that the CAD population will be considered a special population in the future.

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Health Care Information Technology
Progress and Barriers

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In the 3 decades since the term "medical informatics" was first used, individuals working at the intersection of information technology (IT) and medicine have developed and evaluated computer applications aiming to improve health and health care.[1] The road to successful use of IT in medicine has not been easy, with examples of failures in both computer systems and networks.[2,3] However, a variety of applications from the field of medical informatics have matured in recent years.[4]

Fueled by several factors including increased emphasis on ensuring patient safety and preventing medical error, as well as development of new biotechnologies such as gene microarrays, the need for informatics applications in health care has become apparent to the larger community. Recent actions such as the organization of the National Health Information Infrastructure[5] and the National Institutes of Health Roadmap[6] represent milestones that solidify the importance of IT in patient care and research respectively. A growing body of scientific evidence supports the use of this technology, particularly for clinical decision support to improve health care safety and quality.[7] Another important recent development is the creation of the Office of the National Health Information Technology Coordinator. This builds on a refreshingly bipartisan consensus on the value of health care IT.[8,9] It is no exaggeration to declare that the years ahead portend the "decade of health information technology."[10]

Informatics is poised to have a major impact in patient-clinician communication. In the Clinical Crossroads article in this issue of *JAMA*, Slack demonstrates the value that patient-physician e-mail can have in improving patient care, and also catalogs the incomplete but encouraging underlying evidence.[11] As with many applications of IT, the technology can improve the existing situation but also empower clinicians and patients to think more fundamentally about how innovation can lead to changes in the way medicine is practiced. Slack also emphasizes that informatics can help physicians better incorporate into clinical practice one of the most underused resources in medicine, the patient, whose help is greatly enhanced through this new technology.

Although the case for adoption of improved health care informatics appears quite compelling, significant barriers to its use remain, particularly with regard to the electronic health record (EHR). These include cost, technical issues, system interoperability, concerns about privacy and confidentiality, and lack of a well-trained clinician informatics workforce to lead the process.

Certainly the biggest impediment is financial, which results from misalignment of costs and benefits. A recent report suggested that ambulatory EHRs, particularly when augmented with clinical decision support tools, have a substantially positive return on investment for the health care system as a whole.[12] However, those who are expected to pay for such systems, namely physicians and other practice organizations, only see 11% of that return on investment. The rest goes to those who typically do not pay for

See also p 2255.

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EHRs directly, such as insurers, laboratories, and patients. A variety of approaches have been proposed, such as revolving loan funds[13] and "pay for performance" schemes that reward data capture (only possible with use of an EHR), which then enables physicians to measure and improve quality in their practices.[14]

A variety of technical issues pose additional barriers to more widespread adoption of health IT. Implementing an EHR in a clinical setting is much more complicated than connecting a computer to the Internet or installing software from a CD-ROM. Systems must conform to the workflow of a practice or the workflow must be modified in a way such that the system does not impede it. Experience with well-designed systems shows, for example, that ambulatory EHRs need not derail the clinical workflow.[15] However, physician offices, particularly small practices and those in rural or underserved areas, need simple and inexpensive solutions to obtain the benefits of EHRs.

Another challenge is the need for system and data interoperability. Most health care data, whether on paper or electronic, are trapped in "silos." As a result, a patient may have a physician or health system with an advanced EHR, yet if that patient requires care elsewhere, there is little likelihood the information from that advanced system will be accessible. A report from the Institute of Medicine has noted that "health information exchange," the anytime, anywhere access to clinical care information across traditional business boundaries, is essential for improving health care quality.[16] The widening reach of broadband Internet makes this vision achievable. The Center for Information Technology Leadership has estimated that the overall financial return from this type of exchange could total as much as $87 billion per year after the initial investment.[17] However, similar to EHRs in physicians' offices, there are no incentives for individual health plans or physicians to facilitate this effort, and in fact there may be significant first-mover disadvantages since early adopters are likely to pay the initial costs without receiving the benefits that will accrue only when the rest of the community is taking part.[18] Fortunately, political leaders have recently appointed the Committee on Systemic Interoperability to address the required laws, technologies, and standards to achieve this vision.

An additional impediment is the very real concern about privacy and confidentiality. Physicians, other health care professionals, and health care organizations must be vigilant in protecting patient privacy. However, privacy issues exist whether the medical record is paper or electronic. In fact, as outlined in an Institute of Medicine report on this topic, paper-based records are at least as insecure as electronic ones, and probably more so.[19] Unfortunately, perfect security will never be achieved because human curiosity will derail even the best security methods. Health care professionals must work to instill a culture that demands privacy and confidentiality.

Even if the financial and technical issues surrounding the use of health care IT are solved, a workforce capable of leading its implementation must be developed. Physician-informatics leaders must guide the effort in concert with others in health care, with appropriate knowledge and skill in informatics to lead efforts in all health care settings. These individuals need not necessarily be full-time informaticians or require extensive training, but they must understand the worlds of both medicine and IT. Other IT professionals including health information managers, health science librarians, and representatives from other fields are needed to assist in this process. The optimal preparation and workforce for this effort will need to be determined.

Despite these formidable challenges, it is possible that patients, as described by Slack, can be empowered to play an integral role in their health care and to manage their information. Health care IT is not a panacea for all that ails medicine, but it has the potential to improve the quality of care as well as the personal experience for patients.

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