HIT and MIS: IMPLICATIONS OF HEALTH INFORMATION TECHNOLOGY AND MEDICAL INFORMATION SYSTEMS

Evaluating the potential advantages and considering the risks associated with electronic health care records.

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Health care lags behind other industries in adopting information technology by as much as 10–15 years [6]. Early deployments of health information technology (HIT) were primarily for financial accounting of medical transactions. Experiments with computerized medical recordkeeping began in the 1960s. The first electronic health records (EHRs) were designed and deployed starting in the late 1960s and early 1970s. By the mid-1970s, approximately 90% of hospitals used computers for business functions; 174 sites processed electronic data with some medical content [4]. Physicians began adopting EHR systems in the 1980s, following the introduction of the personal computer. In 1991, the Institute of Medicine declared the computer-based patient record is essential for health care [5]—a message it reinforced 10 years later.

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To date, HIT has been mostly the realm of enthusiasts. Practitioners have generally regarded EHRs as costly, cumbersome, and offering little help for tasks at hand. Many still doubt they are ready for widespread deployment. Estimates of the number of physicians and hospitals that have adopted an EHR are varied and unreliable [1], due, in part, to variability in what constitutes an EHR; they vary in sophistication and are not interoperable. In the late 1990s, approximately 5% of the 450,00 physicians practicing in the U.S. had a full EHR and 20% had a partial one [5]. According to a recent survey by the Massachusetts Medical Society, 49% of physicians in that state don't intend to use an EHR [2]. Estimates of hospitals with an EHR range from 5% to 15%, about the same as those said to use computerized physician order entry, an EHR component. Large, financially well-endowed physicians groups and hospitals are leading the effort to automate medical information. Small, financially challenged physician groups and rural hospitals lag behind, creating a potential digital divide.

Since the late 1960s, the U.S. federal government has invested billions of dollars in various efforts intended to automate medical information and promote telemedicine, including development and demonstration grants and contracts, and, in the case of the Departments of Defense (DOD), Health Human Service (DHHS), and Veterans Affairs (VA), developing and deploying EHR systems. The life-cycle cost for the next-generation DOD EHR system, CHCS-II (Composite Health Care System), which started to be rolled out in 2004, is estimated to be over $4 billion [9]. Over the last 30 years, the Indian Health Service has also developed an EHR system, known as RPMS (Resource Patient Management System). The VA has developed an EHR as well: HealtheVet/VistA, the current VA EHR system, has received considerable attention as a potential solution for private physicians' offices. A public-domain version of this software will become available through a federal project; an open source version is available commercially for hospitals. Federal EHR systems reflect the current state of the art; they are not interoperable (although work is under way toward two-way exchange of information between CHCS-II and VistA). In April 2004, President Bush established the goal of an EHR for most U.S. residents within 10 years, and through executive order created the National Coordinator of Health Information Technology. In July 2004, the National Coordinator presented his Framework for Strategic Action that established four goals (each with three objectives) for national adoption of HIT [8]. The most important roles the federal government could play in the widespread adoption of HIT include:

- Establishing a motivating vision and providing the leadership necessary for its accomplishment;
- Facilitating the development of standards for EHRs and promoting their interoperability;
- Using its leverage as the largest purchaser and provider of health care, including the deployment of leading-edge solutions; and
- Providing otherwise the environment and incentives that will expedite the cost-effective adoption of HIT and the realization of its potential benefits.

The first systematic assessments of the costs and benefits of EHRs started in 1975. At the time, experts believed the use of computers in health care would be

widespread within 15 years (by about 1990) [3]. Their forecast remains as true today as it was 30 years ago.

This article focuses on the implications of accelerating the adoption and widespread use of HIT through the 15-year period from the present to 2020. For this purpose, HIT is defined as "the application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of health care information, data, and knowledge for communication and decision making" [10]. This definition includes such applications as:

Electronic health record. The building block of a medical information system that substitutes for the traditional paper medical record or "chart." An EHR need not represent a single physical entity but can be a functional view assembled when needed from data stored in various geographic locations, due to interoperability among EHR systems or use of intelligent agents to knit together data obtained from disparate sources into a single coherent record. The term encompasses a spectrum of systems: imaged-based in which paper is converted to electronic displays; text-based that offer word-processing templates; point-and-click that structure data capture.

Personal health record. A computer-based health record kept or controlled by a consumer (in contrast to a provider).

Decision-support tools. If data is stored in machine-intelligible form, it can be analyzed to provide clinicians and patients with alerts, reminders, and other real-time decision aids.

Telemedicine. The remote practice of medicine through the exchange of clinical information; patient and provider are separated geographically.

Another important component of this definition involves the use of the Internet, including the Web, for information and knowledge exchange.

Driving Forces

The principal forces driving the adoption of HIT include a variety of trends and desires. Trends include a vision that HIT can transform the health care system—thereby simultaneously improving quality and productivity. Given the rising cost of care, HIT may make health care more efficient and reduce the cost of services. In a climate of increasing national health care expenditures HIT may help to contain costs, to liberate resources to satisfy unmet needs, and to restore competitiveness. HIT combined with the Internet is expected to foster patient-focused care, to promote transparency in prices and performance, and to enable consumers to drive the transformation of the health care system.

Desires motivating the adaption of HIT include achieving productivity growth evident in other industries that have made extensive use of IT. Reducing the incidence of medical errors and improving quality by relating patient outcomes to care processes is another desire, along with an increased ability to measure and pay providers for performance.

Bright Side

Perceived EHR benefits are as logical as they are compelling: reduced cost and improved quality of care. The ways that EHRs might reduce the cost of care include:

- Reduced expenses associated with record keeping (filing and retrieving paper medical records), meeting privacy regulations and accreditation standards;
- Improved workflows, practice management, and billing, including one-time electronic order entry and the elimination of transcription;
- Automated sharing of information among providers and patients (avoiding duplicative tests);
- Reduced office visits (to receive tests results) and hospital admissions (occasioned by missing information); and
- Decreased risk of malpractice suits.

Additional ways that EHRs might improve the quality of care and patient outcomes, and contribute to the health of the population, include:

- More complete, more accurate, and better structured clinical data and documentation;
- Automatic sorting and summarization of data so that relevant information is presented to the clinician in context-relevant displays when needed for decision making;
- Direct access and instant updates to records as well as remote access to patients' records at any time (for example, when a patient arrives at a hospital after becoming ill while traveling);
- Fewer dangerous medical mistakes (resulting from poor handwriting or order-entry errors) and improved clinical decisions through the use of structured data, decision support tools, predictive modeling, and disease management;
- Easier quality assurance, including benchmarking provider performance;
- Capability to mine vast amounts of structured medical record data to contribute to formulating research priorities, researching the causes and epidemiology of disease, assessing the effectiveness of preventive interventions and clinical care, paying

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providers based on their performance, monitoring the safety of drugs and devices, surveilling for outbreaks of diseases, including bioterrorism, preventing fraud, waste, and abuse, including monitoring prescriptions, especially for controlled substances; and

- Continuous improvement in clinical decision making, by conducting more easily clinical trials and other studies, managing clinical knowledge, and disseminating more quickly research results to providers and patients, incorporating them rapidly into decision-support technology, and tracking resultant changes in patient outcomes.

Challenges

Expectations of benefits from HIT are so high they may become an obstacle to accelerating its widespread adoption, especially if early attempts falter or produce disappointing results. Current challenges include:

Complexity of the health care enterprise. It is extremely fragmented, financed predominantly by third parties, and steeped in professional tradition that stretches back millennia. Mechanisms driving the transformation of other industries do not seem to operate in health care. Complex regulations and relationships are obstacles that may be difficult to overcome.

Magnitude of the investment, and who should make it. Widespread adoption of HIT may cost as much as $1.5 trillion in the next 15 years. To realize the proven benefits of decision-support technology, additional billions of dollars must be spent on determining which interventions work for whom, and at what cost, and to produce the evidence necessary to guide clinical practice and to implement useful pay for performance schemes. Investment in HIT must compete with other uses of health care dollars; this competition can only intensify in the years ahead. Resources are needed to cover an expanding number of un- and underinsured people; treat an increasing and aging population; provide access to new medical technology; conduct health services and biomedical research and development; and maintain and update the public health infrastructure.

In addition, there is a lack of a clear-cut business case: hundreds of thousands of medical practitioners—essentially small businesses—must decide whether or not to invest in HIT when the financial benefits may accrue mostly to third-party payers. There is also substantial risk involved in purchasing equipment that is likely to become obsolete or from a vendor that may go out of business.

The absence of standards is another significant challenge. Certification of EHRs might help overcome practitioners' reluctance to purchase them, and promote interoperability. However, if providers wait for certified EHRs to appear on the market, their adoption may be delayed and innovation may be slowed. The variation in state privacy laws, as well as regulations pertaining to medical records and practices, complexifies, and may slow, interoperability.

A lack of interoperability may create islands of medical information systems that exchange data with each other and preclude realizing the social benefits promised by the adoption of EHRs.

Finally, there is a danger that accelerating the use of inadequate products may increase the total investment needed to automate medical information and discourage providers on the benefits of EHRs.

Obstacles

Efforts to digitize medicine are likely to experience enormous amounts of money poorly expended, if

not wasted. It is possible some patients will be harmed during the process and the overall results may prove somewhat disappointing.

By 2020, according to present projections, approximately 50% of health care practitioners will be using a functional EHR. Vast expenditures must be made in the short-term while most benefits can only be realized in the long-term. Despite long-standing claims, and data from recent studies, there is still relatively little real-world evidence that widespread adoption of HIT will save money overall. Even if it can, the initial investment might prove more burdensome than imagined.

If resources liberated by HIT-induced productivity gains are used to increase provider income (or leisure) or to buy more health care, the rate of increase in national health expenditures may not decline much, if at all. People are unlikely to desire fewer health care services unless it can be demonstrated to their satisfaction that they produce no health benefits or such benefits are not worth their cost.

HIT may expand opportunities to deliver more health care services, and thus may ultimately turn out to be yet another driver of increased health care expenditures rather than a means to reduce them. Investing in HIT will alone not automatically boost productivity. That will require, in tandem, reengineering work processes, inventing new organizational structures, and changing incentives to leverage HIT investments. While use of HIT may transform the health care system, it may be necessary to restructure the system to liberate sufficient resources to be able to invest in HIT and to align incentives to realize its claimed benefits.

Widespread adoption of HIT can doubtlessly improve quality in the long run. In the short run, improvements in patient outcomes may be smaller than expected, even discounting the potential impact of new risks. In the forecasting period, HIT's impact on the population's health is likely to be relatively modest. Life-style choices and their consequences, including diabetes, threaten to reduce life expectancy for the first time in over 200 years (for example, diabetes care already consumes more than 2% of the U.S. gross domestic product).

Risks

The introduction of new technology increases the potential for error, as well as for reducing it, which is often one of the reasons for its introduction. For example, computer crashes, data capture anomolies, programming errors, and other failures of automation may replace lost charts, bad handwriting, missing information, and other problems experienced with manual systems. Clumsy automation may produce new process problems. If HIT results in more highly coupled systems, failures may increase chances for catastrophes. The widespread use of decision-support technology brings with it the risk of substituting the big blunders of the few for the minor mistakes of the many. Propagating invalid information in decision-support technology integrated into EHRs may prompt practitioners to perform inappropriate interventions and harm rather than help patients.

Do the benefits of EHRs outweigh their risks? People are evenly divided on the question [8]. Their greatest concern is the security, privacy, and confidentiality of their personal health information. It may prove to be the Achilles' heel to realizing most of the claimed benefits of EHRs, and EHRs may pose new threats for compromising sensitive personal health information.

For example, people who keep their personal health records on their home computers may be vulnerable to having the records downloaded, hacked into, or spied upon. With access to EHRs, disgruntled employees, those offered bribes or with other criminal motivations could disclose confidential personal health information on a more massive scale.

Another source of danger is that providers—or the government—may demand access to identified data even when someone has not given explicit consent. With paper medical records possibilities for abuse are limited; with EHRs they are virtually limitless. Legislated privacy protections may do little to allay fears in the face of inevitable, well-publicized breaches of security, leaking of health data, or its use for nefarious purposes. Ultimately, consumers must trust that the system is working for, rather than against, them.

Transformation of Health Care

Health care commonly integrates new diagnostic and therapeutic technology. The widespread adoption of HIT harbors the potential to transform health care services and to change the traditional roles and responsibilities of physicians and other health care practitioners. Implications include:

- Increasingly sharp value confrontations and shifting political alliances, because beliefs and interests—and the distribution of costs and benefits—will vary dynamically by social group.
- Shifting much care to the home, or to local telemedicine centers where patients can be connected to diagnostic devices or operated on by remotely controlled robots.

- Sensors, electronic pill boxes, and other medication-dispensing devices monitoring and ministering to patients at home. If practitioners notice anything amiss, the patient can be instructed appropriately or assistance dispatched to the home. As the technology evolves, it will automatically monitor patients, anticipate situations, issue alerts, and initiate responses. A highly trained practitioner will oversee the automated system and be available to cope with unusual situations or to intervene if it (and its various back-up systems) were to fail, in much in the same way as pilots do today when computers fly aircraft.
- Commoditization of health practices due to the distillation of scientific evidence, search for best practices, their dissemination in decision-support technology, and use of EHRs to monitor performance (and fear of litigation from deviating from accepted care processes).
- Reducing location-bound doctor-patient contact, which some practitioners may welcome because their new role is easier and less time consuming than talking to patients, but losing the interpersonal dynamic in the process.
- Transferring more activities to lower-level health care practitioners (and, ultimately, to consumers); physicians will concentrate on higher-level tasks and exit primary care as their income stagnates.
- Eliminating existing jobs and performing services in locations remote from patients, including offshore, to lower costs and expand the U.S. labor pool (when faced with a shortage of health workers); reduce the need to increase the supply of physicians to manage the health care of an increasingly aged population.
- Changing medical school curricula, so that such subjects as health services research, and knowledge, information, and quality management receive as much time and attention as such traditional fields as anatomy, physiology, and biochemistry.
- Consumers using the Internet to find health information, reinforce motivation to change health behaviors, track health status, communicate with providers, manage their personal health record, run decision support tools to identify risks and trends evident in their data, and, eventually, to function as their own primary care practitioner.

Conclusion

The inexorable increase in national health expenditures and the desire to improve the quality of health care are driving the widespread adoption of HIT. Its use harbors the potential for a wide range of positive as well as negative effects, some of which will be unintended. The central challenge is how best to promote the adoption of HIT to transform health care—by restructuring the delivery system, reengineering care processes, and recreating the culture in which health care occurs—while simultaneously mitigating its potential risks.

Events—especially those desired by forecasters—tend to unfold more slowly than foreseen, and their implications are usually more profound than expected. In 2020, a forecast of widespread use of computers in health care within 15 years might finally be valid. Ultimately, when patient data and medical knowledge are accessible electronically, decision-support technology can improve all types of health care decisions and transform health care. Present trajectories suggest these benefits will be mostly realized in the next century. The implications of HIT are likely to be so pervasive, and their primary, secondary, and subsequent-order effects so penetrating, that they will touch everyone's life and affect virtually every aspect of society. C

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