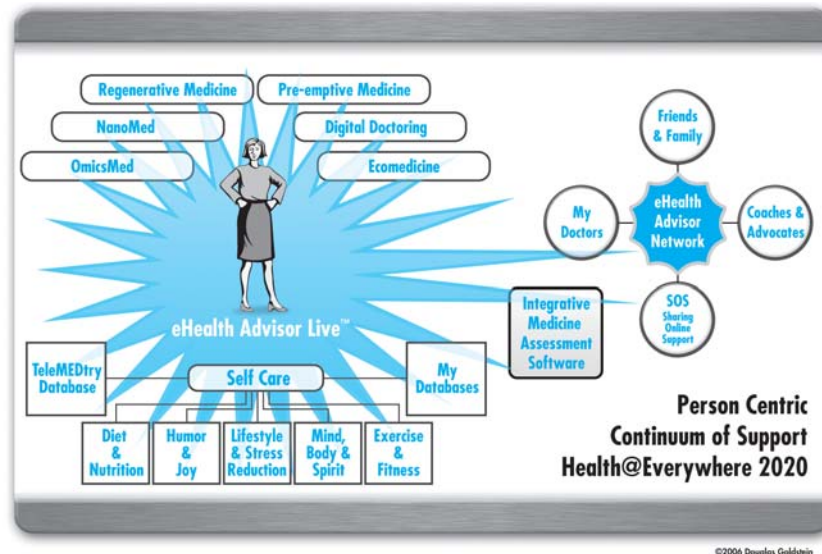


FIGURE 16-1 Person Centric Continuum of Care—"Health@Everywhere 2020"

real-time, around-the-clock health and medical assistance through various wearable, mobile, and implanted systems.

In Figure 16-1, the surrounding sunburst represents points of connection with eHealth Advisor Live™, an intelligent software virtual agent designed to support optimum health and acute/chronic treatment through multiple communication and connection methods. The elements of a person's health connections as represented by the sunburst are described below.

Person-Centered—In health care, people are more than just consumers or patients. A person must take responsibility for his or her own health and leverage all the knowledge and resources available. In the first chapter, we discussed the concept of ConsumerMD, whereby people are their own primary caregivers. Person-centered care is the next evolution, whereby healing and health are part of a multidisciplinary approach that addresses the mind, body, and spirit holistically. In the future, the person with acute and chronic conditions will access the best care and quality through the integration and communication of multiple systems that leverage intelligent software agents that have artificial intelligence, networks of care professionals, and multiple medicine modalities. Person-centered health care is powered by a person's knowledge and know-how, along with online support by what we are calling the virtual eHealth Advisor and eHealth Advisor Network.

Self-Care—Self-care has been and will continue to be the largest provider of healthcare services. The difference in the 21st century is that the medical professional has started to realize the healing power of the mind, body, and spirit. A person's state of health results from a complex interplay of biology and environment, and the medical mainstream now recognizes that health and healing is enabled by various elements including support by friends and family, right diet and nutrition, humor and joy, lifestyle, and mind-body-spirit connection. The solution is not always a pill. Self-care harnesses the power of preventing illness, curing disease, maintaining optimum health, applying the best medical modalities, and using the next generation of wearable, go-anywhere medical services. Later in the chapter, the status and evolution of wearable intelligent technology systems (WITS) and other technologies are highlighted. Medical science, technology, and personal empowerment will come together in the next 20 years to create a service that we call eHAL or the eHealth Advisor Live.™

eHealth Advisor Live™ (eHAL)

eHAL will serve a person's every medical need with the following services:

- Access wireless real-time connection to Internet2 and public and private health and medical knowledge bases
- Access your electronic personal health record (ePHR) anywhere, for review or an emergency
- Have your ePHR updated real-time from wearable or embedded biometric sensors
- Get answers (not just a listing of thousands of Web pages) to health and medical questions
- Get decision support based on billions of bits of medical evidence reviewed and assessed against your medical history and genetic profiles
- Interact with others who have similar interests
- Have a smart, personal, digital advisor, who knows your needs and preferences, manage information for you
- Query a network of care professionals via subscription services or through an alternative access mode
- Buy health- and medical-related products
- Maintain eRx services that manage and monitor the appropriate use of personalized prescriptions and over-the-counter products, from drugs to nutraceuticals
- Schedule live, in-person appointments, if needed
- Monitor and record food and drink consumption, exercise, and other desired activities from sensors in the home or on/in the body
- Get preferred services from health system and doctor partners
- Access an array of additional services tailored to a health or chronic medical condition
- Be a virtual coach and support to the person

eHealth Advisor Live™ (eHAL)—An always-connected virtual health advisor that is more than software and more than hardware. It is a virtual nurse–doctor who knows your needs and is on-call 24/365 to guide and support your health and medical journey. The first HAL was the ubiquitous computer that guided the mission and maintained the life-support systems in the movie *2001: A Space Odyssey*. The eHealth Advisor Live, or eHAL, is a series of health and medical programs and services embedded in a mobile-anywhere device that is always connected to the Internet2 grid (see Chapter 14 for more information about Internet2).

Think of eHAL as a highly evolved, digital assistant with exponentially more computing power than today's personal computer, but available in a mobile device the size of a video iPod or smaller. This eHealth Advisor artificial intelligence service and system could be worn, held in a pocket, put on a belt, or even attached to sunglasses, with a visual display on the lenses and an audio feed in the frame. It is an advanced thinking software system, tailored to the health and medical needs of the specific person. It is a knowledge source, a decision support advisor, health coach, and much more. It represents significant evolution from the mobile multipurpose device described in Chapter 1.

The Institute for Alternative Futures report, "The 2029 Project: Achieving an Ethical Future for Biomedical R&D" (<http://www.altfutures.com/2029/The2029Report.pdf>), which outlines significant health and medical advances that are likely to occur, refers to a similar concept called a "Health Coach Avatar."

The eHealth Advisor Live is the gateway, filter, intelligent search engine, and coach that knows the second-by-second status of medical conditions as fed in real-time to TeleMEDtry and medical history databases that include genetic profiles. The eHealth Advisor Live™ will be the synthesis of the information and health developments underway that involve intelligent computer-embedded clothing, self-generating software programs, and artificial intelligence health agents. Depending on a person's condition, electronic circuitry can be connected wirelessly or even hard-wired to nerves and tissues.

My Doctors—A person's network of medical professionals who maintain medical records about the patient as a result of past in-person interactions. This network will likely include a primary care professional, which could be an advanced practice nurse, primary care physician, board-certified holistic practitioner, or other qualified professional. In-person diagnostic and treatment services would be linked with the provider who actively supports eHealth Advisor Live™ with software/knowledge updates and online help from humans when needed, under monthly subscription arrangements.

Integrative Medicine Assessment Software (IMAS)—Imagine the beauty of having the world's latest and greatest medical evidence base across conventional western, alternative, complementary, Chinese, Native American, and Ayurvedic medicine available upon voice request from your eHAL. IMAS is an example of a comprehensive "multi-medical modality

Health care in 2020 will be dominated by Human User Interfaces (HUI) that allow people to regularly interact with virtual agents that exist only in the programming of a sophisticated artificial intelligence program. For a sample of a virtual agent, visit Ray Kurzweil's Web site and explore the future as the speed of innovation and technology change accelerates. Be sure to visit with Ramona, a virtual agent prepared to answer your questions.

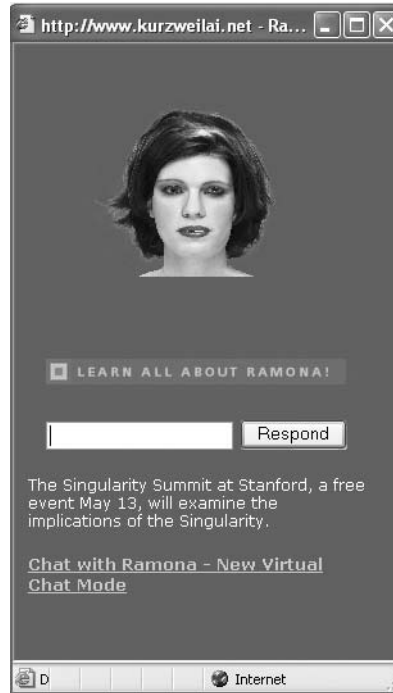


FIGURE 16-2 From GUI to HUI—Human User Interfaces

Source: <http://www.kurzweilai.net/index.html?flash=1>

search-synthesize-tailor to a person's specific health needs" program that would be assessed when needed by eHealth Advisor Live. When there was a new diagnosis of prostate cancer, eHAL would take the person's information provided through medical and genetic profiles, along with electronic feeds from doctors' medical records, include updated information from all provider-based medical records, and combine it with up-to-date TeleMEDtry (see description that follows). Remember, in 2020, clinical data standards and seamless interoperability have been solidly in place for five years. And the dominant interface to computer/Internet services will have evolved from keyboard/graphic interfaces to voice/virtual agent interactions with neuro-interface in advanced trial and experimental phase.

TeleMEDtry—Medical telemetry is the process of monitoring health and medical vital signs, biomarkers, environmental factors, and other physiological processes within and surrounding a human being. TeleMEDtry in 2020 will use all modes of data and information transfer from wired to wireless, and the source devices will include wearable devices, nanotech bots implanted and circulating within the human body, or embedded sensors in a person's home. The data from these sensors will enter the eHAL database for processing, archiving, and analysis.

My Databases—A person's health and medical history in 2020 will far exceed the 20th century paper form that lists little more than conditions and allergies. It will consolidate medical information from every type of care professional from primary care physician, specialist, and hospital to nutritionist, chiropractor, and mental health therapist. The database will also compile real-time physiological information from wearable, implanted, embedded bio-sensors. In addition, the complete genetic, proteomic, glyceomic, and other “-omic” profiles will also be available for the personalization and targeting of NanoMed and MEMSMed to treat and cure diseases.

Search, Screen, and Recommend—With the rapid increase in medical and business knowledge comes the need for better search technology and interfaces that deliver the medical knowledge and recommendations needed by people and professionals. This means better decision support tools that offer ongoing analysis and synthesis of medical evidence for those who subscribe.

eHealth Advisor Live™—Network—eHAL will be augmented by a psycho-social support network to help deal with issues associated with the many chronic and acute conditions encountered through a 100-plus-year life span.

- **SOS (Sharing Online Support)**: A pick-and-choose set of online support groups that are screened and recommended based on the quality of the interactions and nature of the condition
- **Friends and Family**: A private network of selected friends and family who can be available in synchronous or asynchronous mode depending on the preference of a participant

Advanced Medical and Health Science @ Point of Need—The delivery of the latest and greatest health and medical knowledge appropriate for an individual, based on profile and conditions. Additional informa-

tion about biological sciences, technology, and other disciplines is provided throughout Chapters 14 and 15.

Preemptive Medicine—The current revolution in preventive medicine of leads to the next-generation approach called “preemptive medicine,” which will zap cancers and other conditions based on the genetic and environmental warning signals before they even become a disease. Since the field has not yet been invented, and due to limited space in this book, a complete description of this new medical and health discipline will be available at www.medicalinformatics2020.com.

This section has outlined what is possible and probable based on the direction of change and driving forces. Of course, every individual will not use all of these eHealth support options at the same time. Each person will determine which of these services to use at a particular time, and there will be phases of high use—such as a period of time when cancer is being treated—versus times of use that purely focus on exercise and fitness training. Our purpose in building this personal profile of “surround medicine” is to describe what could easily be available in 2020. The views of the future are based on the current technologies and services in development, testing, and initial stages of diffusion throughout healthcare systems in countries around the world.

eHealth Advisor Live™

Is the embodiment of Medical Informatics 2020 as it represents the evolved technology, social science, clinical decision support, and so on that extends and supports people wherever they are. In the future, people will not have to find a computer with an Internet connection and then spend hours searching, assessing, and just getting more and more confused. In 2020, an individual will have the same access to knowledge as professionals. Empowered self-care that is supported by the virtual eHealth Advisor Live (eHAL) will become steadily more important.

The healthcare system exists to serve people when they are in need as patients. “*Quality and People First!*” Tomorrow, emerging technologies can transform this system into one that really focuses on individual and population health optimization. To achieve this future by using the health and medical innovations described in this chapter requires guiding principles and a foundation such as the IOM Ten Rules for Redesigning Health Care, which can be a great foundation. Table 16-1 lists these rules and

Table 16-1 Ten IOM Rules for Redesigning Health Care and Medical Informatics 20/20 View

IOM's Ten Simple New Rules for 21st Century Healthcare System	The Medical Informatics 20/20 View
1. Care based on continuous healing relationships	... real-time eHealthcare anywhere, based on a person's acute or chronic conditions
2. Care is customized according to patient needs and values	... recognizing the interrelationship of mind, body, and spirit in health and disease treatment
3. The patient as the source of control	... with a focus on the person first, and his or her right to participate in the treatment process
4. Knowledge is shared and information flows freely	... which empowers people to make wise decisions
5. Decision making is evidence-based	... and delivered effectively at the point of care
6. Safety is a system property	... at the highest possible levels of quality
7. Transparency is necessary	... including safety, evidence-based treatment, proven community-based treatment and the delivery of knowledge to clinicians and people at the point of need
8. Needs are anticipated	... through preemptive care using data from interoperable electronic health records that are accessed by patients and care providers
9. Waste is continuously decreased	... and the health system is sustainable and ecologically sound
10. Cooperation among clinicians is a priority	... as are partnerships among clinicians, patients, and their families
<i>IOM Rules + Two Medical Informatics 20/20 Rules</i>	
11. Quality and appropriate care delivery anywhere is reimbursed	... which means the reimbursement system must reward quality care for professionals and support appropriate care regardless of location
12. Spread the risk through population-based risk pools	... and reward positive health behaviors of individuals

provides a Medical Informatics 20/20 perspective to guide us in creating the future.

The column on the right of the table adds perspectives representing the Medical Informatics 20/20 view regarding the ten simple rules. Rows 11 and 12 represent gap areas in the IOM rules that are needed for the year 2020. A well-known phrase states that if you want to understand and change behavior then “follow the money.” None of the IOM ten rules addresses reim-

bursement and spreading the risk issues. Transformation of health care depends on changing the reimbursement to reward quality and accountability within the context of broad risk pools that spread risks and costs.

The following highlights reflect driving medical and technology forces and include a discussion of the direction of change, current state, and thoughts on steps for tomorrow that leaders, managers, and healthcare organizations can take as they create the future.

Cutting-Edge Medical Sciences and Technologies

Direction

Medical science—biomedical, “-omics,” pharmaceutical, nanomed, regenerative medicine, and all areas of specialty research and development—will revolutionize the preemption, diagnosis, treatment, and care of acute and chronic conditions. Unfortunately, the reimbursement for medical advances will not evolve as fast, so the time it takes a medical advance to move from research to bedside and from bedside to anywhere will not be significantly compressed.

Current State

This section highlights several very exciting frontiers in medical science that are moving from research phase to testing, and some cases widespread use, in the battle against disease and epidemic and in support of optimum health by 2020. Highlighted here are the fields of medical biology and regenerative medicine. Other emerging medtech areas such as nanomedicine and ecological medicine were reviewed in Chapter 14.

Genetics is the science of genes, heredity, and the variation of organisms. In research today, genetics is the science for the research and analysis of gene function and interactions. Within organisms, genetic information generally is carried in chromosomes, where it is represented in the chemical structure of particular DNA molecules. Genes encode the information necessary for synthesizing the amino-acid sequences in proteins, which in turn play a large role in determining the final phenotype of the organism. Genetics determine much (but not all) of the appearance

of organisms, including humans, and possibly how they act. Several medical genetic breakthroughs are:

- **Breast Cancer Research:** The BP1, a gene discovered by Dr. Patricia E. Berg, is activated in 80% of breast cancer tumors and a majority of acute myeloid leukemias, and shows similar activity in other cancers. Recent data show that BP1 is associated with the progression of normal cells to cancerous breast tumors, and research is underway regarding the development of a gene suppressor and a blood test for diagnosis and monitoring therapy, and confirming the impact of BP1 on other cancers. Additional research by Berg has shown unusually high numbers of BP1 positives in the breast tumors of African American women. This knowledge could prove very useful in discovering answers to racial disparities in rates of breast cancer.
- **Genetic Breakthroughs in the Cause of Crohn's Disease:** Researchers have discovered the first gene that confers susceptibility to Crohn's disease, which affects more than 500,000 Americans and millions worldwide by inflicting a debilitating form of inflammatory bowel disease. Through a multidisciplinary collaboration, scientists across the spectrum of various fields identified a mutated form of a gene called NOD2 that significantly increases a person's risk for developing Crohn's disease. This discovery is built upon research into how genetic and environmental factors combine to initiate an aberrant immune response, which cascades into a destructive inflammation of the digestive system. Crohn's disease, because it involves two or more genes, is genetically complex, and thus the search for the specific genes is much more difficult. Researchers believe that discoveries such as these, indicating the genetic and environmental causes of Crohn's disease, will lead to new therapies and new methods for identifying individuals at risk for developing the disease, and eventually result in better treatments.

“**-Omics**” is the suffix reference to rapidly specializing fields within biology and biomedical research and development. It evolved from the use of the “-omes” suffix. For instance, *proteomics* is the accepted term for the study of the *proteome*. Other uses of “-omics” include:

- **Genomics:** The study of an organism's genome and the use of genes at the system level toward the development of useful therapies and other applications

- **Glycomics:** The area of investigation relating the function, interaction, and structure of chains of sugar. Glycome is the entire carbohydrate component of an organism.
- **Lipidomics:** The field of study of lipids (non-water-soluble metabolites) and their interactions
- **Metabolomics:** The investigation of chemical traces/evidence that cellular processes generate

Regenerative medicine is the field of applied tissue engineering, which has the tremendous and realistic promise of regenerating damaged tissues in vivo (in the living body) and externally creating “tissues for life” available for implantation. Through research and products developed from this field, previously untreatable diseases will become easily and routinely cured. Regenerative medicine will become a major component of health care in the next 20 years. This field refers to the use of stem cells, xenotransplantation, tissue engineering, induced regeneration, and modulation of the aging process. Regenerative medicine applies medical science and technology to restore the structure and function of damaged tissues and organs. This new field encompasses many novel approaches to treatment of disease and restoration of biological function through therapies that stimulate the body to regenerate damaged tissues and the use of tissue engineered implants to encourage regeneration. The promise of regenerative medicine is that there will be a higher quality of life for people suffering from advanced stages of diseases such as Parkinson’s, and it will also lead to extended healthy life spans for others, based on the ability to repair damage that results from aging.

Psychoneuroimmunology is a field of research that studies the connection between the brain, or mental states, and the immunal and hormonal systems of the human body. For instance, the placebo effect and psychosomatic disease are part of this subject. One source of information on this field is the Psychoneuroimmunology Research Society (PNIRS) an international organization for researchers in such scientific and medical disciplines as neuroscience, psychology, immunology, pharmacology, psychiatry, behavioral medicine, infectious diseases, endocrinology, and rheumatology. This organization supports the interchange of research and knowledge among researchers and clinicians studying the interactions between the nervous system and the immune system, and the relationship



FIGURE 16-3 HHS Regenerative Medicine Web Site

Source: <http://www.hhs.gov/reference/newfuture.shtml>

between behavior and health. Some of the research areas identified on the PNIRS Web site (www.pnirs.org) are:

- Neurochemical and hormonal mechanisms that convey messages to and from the immune system and brain
- Stress and immunity, including the role of stress-related hormones and neurotransmitters on the immune system and brain
- Actions of cytokines and growth factors on neuronal and glial cells to regulate behavior, cognition, and neuroendocrine function
- Roles of hormones, growth factors, and cytokines in the immune and central nervous systems
- Inflammation, neuroscience, and behavior
- Neuroimmunopharmacology and the immunomodulating effects of psychotropic drugs and drugs of abuse
- Sleep, exercise, immunity, and health
- Roles of cytokines, hormones, and neurotransmitters in the aging immune system and brain
- Cancer, brain, and immunity
- Regulation of nerve injury and repair by the immune system
- Psychosocial, behavioral, and neuroendocrine influences on immunity and on the development and progression of immunologically mediated disease processes
- Genomics of behavior and immunity

Medical Informatics Superhighway

Medical Informatics 20/20 is the vital infrastructure delivery system for the diffusion of proven medical breakthroughs to be delivered to people before or at the point of care. It's the knowledge superhighway to better health.

Genetic markers, personalized medicine, shift from disease to health potential, regenerative medicine, “-omics,” psychoneuroimmunology, and much more are coming our way. The health and medical industry of the next 25-plus years will be dominated by the need to cater to and serve the aging baby boomers. In the United States, folks over 65 in 2030 will represent 20% of the population. Collaboration, Open Solution, and Innovation (COSI) approaches to the care and support of this population will be vital.

Steps to Tomorrow

- **Monitor Developments and Gain Understanding:** Organizations should establish regular communication channels for monitoring medical developments and their implications for clinical informatics. This can be done through various Web-based tools and through subscription relationships with research and news organizations.
- **Brainstorm About Application to Products and Services:** Environmental and medical technology analysis and opportunities need to be compared against current and future customer services. With the most attractive opportunities to expand services or improve the quality of care, business cases should be developed.
- **Establish Knowledge Networks by Area of Interest or Medical Breakthrough:** Within every organization team, members have specific interests in different aspects of the medical industry. Profile people's expertise and skills and embed them in a knowledge database where it is searchable. With this foundation in place, it would be possible to set up knowledge networks on topics such as proteomics, regenerative medicine, or any number of other options to involve a broad network of participants, which in turn will help

keep the organization up to date on developments that are under the radar screen. Human intelligence linked in a collaborative community can deliver a distinctive advantage through ideas, news, advice, and insights, if properly managed.

Online Resources

- **Health Technology Center:** <http://www.healthtech.org>
- **SG2:** <http://www.sg2.com>
- **The Advisory Board Company:** <http://www.advisory.com>
- **Healthcare Intelligence Network:** <http://www.hin.com>
- **Knowledge Scan:** <http://www.kxknowledge.com>
- **Medical Breakthroughs:** <http://www.ivanhoe.com/>
- **NewsRx:** <http://www.newsrx.com/>

Complementary and Alternative Medicine (CAM) and EHR Systems

Direction

In the year 2020, increasing numbers of people will understand that health is both the absence of disease and the realization of the optimum health status. Over the next decade, look for automated complementary and alternative medicine (CAM) software modules to emerge that will be integrated into the central electronic health record (EHR), personal health record (PHR), and eHealth Advisor Live™ systems of the future.

Current State

The goal of CAM is to support the health and welfare of an individual or population by encouraging healthier lifestyles, stimulating the natural healing abilities of the body, and discovering natural methods of disease treatment and care.

CAM is a group of diverse medical and healthcare systems, practices, and products that are not currently considered to be part of conventional medicine. Patients are increasingly turning to CAM to enhance their health and well-being. CAM includes acupuncture, chiropractic medi-

The Goal of CAM

The goal of CAM is to support the health and welfare of an individual or a population by encouraging healthier lifestyles, stimulating the natural healing properties of the body, and discovering natural methods of disease treatment and care.

cine, osteopathic medicine, the use of herbal remedies, and other practices as augmentations to more conventional medical treatments. The marketplace reflects this growing acceptance of complementary medicine by many patients and a small, but growing number of healthcare providers.

By gathering and integrating healthcare information associated with the application of CAM procedures into a patient's EHR, more accurate measurements of outcomes can be generated. Best practices can then emerge showing which complementary medical practices are most effective when coupled with conventional medical treatments of specific disorders.

Definitions

CAM includes a broad domain of healing resources that encompasses all health systems, modalities, and practices and their accompanying theories and beliefs, other than those intrinsic to the dominant health system of a particular society.

CAM therapies are termed “complementary” when used in addition to conventional treatments. They are termed “alternative” when they are used instead of conventional treatment. Integrative medicine, as defined by the National Center for Complementary and Alternative Medicine (NCCAM), combines mainstream medical therapies and CAM therapies for which high-quality scientific evidence of safety and effectiveness exist.

Many other traditions of medicine and health care are still widely practiced throughout the world, most of which are still considered to be separate and distinct from conventional Western medicine. The most highly developed systems of medicine outside of Western medicine are traditional Chinese medicine, the Ayurvedic traditions of India, and other forms of indigenous or “native” medicine such as those practiced by Amazonian rainforest, African, and North American tribes.

CAM Categories

NCCAM classifies CAM therapies into five categories, or domains:

1. **Alternative Medical Systems**—Alternative medical systems are built upon complete systems of theory and practice. Often, these systems have evolved apart from and earlier than the conventional medical approach used in the United States. Examples of alternative medical systems that have developed in Western cultures include homeopathic medicine and naturopathic medicine. Examples of systems that have developed in non-Western cultures include traditional Chinese medicine, Ayurveda, and Native American medicine. (See NIH's Web site at <http://nccam.nih.gov/health/whatiscam/> for more information.)
2. **Mind–Body Interventions**—Mind–body medicine uses a variety of techniques designed to enhance the mind's capacity to affect bodily function and symptoms. Some techniques that were considered CAM in the past have become mainstream techniques (for example, patient support groups and cognitive-behavioral therapy). Other mind–body techniques are still considered CAM, including meditation, prayer, mental healing, and therapies that use creative outlets such as art, music, or dance.
3. **Biologically–Based Therapies**—Biologically based therapies in CAM use substances found in nature such as herbs, foods, and vitamins. Some examples include dietary supplements, herbal products, and the use of other so-called natural, but as yet scientifically unproven, therapies (for example, using shark cartilage to treat cancer).
4. **Manipulative and Body-Based Methods**—Manipulative and body-based methods in CAM are based on manipulation and/or movement of one or more parts of the body. Some examples include chiropractic or osteopathic manipulation and massage therapy.
5. **Energy Therapies**—Energy therapies involve the use of energy fields. They are of two types:
 - **Biofield therapies** are intended to affect energy fields that purportedly surround and penetrate the human body. Some forms of energy therapy manipulate biofields by applying pressure and/or manipulating the body by placing the hands in, or through, these fields. Examples include Qi Gong, Reiki, and Therapeutic Touch.

- ***Bioelectromagnetic-based therapies*** involve the unconventional use of electromagnetic fields, such as pulsed fields, magnetic fields, or alternating-current or direct-current fields.

The following are the ten most commonly used CAM therapies in the United States during 2002 (see CDC Advance Data Report #343 at http://en.wikipedia.org/wiki/Complementary_and_alternative_medicine#The_top_ten_CAM_therapies), when use of prayer is excluded:

1. Herbalism (18.9%)
2. Breathing Meditation (11.6%)
3. Meditation (7.6%)
4. Chiropractic Medicine (7.5%)
5. Yoga (5.1%)
6. Body Work (5.0%)
7. Diet-Based Therapy (3.5%)
8. Progressive Relaxation (3.0%)
9. Mega-Vitamin Therapy (2.8%)
10. Visualization (2.1%)

Major CAM Organizations

The National Center for Complementary and Alternative Medicine (NCCAM) is the federal government's lead agency for scientific research on CAM. NCCAM is dedicated to exploring complementary and alternative healing practices in the context of rigorous science, training CAM researchers, and disseminating authoritative information to the public and professionals.

The Office of Cancer Complementary and Alternative Medicine (OCCAM), established in October 1998, coordinates and enhances the activities of the National Cancer Institute (NCI) in the arena of CAM (<http://www.cancer.gov/cam/>). There are many other links to CAM associations and organizations. (<http://www.pitt.edu/~cbw/assoc.html>)

Native American Indian Health Care

Increasingly, traditional Native American healing practices are being requested by Native Americans and nonnatives alike. Recent years have shown a surge of interest in the therapies of traditional cultures, in

patients' use of alternative medicine, and in the desire for mind–body therapies and for spiritual treatment, as well as for behavioral medicine treatments for chronic medical illness. Some hospitals have included traditional Native American healers as part of their staff. One of the spiritual practices that patients may request (especially in the American Southwest) is Native American healing (NAH) to complement their conventional medical treatment. Some patients even voice a preference for exclusive NAH. (<http://www.healing-arts.org/mehl-madrona/mmtraditionalpaper.htm>)

The Market

In a recent report on CAM in the United States (2005), the Board on Health Promotion and Disease Prevention states that the total visits to CAM providers exceed total visits to all primary care physicians. Out-of-pocket costs for CAM are estimated to exceed \$27 billion, which shows that CAM is now big business. That does not include those therapies or treatments covered by insurance. Hospitals, managed care plans, and conventional practitioners are now incorporating CAM therapies into their practices. Medical schools, nursing schools, and schools of pharmacy are teaching their students about CAM.

It is hard to get an exact handle on the market for CAM; however, according to a recent article published on the Investors.com Web site, consumers snapped up about \$54 billion worth of CAM services and dietary supplements in 2003. Of that figure, they claim that \$34 billion went to all types of alternative services such as chiropractic, naturopathy, osteopathy, and massage therapy, up from \$25.5 billion in 1999. The U.S. market for dietary supplements is not far behind, generating sales of \$19.8 billion in 2003, up from \$16.5 billion in 1999.

In 2004, NCCAM reported results based on survey data collected in partnership with the Centers for Disease Control and Prevention from more than 31,000 Americans. The data revealed that 62% of survey respondents used CAM in 2002. Another NCCAM report states that approximately 14% of Americans use herbal supplements to prevent disease, maintain wellness, or treat illness or pain.

The *New England Journal of Medicine* estimates that by 2010 the per capita supply of alternative medicine clinicians will grow by 88%, meeting the needs of an increasingly CAM friendly public. Bottom line, there is a huge amount of money tied to the CAM marketplace.

Challenges to Integrating CAM into Conventional EHR and PHR Systems

Most modern EHR, PHR, and other health informatics solutions to date have been developed to meet the requirements of conventional Western medical practitioners. These systems embody many of the implicit assumptions of researchers, doctors, administrators, and other stakeholders associated with these conventional Western healthcare provider organizations. To develop a more effective tool that includes support for CAM practitioners, additional studies further exploring the major differences between CAM and conventional Western medical practices and systems must be conducted.

The major differences in the two forms of medicine are rooted in the patient–practitioner relationship, the larger worldview and system beyond the specific practice, and the core definition of health in each system. While it is outside the scope of this book to explore these differences in depth, additional studies and more detailed analyses will greatly contribute to the design of health informatics systems that will be useful in taking steps to integrate CAM modules within future releases of EHR and PHR systems.

To gain greater acceptance for CAM, there is a need to utilize the power of advanced computational systems to introduce more rigor in capturing and analyzing data related to complementary and alternative medicine practices. By gathering and integrating healthcare information associated with the application of CAM procedures into a patient's EHR, more accurate measurements of outcomes can be generated. Best practices can then emerge, showing which complementary medical practices are most effective when coupled with conventional medical treatments of specific disorders.

At present, there appear to be a number of companies marketing CAM software modules. There are also a number of open source solutions available. However, none appear to have taken any major steps forward to integrate their products and data with PHR or EHR systems. There also seems to be little coordinated activity related to standardizing data elements within the major CAM domains.

Steps to Tomorrow

There are a number of recommendations and next steps for healthcare organizations to take with regard to the development of CAM software modules to be integrated within their EHR systems:

- **Engage Customers** in research to fully understand how your customer segments are viewing and using CAM.
- **Expand Research:** Conduct more detailed research into CAM information systems. Identify and prioritize CAM software modules to be developed, based on the needs of high-priority customers.
- **Participate in Open Source CAM Networks and Projects:** Initiate a collaborative, open source initiative to develop the CAM modules. Initiate efforts to identify and standardize data elements for each CAM domain.
- **Conceptualize and Roll Out Pilots:** Develop a prototype and begin pilot tests of high-priority CAM modules
- **Focus on Enhancing EHRs and PHRs to Leverage CAM for the Patient:** This would include developing and releasing production versions of CAM modules, and eventually integrating CAM software modules with selected PHR or EHR systems. Also, put in place mechanisms needed to refine and further enhance CAM modules.
- **Analysis and Improvement:** Encourage efforts to analyze and evaluate the outcomes of CAM using data collected by CAM modules in PHRs

Online Resources

- **National Center for Complementary and Alternative Medicine:** <http://nccam.nih.gov/>
- **MedLine:** <http://www.nlm.nih.gov/medlineplus/alternativemedicine.html>
- **White House Report on CAM:** <http://www.whccamp.hhs.gov/finalreport.html>
- **British Register of Complementary Practitioners:** <http://www.i-c-m.org.uk/brcp/default.htm>
- **Commercial Site:** <http://www.alternativemedicine.com>
- **Resources/Links:** <http://www.pitt.edu/~cbw/hospital.html>
- **Databases Resources/Links:** <http://www.pitt.edu/~cbw/database.html>
- **Evidence-Based CAM Journal Databases:** <http://ecam.oxfordjournals.org/>
- **Journal of Alternative and Complementary Medicine:** http://www.liebertpub.com/publication.aspx?pub_id=26

- **Other Web Sites:**

- <http://www.alternative-medicine-software.com/>
- <http://www.alternativelink.com/ali/press/PRMitchell6-01.asp>
- <http://www.999alternatives.com/>
- <http://www.biopulse.org/software.html>
- <http://www.vadino.com/wellness.html>

eHealthcare—TeleMedicine and More

Direction

eHealthcare will become the overarching term that describes multimedia health and medical management using technology, Internet, mobile media, and emerging technologies. The “e” in eHealthcare stands for electronic and emerging technologies that support better care and quality medical care for people and societies. The dual meaning for “e” better represents that the fact that emerging technologies in areas of artificial intelligence, self-generating software programs, and other human–computer interface sciences will play significant roles in the tailored and personalized delivery of these services in the year 2020.

Current State

Today’s telecommunications and televideo technologies have enabled great strides forward in telemedicine over the past decade, for example, TeleRadiology, TeleDermatology, and TeleConsultations. Early in the 21st century, the technology moved rapidly into the arena of TeleMedicine at home or anywhere. At home or anywhere health management is based on those developments, innovations, services, and technologies of governments, associations, corporations, and collaborative alliances that are focused on shifting the care paradigm from inpatient and outpatient to anywhere a patient might be—at work, at home, or at play.

The goals of TeleMedicine are to improve care, reduce the number of visits to actual doctors and providers, and allow patients to be seen and treated at locations of their own choosing, thus lowering the per unit cost of care while delivering high-quality care conveniently. At present, patients with chronic diseases are normally required to visit outpatient

facilities for periodic monitoring and treatment management. In many cases, however, the preferred place of monitoring and care would be the patient's home.

Analysis by the Veterans Health Administration has shown that providing home-based service improves outcomes of care for these patients, increases levels of patient satisfaction, and provides cost efficiencies. The role of patients is to interact with the home device and transmit vital signs and other data to the clinical systems used by the healthcare provider. The major role of home TeleMedicine vendors is to furnish recording and transmission devices for the home setting and to process and store data for access by healthcare providers and their clinical systems. TeleMedicine initiatives parallel the broader societal trend in health care whereby providers are seeking ways of offering more cost-effective, high-quality care in the home or at a mobile location rather than in an institutional environment.

Online Resources

- **International Society for Telemedicine and eHealth (ISfTeH):** <http://www.isft.net/cms/index.php?id=1>
- **American Telemedicine Association:** <http://www.americantelemed.org/index.asp>, <http://tie.telemed.org/>
- **Viteron TeleHealthcare, a Bayer-Panasonic company:** <http://www.viterion.com/>
- **Intel Proactive Health Innovation Center:** <http://www.intel.com/research/prohealth/>
- **Body Media:** <http://www.bodymedia.com>

Steps to Tomorrow

eHealthcare projects lay the foundation for both providing quality care to patients with complex chronic conditions—such as diabetes, congestive heart failure, mental health disease, spinal cord injury, wound care, and infectious disease—and making the home the preferred place of care.

- **Create eHealthcare Infrastructure and Collaborations** to secure a national TeleMedicine IT infrastructure including architecture, standards, and so on.

- **Expand eHealthcare Integration into EHRs and PHRs** in order to integrate TeleMedicine data into EHR systems and PHR solutions.

Wearable Intelligent Technology Systems (WITS)

Direction

Wearable information technology devices are rapidly evolving to 'Wearable Intelligent Technology Systems' (WITS). Current and emerging developments in wireless communications, integrated with developments in pervasive computing and wearable technologies, will have a radical impact on future healthcare delivery systems. It is anticipated that wearable computing will become a routine part of healthcare delivery and patient self-management in the coming decades.

Current State

The 1980s were dominated by the use of personal computers (PCs). The 1990s saw the widespread acquisition and use of laptop computers. This decade is seeing the acceptance and use of personal digital assistants (PDA) by many people. The next decade will be dominated by the production and use of wearable IT systems where information technology has evolved into intelligent technology systems. Wristwatches, pagers, cell phones, pocket calculators, PDAs, and Blackberries are all examples of simple wearable information systems that are already in widespread use.

With ever-accelerating innovations and technology and advances in artificial intelligence, it is clear that building blocks are in place that will profoundly affect wearable computing-based intelligent technology:

- **New fibers** called Aracon, made of super-strong Kevlar, can conduct electricity and be woven into ordinary-looking clothes.
- **Chip packaging** allows wearable computers to be washed and dry-cleaned. The electronics are insulated and directly woven into clothing and other textiles.
- **Flexible video screens** made of optical fiber can be woven into clothing and display static and animated graphics downloaded from the Internet, a desktop computer, or a mobile terminal.

- **Head-mounted displays on visors or glasses** allow users to focus on a task while at the same time check information on a computer.
- **On-body and off-body enabling technologies** are becoming more sophisticated and include VPNs, PANs, ISM, DECT, GSM, and Bluetooth wireless.
- **Nanotechnology** is playing a significant role, making computing and communications systems microscopic in size and more conducive to on-body usage.

Wearable Healthcare Intelligent Technology Systems

Although wearable computers have started to enter healthcare delivery environments, wearable systems for both physicians and patients will more fully emerge over the next decade. Wearable computers for physicians will allow them to treat patients and complete their rounds, while connected via wireless networks to computerized patient records. Wearable computers are already allowing physicians to remotely observe patients' vital signs and monitor progress of surgery, from outside of the operating room, using handheld devices.

Medical sensors are now available for use by patients and range from conventional sensors (based on piezoelectrical materials for pressure measurements) to infrared sensors for body temperature estimation to optoelectronic sensors that monitor blood oxygen, heart rate, heart recovery ventilation, and blood pressure. Other health-monitoring devices, such as the vestibular-ocular test apparatus, the glucose counter, and the insulin delivery system, can also be hooked up to a wearable computer without wiring the patient's body. The following are some examples of WITS:

Setting Broken Arms with Smart Material Instant Splints: The U.S. Army Institute of Soldier Nanotechnologies, a research unit devoted to developing military applications for nanotechnology, is working with MIT to incorporate wound detection and treatment systems within uniforms made of "smart" materials, such as a responsive system that provides an instant splint for a broken bone. (<http://web.mit.edu/isn/newsandevents/index.html>)

Monitoring Vital Signs with a Ring Sensor is an ambulatory, telemetric, continuous health monitoring device developed by d'Arbeloff Laboratory for Information Systems and Technology at MIT. It combines basic photo plethysmographic techniques with low-power telemetry.

Worn by the patient as a finger ring, it is capable of monitoring vital signs related to cardiovascular health. Remote monitoring is possible via a wireless link transmitting patient's vital signs to a cellular phone or computer. Clinical trials have been done in conjunction with Massachusetts General Hospital's emergency room, and researchers are now working on commercialization of the ring-sized device (Technology Review magazine, April 2004). (http://darbelofflab.mit.edu/ring_sensor/ring_sensor.htm)

“SmartShirt” or the Sensate Liner for Combat Casualty Care was first developed by researchers at the Georgia Institute of Technology under the auspices of the U.S. military's 21st Century Land Warrior Program and the Defense Advance Research Projects Agency (DARPA). The “SmartShirt” is a fiber-optic-laden garment with a built-in patented conductive fiber/sensor system that relays a soldier's vital signs in real-time, his location, and the exact time of injury. This technology can also be woven into children's sleepwear, possibly preventing sudden infant death syndrome (SIDS) by alerting parents (via PDA or wristwatch) the moment a baby stops breathing. (<http://www.gtwm.gatech.edu/images/wear.html> and http://www.gatech.edu/news-room/archive/news_releases/sensatex.html)

X-Ray “Vigilance” Vision for patient safety is being used by anesthesiologists at Vanderbilt University Medical Center (VUMC) to see an object right in front of them or in a distant operating room. A portable computer and high-tech eyepiece allow them to simultaneously monitor multiple operating rooms from one location. Vigilance integrates information from multiple preexisting sources: the operating room's anesthesia machine, heart monitor, and video cameras are connected to Vanderbilt's secure data network, and surgical teams use in-room workstations to document care and vital signs. The physical package was assembled from off-the-shelf components, but its software was developed at Vanderbilt. (http://tennessean.com/business/archives/04/05/51946027.shtml?Element_ID=51946027 and http://www.healthcare-informatics.com/issues/2005/01_05/cover.htm)

As If You Were There: The Vocera Wearable Communication System is being used at the Providence Portland Medical Center. This wireless system provides hands-free, voice-activated communications within networked buildings/campuses. Aimed at mobile workers in hospitals, retail operations, and other industries, the system allows users to wear a device

that weighs less than two ounces to interact with each other instantly and make decisions quickly with simple voice commands. (<http://www.vocera.com/products/products.aspx>)

Wireless Patient Monitoring: BodyKom is a new system being tested by Kiwok (a Swedish technology company), TeliaSonera AB, and Hewlett-Packard that connects wirelessly to sensors on the patient. If changes are detected in the patient's body, the hospital/healthcare services are automatically alerted over a secure mobile network connection. It could be used to monitor heart rate, diabetes, asthma, and other diseases that require timely intervention. (http://www.usatoday.com/tech/news/2005-03-30-wireless-monitoring_x.htm)

Helping Me Lose Weight Anywhere: BodyMedia, a Pittsburgh company, is a leader in wearable body monitoring. Its affordable watches, bands, and other devices collect, process, and present information about an individual's health and behaviors. The company makes a special "smart band" that is worn on the upper arm and collects data on the wearer's physical state, such as the way the body releases heat. These devices support weight management, fitness, disease management, and research. BodyMedia has developed special bands for monitoring the well-being of infants and the elderly. (www.bodymedia.com)

Alert: Fireman's Body Temperature Is Critical. The LifeShirt System, developed several years ago by VivoMetrics of Ventura, California, is being used in several top medical schools. The garment, which collects and analyzes its wearer's respiration flow, heart rate, and other key metrics, demonstrates in real-time whether a new treatment is working. There will also be a shirt for emergency-services workers, such as firefighters, that will wirelessly alert commanders when a firefighter's core body temperature or stress levels reach critical levels. VivoMetrics expects to introduce a shirt in 2006 that will allow parents to monitor asthmatic children. (<http://www.vivometrics.com/site/system.html>)

Finally, it is hypothesized that as sensor and computing technologies continue to evolve, their integration into wearable medical devices for monitoring, diagnosis, and treatment of illnesses will become commonplace. A personalized health management device would allow a person to be more interactive and more conscious of his or her own condition in order to adopt a healthier lifestyle and obtain personalized therapy. These devices could also help healthcare providers monitor patients during rehabilitation, thereby decreasing hospitalization time.

Steps to Tomorrow

The following are a set of recommendations for technologically advanced healthcare organizations to take:

- ***Establish a Multidisciplinary Workgroup*** to identify functional requirements and/or potential uses of wearable health IT systems for physicians and patients.
- ***Identify Partners and Funding Sources*** to collaborate on the development of wearable health IT systems and determine each organization's roles (e.g., research, development, pilot testing). Identify possible funding sources such as foundations that might support the use of wearable health IT products/services in underserved populations.
- ***Conduct Research and Feasibility Studies***, including a detailed literature search, to obtain lessons learned from existing projects in this field. Complete a feasibility study and cost-benefit analysis for the potential initiative. Investigate changes in clinical practices and business processes that may need to be made in anticipation of utilizing wearable health IT products/services.
- ***Initiate Pilot Projects*** to acquire, develop, and test wearable technology that could eventually be incorporated into the healthcare organization.

Smart eHealth Record Systems for Providers and People

Direction

By 2020, more than 80% of people in developed countries, including the United States, will use an ePHR that is connected to a mobile device and EHR system with various levels of intelligence embedded in its software application. In addition, primary care physician and consulting physicians will have access to an integrated comprehensive EMR that includes both textual data and medical images from across specialties and facilities based on an interoperable network.

Current State

As of 2007, it appears that less than 20% of healthcare provider organizations have acquired and implemented an electronic health record (EHR) system. By 2020, however, we predict that the situation and numbers will be reversed. It is anticipated that more than 80% of healthcare provider organizations, large and small, will have acquired and implemented EHRs. The EHRs in use will be interoperable and standards-based, and many will be open solutions that are supported by an international network of companies and community of users and developers.

As of 2007, the development and implementation of personal health records (PHR) are still in the very early stages. However, by 2020, we predict that more than 80% of the people in the United States will have begun using PHRs in one form or another. These Web-based, encrypted applications will provide people with online educational materials, interactive tools for physician communication and wellness, and storage banks for personal health data that includes genomic information and clinical images.

Many healthcare provider organizations have already started to deploy and use EHR systems and have begun to acquire and use a variety of electronic clinical imaging systems. However, these systems have not typically been integrated into a single, comprehensive EHR system. Providing clinicians with online access to these more complete, multimedia medical records, whenever or wherever they might need them, will result in increased clinician productivity, facilitate medical decision making, and improve quality of care.

- A truly effective EHR system should have the capability to capture clinical images, scanned documents, electrocardiogram (EKG) waveforms, and other nontextual data files, and make them part of the patient's electronic medical record.
- Both image and text data should be provided in an integrated manner that facilitates the clinician's task of correlating the data and making patient care decisions in a timely and accurate manner.
- Computer workstations used by clinicians, wherever they might be, should be able to display the high-resolution clinical images stored in the EHR.
- Imaging systems should be able to use the Digital Imaging and Communications in Medicine (DICOM) standard to obtain images

directly from image-acquisition modalities like CT, MRI, ultrasound, and digital X-ray.

- All captured clinical images should be associated with the text report of the procedure or the related progress note within the EHR.
- The EHR system of 2020 should serve as a tool to aid communication and consultation among physicians, whether in the same department, in different medical services, or at different sites.

Steps to Tomorrow

The level of national awareness for the adoption of healthcare IT as an enabler of change has never been so high. One of the highest priorities today is the reduction in medical errors and preventable deaths, which is much more achievable using Medical Informatics 20/20 and the EHR tactic. The following is a set of recommendations for healthcare organizations to take in digitizing the medical record:

- ***Understand the Role of Collaboration—Open Solutions—Innovation*** in supporting efficient and effective implementation.
- ***Establish an Interdisciplinary Workgroup*** to identify functional requirements and/or potential uses of wearable health IT systems for physicians and patients.
- ***Educate and Engage Customers:*** Develop several groups of patients/customers with different medical conditions and situations, and educate them about the benefits of PHRs. These groups can also become the first test markets for your next-generation EHR with a PHR view for patients.
- ***Identify Partners*** to collaborate on the development of EHRs and the patient-view PHR, and determine each partner's roles (e.g., research, development, pilot testing).
- ***Conduct a Feasibility Study*** and cost-benefit analysis for this initiative.
- ***Establish a Pilot Project*** to acquire, develop, and test EHR and PHR technology for the healthcare organization.
- ***Profile Clinical and Business Processes Changes and the Paradigm Shift*** that happens when patients take control of their medical records through electronic PHRs. The opportunities for supporting health expand dramatically when patients can add

information, vital signs, and other physiological data into a PHR for monitoring and support.

Genomic Information Systems and Biorepositories

Direction

By 2020, the first generation of genomic information systems will have been deployed. Genomic software applications and biorepositories will become a standard component of any sophisticated and increasingly smart EHR system by the end of the coming decade, which was described earlier in this chapter as the virtual eHealth Advisor Live (eHAL).

Current State

It is clear that genomic information will become a standard component of a person's health and medical record in the coming years. Much of the work being done in this area involves collaboration between public and private sector organizations with a heavy emphasis on standards and open source solutions. By integrating computerized electronic patient records with genomic biorepositories, bioinformaticists will be able to begin development of sophisticated applications that will truly transform healthcare delivery in the 21st century. These applications will use advanced statistical and computational analytic techniques and will combine human genome research with the identification of proteins within chromosomes that cause inherited diseases and predispositions toward diseases that might be triggered by environmental, dietary, and other catalysts. These advances could usher in a new era of individualized preventive medicine.

The creation of biorepositories is closely linked with the development of genomic information systems. Several institutional-level biorepositories have arisen over the past few years. Already, governmental systems have been established at the National Institutes of Health (NIH), the Centers for Disease Control and Prevention (CDC), and within the Department of Defense (DoD). Several universities have also created such a resource. In industry, there are about a half dozen companies that are attempting to create similar resources.

Over the next two decades, a goal for genomics will be to transform knowledge about the human genome into improvements in clinical practice, moving it from bench to bedside to beside a patient anywhere. Many of the government agencies and private clinical research enterprises engaged in developing genomic information systems are embracing collaborative ventures and open source solutions. Collaboration within this community of genetic researchers, biomedical drug developers, and clinicians is essential if substantial progress is to be made over the near term.

Steps to Tomorrow

Genomic information and applied knowledge will routinely become part of a person's virtual eHealth Advisor Live™ (smart medical record system and network) in the coming decade. Organizations should take the following next steps:

- ***Initiate an EHR Genetic Council:*** Establish a council addressing the integration of the organization's clinical record systems with genomic information systems into a unified electronic health record system of the future.
- ***Research the State of Development:*** Review existing genomic and bioinformatics systems for emerging languages, standards, and open source solutions that may be used or easily adapted to meet organizational needs. Implications for current clinical data repository/EHR projects should be assessed.
- ***Identify Pilot Projects:*** Do a pilot project to acquire and/or build the genomic information system that will eventually be incorporated into the EHR. This project could be designed to align with service line priorities and populations in need with a genetic component such as women's health and breast cancer.
- ***Form Collaborations:*** Collaborate further with other organizations on the collection of genomic data that could potentially be shared for the mutual benefit of everyone involved.
- ***Track Clinical Development and Practices:*** Investigate changes in clinical practices and business processes that the organization will need, in anticipation of using genomic information in the future.

In Support of Better Health Care

Throughout the book, we have highlighted and built the case that Collaboration, Open Solutions, and Innovation do play a vital role in achieving quality care and supporting EHRs for all people. Chapter 16 has described a number of examples of electronic and emerging technologies that are and will affect personal health and medical care over the next 20 years. The Medical Informatics 20/20 model is the delivery system to aid in the transport of new tools to support a quality of life and extension of health care to wherever a person may be and at the point of need and eventually on a preemptive basis.

