

Review Paper ■

Will the Wave Finally Break? A Brief View of the Adoption of Electronic Medical Records in the United States

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Abstract For over thirty years, there have been predictions that the widespread clinical use of computers was imminent. Yet the “wave” has never broken. In this article, two broad time periods are examined: the 1960’s to the 1980’s and the 1980’s to the present. Technology immaturity, health administrator focus on financial systems, application “unfriendliness,” and physician resistance were all barriers to acceptance during the early time period. Although these factors persist, changes in clinicians’ economics, more computer literacy in the general population, and, most importantly, changes in government policies and increased support for clinical computing suggest that the wave may break in the next decade.

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In a series of reports over the last 15 years, the Institute of Medicine (IOM) has highlighted that wider use of information technology in health care is essential for major improvements in the quality of care.^{1–6} The publicity surrounding these reports has led to an increased interest in electronic medical records (EMR), including computer-based physician, or provider, order entry (CPOE) and clinical decision support systems (CDSS), all of which were the focus of some of the earliest work in medical informatics. The prospect of finally seeing these systems in widespread use is gratifying to those who have labored for more than 35 years to develop and promote them, but this latest flush of interest is not the first time such enthusiasm has flourished. In 1970, Schwartz,⁷ proposed that it was probable that clinical computing would be commonplace “in the not too distant future.” Yet almost 35 years later, when CPOE use is estimated to have at best approximately 10% market penetration,⁸ we are again speculating over having reached a “tipping point.” The title of this article comes from one of the authors (DS) who referred in a 2004 American College of Medical Informatics presentation to

the prediction of the widespread use of the electronic medical record as “the wave that never breaks.” In this article we discuss some of the factors that at different times seemed to pre-empt the “age of clinical computing” and explore reasons why there may be more reason for optimism in today’s health care climate than at earlier times.

The Beginning of Computers in Healthcare—1960s to 1980s

Computers were first used for administrative and fiscal functions in hospital settings in the early 1960s, following prior use in business and in research settings. At the same time, the early work in medical informatics focused on clinical computing with a clear goal—to improve clinical decisions and reduce medical errors—essentially through electronic access to procedure results, faster access to relevant medical information in the literature, and, from the beginning, decision support functions such as reminders and alerts.^{9,10} It had been widely hypothesized that physicians’ errors of omission and commission were at least as frequently related to their lack of information about the patient as they were to lack of medical knowledge.¹¹ Not only were the early goals of improving both access to patient information as well as access to medical knowledge similar to what is proposed today, but the strategies that are the focus today were also envisioned in the early EMRs—encounter note documentation, coded information, and more active decision support. Some of these early systems were exemplars of this vision. The HELP system at LDS Hospital in Utah, the development of the COSTAR system at Massachusetts General Hospital, the TMR system at Duke, and the Regenstrief Medical Record System have been recognized as models for EMRs.^{9,12–14} The work of Lindberg and his colleagues at Missouri also deserves mention for pioneering the concept of a departmental system for laboratory automation.¹⁵ These systems and others developed during this period utilized workflow, display, and user interface techniques that are widely used and embellished upon today. Systems such as these led Schwartz⁷ and others to predict the rapid adoption of computer systems into clinical care. Obviously, widespread early

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adoption did not occur, and, in retrospect, there is a variety of factors that inhibited adoption.

One might have expected that the enthusiasm for scientific medicine in the 1960s and 1970s as evidenced by growing numbers of pharmaceuticals, diagnostic equipment, and burgeoning laboratory tests would have spurred a plethora of computer applications and implementations into daily clinical use, but this was not to be. Physicians were unwilling to rely on the often cumbersome, slow, expensive, and sometimes unreliable technology of these systems. Administrators were not willing to invest in these systems either, since the financial benefits were not clear at that time. Even when systems were clearly demonstrated to have improved quality and cost, if they impeded clinicians' workflow they were not widely adopted. Many of the decision support systems developed during that era were not integrated into hospital clinical information systems; meanwhile, physicians continued to rely on their own autonomy and authority and may not have wanted to use decision support systems even if they were available. Often, it appeared that those scientific advances that did not challenge physician authority and autonomy were embraced, while those that potentially diminished the doctor's independence were resisted. In 1982, Komaroff¹⁶ characterized the prevailing attitude as, "I am being regimented if you give algorithms to me, but I am being systematic if I develop algorithms for myself." Unfortunately, as Miller and Masarie¹⁷ pointed out, the early decision support systems functioned more like the "Greek Oracle" rather than permitting a more flexible, interactive approach. The intrinsic rigidity of such models reinforced the perception of regimentation.¹⁷ Further, it would be some years before Wennberg and Brook,^{18,19} among other researchers, produced a body of work that clearly revealed to clinicians and administrators that independent decision-making often caused unacceptable variations in both health care processes and outcomes.

In addition, with the federal government enacting the Medicare and Medicaid legislation and the dominance of fee-for-service practice, hospital administrators and insurers alike were content to let physicians continue to practice autonomously. This led to rapid expansion and increases in the revenues globally within the health care sector. Clinical reference systems of that era could not match fine-grained data on care processes to patient outcomes (other than death or very serious injury), so there was little incentive to embrace innovations such as computer-based order entry. The government largely paid the bills and did not require changes in practice as long as the hospital was accredited by the Joint Commission on Accreditation of Healthcare Organizations (then JCAHospitals). There was more investment in computers, but almost entirely in fiscal, administrative, and ancillary systems with a billing, not a clinical, focus. In short, there was scant implementation of EMRs for clinical activities in either primary care offices or hospital settings.

By the 1980s the technology for the EMR had evolved considerably. The mainframes of the 1960s had evolved first to minicomputers and then to microcomputers; Microsoft Windows was introduced on a large scale in 1983 (although its widespread use did not occur until the release of version 3.1 in 1992). Networking was introduced on a large scale in the 1980s. This created a need for a data interchange protocol in health care, which stimulated the creation of HL7. This also

stimulated the controversy, which continues today, between networked "best of breed" applications and single technology integrated systems.

A major focus of informatics research during the 1980s was on the use of expert system methodologies developed in the 1970s to develop clinical decision support systems to assist with clinical diagnoses. Publications describing such systems including QMR, DXPLAIN, and ILIAD appeared in the 1980s, as did research that showed that reminders incorporated into electronic medical records could decrease health care costs.²⁰⁻²³ Again, these clinical decision support activities focused on reducing medical errors related to overlooked patient information as well as improved access to medical knowledge.

The demonstration that these systems not only had the potential to improve care, but also to affect health care costs, was seen at the time as providing the motivation for increased use of these systems. By then, the huge increases in health care outlays as a result of the previous decade's reimbursement practices led to the implementation of payments mandated by the diagnosis-related groups (DRG) legislation in the 1980s as well as the shift to managed care and other efforts to cut costs in the 1990s. DRGs held the potential for providing an incentive to link clinical and billing systems, since, for the first time, reimbursement depended not only on what was done to a patient, but also on the diagnosis(es). At the time, improvements in health care information and communications technology (HICT), along with the renewed motivation to cut health care costs, were viewed as an impetus to increase clinical computing. After all, HICT had been developing for decades. Would the wave finally break and EMRs in daily clinical practice become widely adopted? Alas, this did not occur. Instead, as the pressure to reduce costs increased, there was even less motivation to invest in expensive new clinical systems. The recognition that an EMR could improve health care quality, reduce medical errors, and reduce health care costs was still not sufficient motivation to overcome resistance to EMR adoption. Without strong physician demand, hospital and practice administrators did not see sufficient potential financial return to try to overcome this resistance either in the inpatient or outpatient setting.

1980s to Present

From the 1980s on there was a steady improvement in technology, including the continued development of standards, such as HL7 and others. This period was also marked by an increasing interest of the federal government in policies and activities that had potential to further the development of electronic medical records.

Although the DRG legislation did not bring about the increased use of the EMR, there were a series of other quasi-governmental and governmental initiatives beginning in the late 1980s that fostered policies essential for a broader dissemination of the EMR. In the late 1980s, a conference at the National Institutes of Health (NIH) led to an IOM report dealing with electronic health records. This report, *The Computer-based Patient Record: An essential technology for health care*, was released in 1991.¹ It explored three key aspects: uses and users, technology, and policy and implementation. To meet emerging needs of health care, a total rethinking of the medical record was needed. Simply recasting the old

record into a computer-based format would not get the job done. The term *computer-based patient record (CPR)* was used to describe this new type of record. Twelve functions for CPRs were described, and this list has remained both timely and comprehensive. The future record should provide a number of necessary functions, and the center of the action should be the patient and not "medicine." The goal was to improve relevant communications and then keep a relevant record of the communications. The key was not the technology but how the technology could be utilized to reinvent health care. The report led directly to the creation of the Computer-based Patient Record Institute, and the report became one of the IOM's most widely circulated publications. It pointed out the importance of unique identifiers and other standards. It emphasized the need for decision-support and a concern about systems' confidentiality and security. Such was the interest in the report that it was reissued in 1997 with progress reports on the U.S. and European efforts.

As the IOM CPR Report increased visibility of electronic health records worldwide, two reactions occurred. Europe, Canada, Australia, and New Zealand developed national strategies to make electronic health records a core feature of their health care systems. In the United States, the Department of Defense and the Veterans Administration advanced their efforts, taking advantage of the confidentiality and security regulations that had been in place inside government since the late 1970s. However, only a few major private sector organizations like the Kaiser Health System picked up the challenge of implementing large-scale electronic health records. At the national level in the United States, it was apparent that without confidentiality and security protections, CPRs would not move into widespread use. There was also growing concern over administrative costs, and information technology (IT) was seen as a way to simplify administrative procedures. Policy debates went overwhelmingly focused on privacy legislation rather than sponsoring CPRs equipped with robust confidentiality and security systems. However, sensible national privacy legislation for electronic health systems was not passed despite bipartisan support early in the process. Provisions were placed in the HIPAA legislation to cover a number of exigencies in case that specific enabling legislation was not passed. Examples include unique identifiers for providers, payers, and patients as well as desired components for electronic health records. Court challenges have allowed virtually all dimensions identified in the HIPAA legislation short of personal identifiers to move forward. Although there is debate as to whether these provisions are adequate or excessive for security and confidentiality of electronic health information, or whether the patient identifiers should have also been established, these standards did help promote the HICT agenda.

In HIPAA's Administrative Simplification provisions, the National Committee on Vital and Health Statistics (NCVHS) was named to advise the Secretary of Health and Human Services on those dimensions that related to confidentiality and security, identifiers, and standards for computer-based patient records. The HIPAA legislation essentially reformulated the NCVHS from a longstanding advisory committee focused totally on "after-the-fact" vital and health statistics into the nation's health information policy advisory committee. Because there was no national effort to advocate for a national

health information infrastructure (NHII) capable of assuring a scalable, interoperable system of HICT networks and clinical support, NCVHS organized an NHII working group. This group's initial and subsequent reports have become the template documents for U.S. NHII activity.

The most dramatic change that occurred between the 1991 IOM report and circumstances in 2000 was the development of the World Wide Web on the Internet. This gave rise to the potential of e-health and computer-based personal health records. Sadly, September 11, 2001 made the importance of having computer-based population records more than simply a good thing. The threat of bioterrorism increased the motivation to make computer-based community records an essential part of homeland security efforts. Concurrently, major work was in progress over the past decade at the National Library of Medicine (NLM), especially with MEDLINE and the UMLS initiative. In 2003, the NLM licensed SNOMED-CT for use by health care institutions throughout the United States.

The National Academies, and especially the IOM, have continued to build upon their HICT work and have published reports entitled, *Health Data in the Information Age* (1994), *Telemedicine* (1995), *For the Record* (1997), *Trust in Cyberspace* (1999), and *Networking Health* (2000). This impressive body of work has served as a complement to the series of reports on quality that began to surface from the IOM in 1999^{1-3,5} and broadened the concept of a CPR into what is now the being called the EHR, or electronic health record.⁶

Key conclusions of the IOM Report, *Crossing the Quality Chasm*, were that trying harder would not work since current systems were inadequate; only changing health care delivery systems would make a difference.³ Further, the IOM report stated that "in the absence of a national commitment and financial support to build a national health information infrastructure, the committee believes that progress on quality improvement will be painfully slow."³

Although the use of the EHR today is still low, there is an increased interest in the technology and a sense of momentum building at the federal level. The Agency for Healthcare Research and Quality is investing millions in health information technology research. In May 2004, the NHII office that had been in the office of the Secretary for Health and Human Services was given new visibility through the appointment of David Brailer, MD, PhD, as National Health Information Technology Coordinator reporting to the Secretary. Brailer's plans include more extensive funding of HICT with a vision of all Americans having electronic health records within ten years.²⁴

Investment in information technology in health care today is higher than it has ever been, although it still remains significantly lower than in other industries. This increase in investment has been prompted in part by the need for modernization of legacy systems as a result of Y2K, HIPAA, and the continued IOM reports. It has been augmented on by the carrot and stick of the Leapfrog Group's standards (<www.leapfroggroup.org>). There are more HICT vendors today than ever. Increasingly, academically-trained medical informaticians are joining the vendor ranks. For several years, the focus of the major health care information technology trade magazines has been on clinical computing, and the

most recent HIMSS leadership survey of health care CIOs found that electronic medical records and systems for patient safety were among the top IT priorities.²⁵ One challenge that has not yet been adequately addressed is the development of scalable, interoperable EHR systems. Another is institutional and financial support to create a sufficient workforce to achieve national goals. It is debatable whether the lack of emphasis on interoperable systems is more a result of vendors fragmenting the market, buyers' lack of interest, resistance from payers, perceived market advantage by provider groups or health systems by those making the investment, or fear of sharing information. Nevertheless, these developments, along with the IOM reports, provide support to those who feel that this time, in the near future, the wave will finally break. But is it any different now from those other times when the field was optimistic?

Will the Next Five Years Be Different?

One of the major differences in the current health care environment is the convergence of several trends that have been building for decades. The technology has improved, and there is more investment in health care communications technology. Another key difference in today's health care environment is the experience of the new crop of health professionals. Future physicians currently in medical school and residency training are very different from their predecessors of even a decade earlier with regard to their comfort with computers. The same can be said for nurses and allied health professionals. Children born after 1980 are, as Don Tapscott said in his book, *Growing Up Digital*, the first generation to regard computers as an appliance, similar to the television and the refrigerator.²⁶ This generation had computers in elementary school, grew up playing video games, and substituted instant messaging for the telephone. Not only is this generation adept and at ease with computers, but, as Tapscott says, they place a value on collaboration and sharing information.²⁶ Furthermore, many of the current residents are being trained at the academic medical centers affiliated with VA hospitals that have been at the forefront of EMR and CPOE development. These residents have seen what these systems can do for improving quality and safety. Of course, perceived and real slowness or inefficiency in physicians' computer input techniques may always be a barrier to adoption, but the comfort level of the current generation of medical students and young physicians with contemporary human-computer interfaces will likely overcome this barrier.

The current medical and health sciences students and post-graduate trainees are not only more comfortable with computers, but also, as a result of their medical education, they are more accepting of the standardization in medical care that CPOE and CDSS will bring. Weed's article advocating the Problem-Oriented Medical Record (POMR) appeared in 1968. The POMR consistently structured clinical thinking, and although the concept was initially resisted, today the basic idea of revealing the logic behind clinical decisions within the medical record is universally accepted.^{27,28} The motivation behind the POMR was to make medical practice more scientific and compatible with computer formatting, and the next logical steps, as Weed recognized, were an EMR and CDSS. Over the years since Weed's original POMR article was published, there has been increasing emphasis on practicing scientific

medicine. Objective data, such as laboratory and other diagnostic procedures, were seen as more reliable than subjective data (sometimes to a fault). The statement about algorithms quoted earlier indicates that physicians may always have expressed a commitment to practice scientific medicine, but what we see today is more emphasis on using the best scientific data, such as randomized clinical trials and extensive meta-analysis of the literature with less emphasis on individual, or case-based, experience as a dominant guide for practice. While the concerns about cookbook medicine have not entirely disappeared, the value of being systematic and working within a system that has real rigor built into it has grown even stronger. When these dimensions are combined with the need to cope with an ongoing knowledge explosion, the upcoming generation of physicians realizes that they are living on the cusp of a truly new era. These changes are likely to make both health professionals and the public more receptive to the advantages of using an NHII. EHRs (electronic patient, personal and community records) can help to implement evidence-based adaptive clinical decision support systems.

Finally, there has been growing recognition of the need for major changes in health care policy in the United States. Assuring a robust HICT infrastructure for America requires surmounting substantial standards-related, financial, and regulatory barriers. The first NHII conference in 2003 demonstrated that many experts agree that the government must become part of the solution in terms of financial incentives for EHR adoption. However, although the federal government recognizes that it must provide financial incentives for EHR adoption, the current federal deficit and competing priorities for limited funds, make it uncertain whether the government will make sufficient investments in underwriting widespread EHR implementation. In addition, it has been suggested that while the physicians will have to substantially change their practices, most of the EHR benefits may go to the organization, the payers, or even the patient, rather than directly to the physician.²⁹ This is a major justification for providing the physician with financial incentives for EHR adoption.

The unique personal identifier is still a contentious issue. What is different now from earlier eras is that two broad policy tracks related to EHR implementation are likely to converge. One track is a well-articulated and defensible NHII initiative that proposes interoperable, ubiquitous, robust EHRs. The second track focuses on the record of underperformance of our current health care system and the need to make major improvements in health care quality and safety, access, and cost. The convergence of these policy initiatives is reflected in the appointment of the National Healthcare IT Coordinator and the recognition at the top levels of government that regulatory barriers should be addressed, and some financial incentives will be needed to overcome physician resistance to EHRs. These changes would create, for the first time, a U.S. healthcare system that is of genuine "industrial strength" rather than being simply a massive set of expensive "mom and pop" shops. The IOM Chasm report laid out the essential elements of 21st Century Healthcare.³ These include: widespread use of evidence-based medicine (including adaptive evidence-based decision support systems), robust information infrastructure (embodied in NHII and EHRs), aligned reimbursement incentives and regulatory requirements, and a workforce skilled in evidence-based

medicine, information technology, and process improvement. These elements, combined with a focus on assuring a health care system that is safe, patient centered, effective, efficient, equitable, and timely, should make for a compelling formula that will get the job done.

However, as exciting as the current initiatives are, the field must remember earlier times when other compelling initiatives failed to produce major changes in either health care or the widespread use of electronic health record systems. While there is concern nationally about the need to improve the quality of care, it is not clear that these concerns are sufficient motivation for individual physicians to rush to adopt systems that not only may cost them large sums of money, but also could be perceived as markedly less convenient and more time-consuming than the current system. The optimism that we have today must be tempered with the recognition that the receptive environment is only the prerequisite for widespread adoption. For the wave to break, we must surmount the resistance to change across in the entire process of health care delivery.

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