Finding a Cure: The Case for Regulation and Oversight of Electronic Health Record Systems

Sharona Hoffman  
*Case Western Reserve University School of Law*, sharona.hoffman@case.edu

Andy Podgurski  
*Case Western University*, andy@eecs.case.edu

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FINDING A CURE: THE CASE FOR REGULATION AND
OVERSIGHT OF ELECTRONIC HEALTH RECORD SYSTEMS

Sharona Hoffman & Andy Podgurski*

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* Professor Hoffman is Senior Associate Dean for Academic Affairs, Co-Director of
  Law-Medicine Center, Professor of Law, and Professor of Bioethics, Case Western Reserve
  University School of Law. B.A., Wellesley College; J.D., Harvard Law School; LL.M. in
  Health Law, University of Houston. Professor Podgurski is Associate Professor of Electrical
  Engineering and Computer Science, Case Western Reserve University. The authors wish to
  thank David Aaron, Jessica Berg, Jessie Hill, Jacqueline Lipton, Maxwell J. Mehlman,
  Duncan Neuhauser, and Greg Vetter for comments on previous drafts. We are also grateful
  for the skillful research assistance of Katy Kassimatis. Research on this paper was made
  possible in part by support from the U.S. National Institutes of Health through the Case
  Western Reserve University Center for Genetic Research Ethics and Law (NIH grant # P50
  HG-003390). Professor Podgurski’s research was also supported by National Science Foun-
  dation grant CCF-0702693.
I. INTRODUCTION

In the foreseeable future, it is likely that the familiar, paper-based patient medical files, contained in thick folders and stored on long shelves or in filing cabinets, will become a thing of the past. Both the federal government and health care advocates are enthusiastically promoting the adoption of health information technology (“HIT”) and
electronic health records ("EHR") systems  as means to transform and
improve health care in the U.S. 2

noted that the World Health Organization, in 2000, ranked the U.S.
health care system 37th out of 191 and identified our poor use of in-
formation technology as among the primary reasons for this “dismal”
ranking. 3 The editorial decried the fact that “American primary care
doctors lag years behind doctors in other advanced nations in adopting
electronic medical records or prescribing medication electronically.” 4
Indeed, only seventeen percent of physicians in ambulatory care set-
tings 5 use EHR systems to any extent, and only eleven percent of hos-
pitals have fully implemented EHR systems. 6

Medical errors have been estimated to result in as many as 98,000
deaths each year in the U.S. and to cost as much as $29 billion. 7 Ap-
propriate use of carefully designed EHR systems could dramatically
reduce those numbers. These systems can promote efficiency, dimin-
ish costs, save time, and save lives. For example, the Palo Alto Medi-
cal Foundation learned of Merck & Co. ’s recall of certain batches of
hepatitis A vaccine that had lost their potency and was able, using its

1. An EHR is a record of “electronically maintained information about an individual’s
lifetime health status and health care, stored such that it can serve . . . multiple legitimate
users.” BIOMEDICAL INFORMATICS: COMPUTER APPLICATIONS IN HEALTH CARE AND
(1990) [hereinafter BIOMEDICAL INFORMATICS]. EHR systems, as we are using the term, are
systems that add to EHR databases information management tools including clinical alerts,
reminders, decision aids, links to medical literature, and tools for data analysis, such as
search engines. See id.
2. INST. OF MED., KEY CAPABILITIES OF AN ELECTRONIC HEALTH RECORD SYSTEM 1–2
(2003) (stating that “[t]here is a great deal of interest within both the public and private
sectors in encouraging all health care providers to migrate from paper-based health records
to a system that stores health information electronically and employs computer-aided deci-
sion support systems” and that the “development of an IT infrastructure has enormous po-
tential to improve the safety, quality, and efficiency of health care in the United States”); see
also THE LEWIN GROUP, HEALTH INFORMATION TECHNOLOGY LEADERSHIP PANEL FINAL
REPORT 3 (2005) (recognizing “HIT implementation as an essential, high priority for health
care”).
and Italy were ranked first and second. Id.
4. Id. The editorial also argued that “despite our vaunted prowess in computers, software
and the Internet, much of our health care system is still operating in the dark ages of paper
records and handwritten scrivals.” Id.
5. Ambulatory care is treatment that is given at the office of a physician or other pro-
vider. See STEIDMAN’S MEDICAL DICTIONARY 59 (28th ed. 2005) (defining “ambulatory” as
“denoting a patient who is not confined to bed or hospital as a result of disease or surgery”).
6. See AM. HOSP. ASS’N, CONTINUED PROGRESS: HOSPITAL USE OF INFORMATION
TECHNOLOGY 1 (2007), available at http://www.aha.org/aha/content/2007/pdf/070227-
continuedprogress.pdf; Catherine M. DesRoches et al., Electronic Health Records in Ambu-
further discussion of how many health care providers currently use EHR systems, see infra
notes 149–53 and accompanying text.
7. TO ERR IS HUMAN: BUILDING A SAFER HEALTH SYSTEM 1–2 (Linda T. Kohn et al.
eds., 2000).
EHR system, to identify 17,000 patients who needed to be re-vaccinated.8

An emergency room doctor at a large Texas hospital also provided two vivid illustrations of the need for EHR systems from his personal experience.9 In one case, a woman with a splint on her arm stated that she had a broken arm, was suffering severe discomfort, and had run out of the painkillers she was given when initially treated at another hospital. In the absence of access to the other hospital’s records, the doctor ordered X-rays of her arm and neck, only to discover that she had no injury. The time and expense wasted in uncovering the woman’s scheme to obtain prescription narcotics could have been avoided had the physician been able to discredit her claim through a search of electronic records. In a second instance, the doctor treated a paraplegic patient who had a urinary tract infection. Because he did not have access to the patient’s records at other facilities, the physician did not know that the infection, caused by the patient’s permanent urinary catheter, was resistant to the antibiotics that he had prescribed. The patient died of heart failure in the hospital.

Politicians and government leaders have expressed great enthusiasm for the development and implementation of EHR systems. In April 2004, President George W. Bush announced plans to ensure that most Americans’ health records are computerized within ten years10 and to create a National Health Information Network (“NHIN”).11 Numerous proposed bills have been introduced in Congress to promote HIT initiatives.12 Executive and legislative efforts at the state level have established strategies and target dates for HIT implementation, commissions to develop recommendations for HIT use, and financial incentives for HIT adoption.13 EHR systems also became an issue in the 2008 presidential campaign, as both Senators McCain and Obama discussed their potential benefits.14

9. E-mail to Sharona Hoffman, Professor of Law, Case Western Reserve University Law School (Aug. 29, 2007, 22:46:00 EDT) (on file with author).
12. See infra notes 160–62 and accompanying text.
However, the novel and significant risks generated by EHR systems cannot be ignored. Products with poor information display and navigation can impede rather than facilitate providers’ work. The growing capabilities of EHR systems require increasingly complex software, which heightens the danger of software failures that may harm patients. To illustrate, one report relates that a hospital pharmacy’s computer program generated erroneous medication order lists, leading to the delivery of the wrong drugs to patients in many wards.17

Thus far, the legal literature has not assessed the need for careful regulatory oversight of EHR systems akin to that required, in principle, by the Food and Drug Administration (“FDA”) for life-critical medical devices. This Article begins to fill that gap. It analyzes EHR systems from both legal and technical perspectives and examines how law can serve as a tool to promote HIT. Extensive regulations already exist to govern the privacy and security of electronic health information. Privacy and security, however, are only two of the concerns that merit regulatory attention. Perhaps even more important are the safety and efficacy of these life-critical systems.

The benefits of EHR systems will outweigh their risks only if these systems are developed and maintained with rigorous adherence to the best software engineering and medical informatics practices and if the various EHR systems can easily share information with each other. Regulatory intervention is needed to ensure that these goals are achieved. Once EHR systems are fully implemented, they become essential to proper patient care, and their failure is likely to endanger patient welfare.

| 16. See Pamela Hartzband & Jerome Groopman, Off the Record — Avoiding the Pitfalls of Going Electronic, 358 NEW ENG. J. MED. 1656, 1657 (2008) (“In the new electronic sea of results, it becomes difficult to find those that are truly relevant”); Christine A. Sinsky, e-Nirvana: Are We There Yet?, 15 FAM. PRACT. MGMT. 6, 6 (2008), available at http://www.aafp.org/fpm/20080300/6enir.html (arguing that existing EHR systems have severe usability problems and provide poor support to physicians). |
| 17. Richard I. Cook & Michael F. O’Connor, Thinking About Accidents and Systems, in IMPROVING MEDICATION SAFETY 80–82 (Kasey Thompson & Henri R. Manasse eds., 2005) (explaining that the problem was rooted in a backup tape that was incomplete and corrupted). |
| 18. See infra Part III.B.1 for discussion of FDA’s regulation of medical devices. |
| 20. See Frank Richards, Infrastructure, in IMPLEMENTING AN ELECTRONIC HEALTH RECORD SYSTEM 21, 21 (James M. Walker et al. eds., 2005) [hereinafter IMPLEMENTING AN EHR SYSTEM] (explaining that “falling back on manual processes when the automated
The remainder of the Article will proceed as follows: Part II provides background and analysis of EHR systems, including their benefits and risks. Part III assesses the need for regulatory oversight of EHR systems. Part IV develops detailed recommendations for the contents of a regulatory framework. These recommendations include a requirement that all health care providers use approved EHR systems and that the government provide financial assistance to support the implementation of the new systems. In addition, the proposal addresses the following: the selection of an agency to regulate EHR systems; the creation of approval and monitoring processes for EHR systems; the standardization of system features and capabilities; interoperability; and the establishment of a national research databank of de-identified electronic patient records. Part V concludes.

II. EHR SYSTEMS: BACKGROUND AND ANALYSIS

A. What Are EHR Systems?

No universally accepted definitions have been developed for “EHRs” or “EHR systems.” There is, however, some agreement about their essential components. EHR systems, as the term is used in this Article and by other commentators, do much more than keep records. In 2003, the Institute of Medicine (“IOM”) identified the following elements as “core EHR functionalities”:

- **Health information and data**: The system should display laboratory test results, allergies, lists of other medications the patient is taking, medical and nursing diagnoses, patient demographics, and providers’ notes.
- **Results management**: EHRs should provide laboratory test results, radiology procedure results, and other treatment results.
electronically to enhance provider access to needed information and promote efficiency and easier detection of abnormalities.\(^{26}\)

- **Order entry and management:** Computerized medication orders and other care instructions can reduce or eliminate lost orders, duplicate orders, mistakes caused by illegible handwriting, and delays in filling orders.\(^{27}\)

- **Decision support:** Computer reminders and prompts can improve preventive care, diagnosis, treatment, and disease management.\(^{28}\)

- **Electronic communication and connectivity:** EHR systems should facilitate online communication among medical team members, other providers such as laboratories or pharmacies, and patients through e-mail, web messaging, integrated health records within and across treatment settings, telemedicine,\(^{29}\) and home telemonitoring.\(^{30}\) Communication should be possible among providers in different geographic locations and medical organizations.\(^{31}\)

With these features, EHR systems can significantly improve medical treatment by ensuring that patients’ health information is easily available to providers who require it, by preventing or correcting clinicians’ errors or oversights before they cause harm, and by helping to promulgate best medical practices. In addition, EHR systems can serve important administrative functions:

- **Patient support:** Patient education and self-testing at home should be facilitated by electronic systems.\(^{32}\)

- **Administrative processes:** Electronic scheduling systems, insurance eligibility verification, billing, and claims processing systems should be components of EHRs. Computerized tools can also be used to identify individuals who are potentially eligible for clinical trials, those who should be informed about a drug recall, or candidates for chronic disease management programs.\(^{33}\)

\(^{26}\) Id. at 7–8.
\(^{27}\) Id. at 8.
\(^{28}\) Id. at 8–9.
\(^{29}\) Telemedicine is “the delivery of health care at a distance, increasingly but not exclusively by means of the Internet.” BIOMEDICAL INFORMATICS, supra note 1, at 991.
\(^{30}\) Home telemonitoring can be defined as “an automated process for the transmission of data on a patient’s health status from home to the . . . health care setting.” Guy Paré et al., Systematic Review of Home Telemonitoring for Chronic Diseases: The Evidence Base, 14 J. AM. MED. INFORMATICS ASS’N 269, 270 (2007).
\(^{31}\) INST. OF MED., supra note 2, at 9–10.
\(^{32}\) Id. at 10.
\(^{33}\) Id.
• **Reporting and population health management:** Through the implementation of standardized terminology and machine-readable records, EHR systems should enable providers to collect clinical data in order to meet public and private reporting requirements.34

The federal government’s ultimate goal is a fully interoperable EHR system. The system will initially operate on a regional basis using Regional Health Information Organizations (“RHIOs”) and eventually transition to an NHIN.35 “Interoperability” means “the ability for systems to exchange data and to operate in a coordinated, seamless manner.”36 If EHR systems across the country are made interoperable, patients who relocate to different cities or seek second opinions from doctors outside their physician networks could have their records electronically transmitted to the new physicians, who could use them on their own EHR systems.

One well known RHIO is the Regenstrief Medical Record System, which is used by numerous facilities in the Indianapolis area.37 The system captures medical data, includes an order entry mechanism, provides reminders and informational feedback, and features search and retrieval capabilities for research purposes.38 The largest EHR system in the U.S. is the Veterans Health Information Systems and Technology Architecture (“VistA”) developed by the Department of Veterans' Affairs (“VA”). A primary component of VistA is a physician interface called the Computerized Patient Record System (“CPRS”).39 The CPRS, which has been widely praised,40 provides complete EHRs, an order entry system, critical alerts, remote access to health information at other VA facilities, and decision support, including reminders.41

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34. Id. at 10–11.
36. BIOMEDICAL INFORMATICS, supra note 1, at 952.
38. Id. at 225–27, 248.
40. See, e.g., Joel Kupersmith et al., Advancing Evidence-Based Care for Diabetes: Lessons from the Veterans Health Administration, 26 HEALTH AFF. w156, w156 (2007) (stating that the VA’s Veterans Health Administration provides “a unique laboratory for using the [EHR] to transform health care and accelerate discovery”); Perlin et al., supra note 39, at 832.
41. Perlin et al., supra note 39, at 832–33.
Some current HIT initiatives utilize two alternatives to comprehensive EHRs: continuity of care records ("CCRs") and personal health records ("PHRs"). CCRs are summaries that aggregate data from a variety of sources to form a limited record of the patient’s provider and insurance information, current health care status, and medical history, including allergies, medications, diagnoses, and recent procedures. These subsets of full patient EHRs can be e-mailed to the patient’s next care giver or given to the patient on paper or portable electronic media to be taken to her next appointment. While useful, CCRs are not as comprehensive as full EHRs, and, unlike EHR systems, CCRs do not offer order entry mechanisms, decision support, or interoperability, all of which provide significant benefits to patients and clinicians.

PHRs contain medical and claims information that is collected and maintained by patients who may then share this information with other parties, including employers, insurers, and private enterprises. One source describes the PHR as follows:

[A]n Internet-based set of tools that allows people to access and coordinate their lifelong health information and make appropriate parts of it available to those who need it. PHRs offer an integrated and comprehensive view of health information, including information people generate themselves such as symptoms and medication use, information from doctors such as diagnoses and test results, and information from their pharmacies and insurance companies. Individuals access their PHRs via the

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42. Terry & Francis, supra note 11, at 687–88.
44. Burton et al., supra note 43, at 461.
45. See supra note 36 and accompanying text (discussing interoperability); infra Parts II.B.2, IV.C.2, and IV.C.5 (discussing computerized order entry, decision support, and interoperability).
Internet, using state-of-the-art security and privacy controls . . . \( ^{47} \)

Wal-Mart and other large employers, such as Intel and BP, with a total of 2.5 million employees, have formed a PHR system named Dossia.\(^ {48} \) Both Google and Microsoft have developed products that enable customers to maintain PHRs.\(^ {49} \)

However, stand-alone PHRs may be of limited use. To the extent data is entered by patients themselves, they may often be incomplete or inaccurate.\(^ {50} \) Furthermore, without interoperability and the capacity to exchange data with EHR systems operated by all facilities at which the patient receives care, PHRs would constitute isolated and partial records, because they could not be accessed by all physicians and could not be updated with each new patient encounter.\(^ {51} \) Finally, stand-alone PHRs will not offer some of the most important benefits of EHR systems, including decision support and order entry. Consequently, some commentators assert that PHRs will be of significant benefit to patients and caregivers only if they are integrated into providers’ EHR systems.\(^ {52} \)

**B. Benefits of EHR Systems**

Many experts have justifiably expressed strong enthusiasm for EHR systems, and many policy makers have asserted a commitment to promote their broad adoption.\(^ {53} \) These systems could facilitate clinicians’ access to critical patient information and could prevent medi-

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50. Paul C. Tang et al., Personal Health Records: Definitions, Benefits, and Strategies for Overcoming Barriers to Adoption, 13 J. AM. MED. INFORMATICS ASS’N 121, 122 (2006) (asserting that “it is unlikely that individuals would keep records . . . up to date” and that “most patients cannot reliably report specific laboratory values such as their specific cholesterol level or hemoglobin A1c”).

51. Id. at 124 (explaining that PHRs could “become ‘information islands’ that contain subsets of patients’ data, isolated from other information about patients, with limited access and transient value”).

52. See, e.g., id. (“[A]ll the advantages of PHRs for providers depend on the PHR being integrated with the provider’s EHR.”).

53. See supra notes 10–14 and accompanying text.
Electronic Health Record Systems

cal errors, thereby potentially saving thousands of lives and billions of dollars.54

This Section describes the numerous benefits of EHR systems, which could dramatically improve health care in the U.S. and worldwide. These benefits support the widespread adoption of EHR systems and the establishment of an NHIN.

1. Facilitating Access to Patients’ Medical Records

EHR systems enable health care providers to obtain critical medical information about their patients as soon as the need for it arises. Essential to this capacity is interoperability.55

Interoperable EHR systems could allow doctors with proper authorization to access to relevant information about their patients, including medical histories, drug lists, and allergies, no matter where the patients had been previously treated. This capability could be invaluable in treating patients who arrive at the emergency room unconscious. It could also significantly facilitate and enhance the treatment of economically disadvantaged patients, who may not have attentive primary care physicians to manage their care56 and who may not fully recall or understand the details of their medical histories.

Many patients who are not economically disadvantaged also have records that are fragmented and not fully accessible to all physicians treating them. According to one source, the average patient on Medicare visits seven different physicians every year.57 If these doctors do not communicate and carefully coordinate the patient’s care, any one of them may miss vital information that is critical to the individual’s welfare.

An additional strength of EHRs is that, if appropriately backed up or replicated, they should be less vulnerable to loss or destruction than paper records. This problem with paper records was highlighted in the aftermath of Hurricane Katrina, when the medical records of many displaced New Orleans residents were destroyed.58

54. See TO ERR IS HUMAN: BUILDING A SAFER HEALTH SYSTEM, supra note 7, at 1–2.
55. See supra note 36 and accompanying text.
2. Improving Quality of Care and Reducing Poor Treatment Decisions

EHR systems can reduce errors and thereby improve patient safety, particularly through decision support features. Decision support is “any information added by a system to assist the clinician’s decision-making process.” EHR systems can incorporate reminders, prompts, and links to medical literature to promote accurate, timely, and responsible care. Studies have shown that computerized reminder systems improve immunization rates, preventive care, clinician adherence to practice guidelines, and the thoroughness of patient histories. Studies have also shown that EHR systems reduce prescribing costs, prescribing mistakes, and unneeded diagnostic tests. According to one source, computerized physician order entry (“CPOE”) systems could likely prevent sixty-five percent of prescribing errors, largely by incorporating decision support features that would educate doctors about medications. In one instance, for example, a doctor typed a prescription for ten times the proper dosage, and the EHR system informed him of the error.

59. See Basit Chaudhry et al., Systematic Review: Impact of Health Information Technology on Quality, Efficiency, and Costs of Medical Care, 144 ANNALS INTERNAL MED. 742, 748 (2006) (citing the benefits of “increased delivery of care based on guidelines . . . , reduction of medication errors, and decreased rates of utilization for potentially redundant or inappropriate care”); see also INST. OF MED., supra note 2, at 5. But see infra Part II.C.1 for discussion of the possibility that EHR systems might sometimes cause errors instead of preventing them.


62. See Burton et al., supra note 43, at 461, 464; see also Paul R. Dexter et al., A Computerized Reminder System to Increase the Use of Preventive Care for Hospitalized Patients, 345 NEW ENG. J. MED. 965, 968 (2001) (finding that “the use of reminders increased the use of pneumococcal and influenza vaccination from practically zero to approximately 35 percent and 50 percent, respectively” for hospitalized patients); Elizabeth Mitchell & Frank Sullivan, A Descriptive Feast but an Evaluative Famine: Systematic Review of Published Articles on Primary Care Computing During 1980–97, 322 BRIT. MED. J. 279, 281 (2001) (describing “improvements in immunisations and preventive care and reductions in prescribing costs and unnecessary tests” due to computerization); Mike Pringle, Using Computers to Take Patient Histories, 297 BRIT. MED. J. 697, 697 (1988) (“Computer histories are more exhaustive than those taken in the normal way.”); Charles Safran et al., Guidelines for Management of HIV Infection with Computer-Based Patient’s Records, 346 LANCET 341, 344 (1995) (concluding that EHR systems help clinicians to adhere to practice guidelines).

63. Bobb et al., supra note 61, at 788.

64. Ceci Connolly, Cedars-Sinai Doctors Cling to Pen and Paper, WASH. POST, Mar. 21, 2005, at A01.
EHR systems might also dissuade physicians from practicing wasteful “defensive medicine.” Clinicians could rely on decision support mechanisms to determine whether particular diagnostic procedures or treatments are warranted. Because these mechanisms would be designed based on widely accepted medical practices, the doctors could, if necessary, cite their reliance on the mechanisms to defend their medical decisions.

Likewise, the systems could reduce the unnecessary use of antibiotics. One study found that seventy-three percent of adults who visit primary care physicians for sore throats are treated with antibiotics, even though only five to seventeen percent of adults’ sore throats require antibiotic therapy. The excessive use of broad spectrum antibiotics has led to the emergence of antibiotic-resistant bacteria. This phenomenon might become less common with the assistance of decision support systems designed to provide guidance concerning prescription drugs.

Currently, the lag between the discovery of new treatments and their consistent use in medical practice can be up to twenty years. EHR systems, however, could significantly expedite the broad dissemination of knowledge about effective new treatments through decision support mechanisms.

Furthermore, by allowing physicians to search patient records electronically for the information they require, EHR systems can reduce the amount of time providers spend reviewing patients’ medical histories. In addition, electronic searches can allow clinicians to

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65. See David M. Studdert et al., Defensive Medicine Among High-Risk Specialist Physicians in a Volatile Malpractice Environment, 293 JAMA 2609, 2609 (2005) (noting that defensive medicine is prevalent among Philadelphia physicians in specialties with a high risk of litigation). “Defensive medicine” is the practice of making healthcare decisions “with the sole intention of preventing” malpractice lawsuits and can include the provision of excessive unnecessary care or the avoidance of beneficial treatment that is high-risk. G.D. Dalton et al., Effect of Physician Strategies for Coping with the US Medical Malpractice Crisis on Healthcare Delivery and Patient Access to Healthcare, 122 PUB. HEALTH 1051, 1054–55 (2008).


67. See Besser, supra note 66, at 605.


70. See Richard J. Baron et al., Electronic Health Records: Just Around the Corner? Or over the Cliff?, 143 ANNALS INTERNAL MED. 222, 225–26 (2005).
identify patients who should be informed about matters such as drug recalls.\(^7\)

Of particular significance is the potential role of these systems in reducing health disparities in the U.S.\(^7\) Health disparities between whites and blacks have been the subject of much commentary and debate in recent years.\(^7\) Technology that provides resource-poor practices with automatic decision support, reminders, and alerts based on the most advanced medical knowledge could enhance the care available to economically disadvantaged patients. With affordable or subsidized EHR systems, clinicians who are pressed for time and resources would have information at their fingertips that they might otherwise be unable to access. It must be noted, however, that, if only wealthy practices can afford EHR systems and others are left without the improvements they enable, the technology could increase health disparities between rich and poor communities. Consequently, it will be important to offer financial support for EHR system adoption to some practices.\(^7\)

EHR systems also have much to contribute to public health emergency response efforts. EHR vendors\(^7\) and public health officials could use decision support functions in EHR systems to inform clinicians as to how best to respond to public health emergencies.\(^7\) For example, EHR systems nationwide might be quickly reconfigured to advise caregivers to treat patients with particular symptoms as possible carriers of an emerging infectious disease.

3. Cost Savings

Many commentators associate significant cost savings with EHR systems, despite the expenses of purchasing, implementing, and oper-

\(^{71}\) See id.

\(^{72}\) See Alexandra E. Shields et al., Adoption of Health Information Technology in Community Health Centers: Results of a National Survey, 26 HEALTH AFF. 1373, 1381 (2007) (stating that expanding HIT capacity “seems a valuable strategy to further reduce health disparities for a substantial number of financially vulnerable patients”).


\(^{74}\) See infra Part IV.A.1.

\(^{75}\) Throughout this Article we use the term “vendor” broadly to refer to those who develop or modify EHR system software, install it, or integrate it with existing systems. Health care providers who perform these functions themselves should be deemed vendors for legal purposes relating to EHR system activities ordinarily performed by vendors.

\(^{76}\) These adaptations could be similar to automatic anti-virus downloads, which are now commonly available.
ating them. Some commentators have estimated the net economic benefits of EHR implementation to range from $8400 to $140,100 per physician over five years. Others have found savings of $16.7 million over ten years for a hospital operating a CPOE system. Still others have estimated $77.8 billion a year in savings for the institution of a standardized, interoperable national system. These cost savings result from: fewer duplicated tests; reduction in administrative expenditures; a decrease in medical errors and adverse drug events linked to ignorance about the patient’s allergies, medical history, and other prescription drugs; and, from the provider’s perspective, from improved mechanisms for calculating and recording charges. Doctors would be able to retrieve the EHRs of patients who present at emergency rooms no matter where those records are housed and thus would not need to conduct diagnostic tests that the patient has already recently undergone. Furthermore, access to a patient’s complete EHR, including medical history, allergies, and current medication list, could prevent medical errors in the emergency room that might lead to lengthy hospitalization, surgery, and other expensive care.

Other commentators note, however, that to date there is a dearth of compelling empirical evidence that proves the cost-effectiveness of EHR systems. Indeed, because of the relatively low rate of EHR system adoption, to date there is only limited data concerning cost savings. The evidence base is likely to improve as more institutions adopt EHR systems and an increasing number of researchers and economists begin to study their impact.

77. See infra notes 131–33 and accompanying text for discussion of these costs.
81. See CONG. BUDGET OFFICE, supra note 80; Kaushal et al., supra note 79, at 263 tbl.1; Walker et al., supra note 80, at W5-16.
82. S. Clamp & J. Keen, Electronic Health Records: Is the Evidence Base Any Use?, 32 MED. INFORMATICS & INTERNET MED. 5, 9 (2007) (stating that the authors “found no technically sound evidence about cost changes associated with EHR”).
83. Hillestad et al., supra note 61, at 1104 (“[T]he currently useful evidence [concerning HIT efficiency savings] is not robust enough to make strong predictions . . . .”).
4. Promoting Research

EHRs could also promote medical research and the collection of much needed evidence concerning the efficacy of various treatment alternatives.\textsuperscript{84} The term of art for decision-making rooted in scientific knowledge is “evidence-based medicine,”\textsuperscript{85} a concept that is now frequently discussed in academic and scientific circles.\textsuperscript{86} First, EHRs could facilitate the identification of patients for clinical studies by allowing investigators to search their patient records electronically for individuals who meet the inclusion criteria for particular clinical trials. Second, many studies could be based directly on analysis of the extensive and comprehensive data contained in electronic records.\textsuperscript{87} EHR systems should facilitate efficient and extensive collection of evidence and development of new knowledge.\textsuperscript{88}

Randomized, controlled clinical trials are considered the gold standard of medical studies.\textsuperscript{89} However, research can also be accomplished through observational studies, which could be facilitated by the use of EHRs.\textsuperscript{90} Rather than conducting a controlled experiment, investigators might review the charts or electronic files of patients receiving different medications or different types of surgery to treat a

\textsuperscript{84} See sources cited infra notes 386–87 (discussing the uncertainty surrounding many medical decisions).

\textsuperscript{85} See Marc A. Rodwin, The Politics of Evidence-Based Medicine, 26 J. HEALTH POL. POL’Y & L. 439, 439 (2001) (explaining that “[e]vidence-based medicine is portrayed as an alternative to medicine based on authority, tradition, and the physician’s personal experience” and that it involves evaluating the “safety, effectiveness, and cost of medical practices using tools from science and social science”).

\textsuperscript{86} See, e.g., Scott R. Sehon & Donald E. Stanley, A Philosophical Analysis of the Evidence-Based Medicine Debate, 3 BMC HEALTH SERVICES RES. (2003), http://www.biomedcentral.com/1472-6963/3/14 (arguing that the medical community must clarify the “nature of [evidence-based medicine] and its relationship to alternative approaches to medicine”).


\textsuperscript{88} Liang, supra note 69, at w120.

\textsuperscript{89} Friedrich K. Port, Role of Observational Studies Versus Clinical Trials in ESRD Research, 57 KIDNEY INT’L (SUPPLEMENT 74) S3, S3 (2000), available at http://www.nature.com/ki/journal/v57/n74s/pdf/4491615a.pdf (“Randomized controlled clinical trials have been considered by many to be the only reliable source for information in health services research.”). Experimental studies involve “the collection of data on a process when there is some manipulation of variables that are assumed to affect the outcome of a process, keeping other variables constant as far as possible.” BRYAN F.J. MANLY, THE DESIGN AND ANALYSIS OF RESEARCH STUDIES 1 (1992).

\textsuperscript{90} CHARLES P. FRIEDMAN & JEREMY C. WYATT, EVALUATION METHODS IN BIOMEDICAL INFORMATICS 369 (2d ed. 2006) (defining an observational study as an “[a]pproach to study design that entails no experimental manipulation” in which “[i]nvestigators typically draw conclusions by carefully observing [subjects] with or without an information resource”); MANLY, supra note 89, at 1 (explaining that observational studies involve the collection of data “by observing some process which may not be well-understood”).
particular condition in order to determine the efficacy of each approach. At times, observational studies may be skewed by uncontrolled variables, such as changes in diet, exercise, stress level, or other lifestyle modifications that are not noted in the record and of which researchers remain unaware. However, observational studies may also have several advantages over clinical trials. Interoperable systems can allow researchers to access vast amounts of information about various subpopulations over long periods of time. Researchers can monitor patients for years after drugs have been approved by the FDA and detect patterns of adverse events, avoiding continued harm to patients such as that caused by ignorance about the side effects of Vioxx. These studies can also be considerably less costly and time-consuming than experimental research because the data used already exist and investigators need not comply with federal research regulations or obtain approval from Institutional Review Boards (“IRBs”) if records are de-identified. In addition, investigators could study the cases of individuals with very rare diseases that cannot be studied through large-scale clinical trials. Likewise, researchers could review the records of patients who receive care of varying quality, including substandard care. Such substandard care, which is at times provided in real world treatment settings, would not be provided in the controlled setting of a clinical trial.

It is not anticipated that EHR-based observational studies would replace randomized clinical trials. However, observational studies are a valuable addition to the research toolkit. In the words of one

92. See MANLY, supra note 89, at 4–5 ("[A] prima facie conclusion may be invalid because of the confounding effects of uncontrolled variables."); Benson & Hartz, supra note 91, at 1878 ("Concern about inherent bias [in observational studies] has limited their use in comparing treatments"); Gary Taubes, Do We Really Know What Makes Us Healthy?, N.Y. TIMES, Sept. 16, 2007, § 6 (Magazine), at 52 (describing the limitations of observational studies and stating that they “can only provide what researchers call hypothesis-generating evidence — what a defense attorney would call circumstantial evidence”).
93. See Liang, supra note 69, at w120 (“EHRs have the potential to take over where clinical trials and evidence-based research leave off, by providing real-world evidence of drugs’ and treatments’ effectiveness across subpopulations and over longer periods of time.”).
95. Benson & Hartz, supra note 91, at 1878; Port, supra note 89, at S3.
96. 21 C.F.R. § 56.102(g) (2007) (“Institutional Review Board (IRB) means any board, committee, or other group formally designated by an institution to review, to approve the initiation of, and to conduct periodic review of, biomedical research involving human subjects.”).
97. See infra note 394 and accompanying text (discussing regulatory requirements for the approval of research studies).
98. See, e.g., Etheredge, supra note 94, at w108.
99. See Port, supra note 89, at S5 (arguing that both observational studies and clinical studies have their place and complement each other); see also Jerry Avorn, In Defense of
commentator, EHRs “will offer the capacity for real-time learning from the experience of tens of millions of people and will greatly increase the ability to generate and test hypotheses.”

C. The Challenges of EHR System Implementation

Despite the many potential benefits of EHR systems, they are not an unalloyed good. Their design, implementation, use, and maintenance raise important concerns that must not be overlooked. EHR system failures can cause significant injury and cost lives. Unauthorized disclosure of electronic health information can also lead to large scale privacy breaches, and the cost of implementing EHR systems may threaten the financial viability of some medical practices. The risks generated by these complex software systems are sufficiently serious that they demand regulatory oversight.

1. Potential for Errors

In some instances, EHR systems may generate errors rather than prevent them, especially early in the adoption process. Many of these errors could significantly harm patients. One study of a hospital’s CPOE system identified twenty-two circumstances in which CPOE increased rather than decreased the likelihood of error.

Sources of such errors include: fragmentation of data; failure to integrate all hospital systems; and human-computer interface difficulties rooted in the machine rules’ failure to reflect work organization or expected provider behavior. For example, errors can result from computer crashes or from maintenance shutdowns that lead to lost orders. They may also result from system inflexibilities that significantly impede providers’ ability to enter nonstandard specifications or

Pharmacoepidemiology — Embracing the Yin and Yang of Drug Research, 357 NEW ENG. J. MED. 2219, 2220 (2007) (listing the strengths and weaknesses of clinical and observational studies of medications); Benson & Hartz, supra note 91, at 1878, 1884 (concluding, based on a literature review, that “observational studies and randomized controlled trials usually produce similar results”).
100. Etheredge, supra note 94, at w108.
101. See infra Part III.A.2 (arguing for regulatory oversight of EHR systems).
102. See Stead, supra note 78, at 38.
104. Stead, supra note 78, at 38 (discussing human-computer interface problems); see Jonathan R. Nebeker et al., High Rates of Adverse Drug Events in a Highly Computerized Hospital, 165 ARCHIVES INTERNAL MED. 1111, 1114–15 (2005) (finding high rates of error at a hospital whose CPOE system did not have adequate decision support); Robert L. Wears, Computer Technology and Clinical Work, 293 JAMA 1261, 1262 (2005) (explaining that “the model of health care work inscribed” in CPOE and decision support systems clashes “with the actual nature of clinical work”).
105. Koppel et. al., supra note 103, at 1201.
to order non-formulary medications. Usability problems, such as display and navigation deficiencies, can also cause errors.

Furthermore, complex software systems invariably exhibit a significant degree of coupling or interdependence between their many components. Consequently, a failure of one component may cause or contribute to the failure of another component that is not obviously related to the first component. Similarly, complex software sometimes fails unpredictably due to unforeseen or untested interactions between its various features and services. Under certain conditions, a clearly safety-critical component of an EHR system, such as a diagnostic aid for cardiac care, might function incorrectly because of a subtle interaction with an apparently unrelated defective component, such as a billing feature.

Other errors may cause physicians to absorb financial losses. One physician reported that billing interface errors caused many of his patients to be improperly categorized as established rather than new patients, which resulted in a $90,000 revenue loss.

Some failures caused by flawed software design, implementation, or validation could be avoided with improved software engineering practices. However, as EHR system functionality becomes more complex, the safety risks to patients may grow unless additional quality control interventions are initiated.


110. Undesirable coupling and complex interactions between software components can be reduced by the application of certain software design techniques such as object-oriented design, but dependencies between components are an inherent aspect of software systems and cannot be eliminated or rendered insignificant. ERICH GAMMA ET AL., DESIGN PATTERNS: ELEMENTS OF REUSABLE OBJECT-ORIENTED SOFTWARE 24–25 (1999) (discussing design patterns that reduce coupling).


113. See infra Parts IV.B and IV.C for recommendations.
2. Privacy and Security Concerns

Both patients and analysts have expressed concern that EHR systems will threaten patient privacy and be vulnerable to security breaches. With a fully interoperable NHIN, EHRs could be accessed from anywhere in the country and transmitted illicitly across the world quickly, cheaply, and with little risk of detection. The security of health information is, in fact, compromised with alarming frequency as a result of computer theft, sale of used computers without removal of data from hard drives, hacking, inadvertent disclosures, and deliberate misuse of information by those with access to it. As an example, Georgetown University Hospital suspended a test program with electronic prescription provider InstantDx after a serious security breach was discovered in 2006. The hospital had securely transmitted data concerning thousands of patients to InstantDx, but, because of InstantDx’s flawed security practices, an Indiana consultant was able accidentally to stumble upon the online files while installing medical software for a client.

To address privacy and security concerns related to personal health information, the U.S. Department of Health and Human Services (“HHS”) promulgated the Health Insurance Portability and Accountability Act (“HIPAA”) Privacy Rule and the HIPAA Security Rule, the latter of which governs the security of certain electronic health information. We have critiqued these regulations at length in prior work and noted their shortcomings. The Privacy Rule covers only a narrow range of entities, namely health plans, health care clearinghouses, and health care providers who transmit health information electronically for claims, billing, or health plan purposes. It does not cover employers, marketers, life insurers, or many others who might handle personal health information. The Privacy Rule also does

114. Terry & Francis, supra note 11, at 696; National Committee on Vital and Health Statistics, Privacy and Confidentiality in the Nationwide Health Information Network 8–13 (June 22, 2006), http://ncvhs.hhs.gov/060622lt.htm [hereinafter NCVHS] (“Protecting the confidentiality of personal health information in such settings requires institutions to establish different access rules depending on employees’ responsibilities and their need to know the information to carry out their role.”).


116. Id. at 6.


118. Id.


122. Id. at 344–59.

123. 45 C.F.R. § 160.103 (2007).
not feature a private cause of action, so its deterrent and remedial effects are limited. In addition, the Security Rule’s standards are extremely vague, leaving a vacuum of guidance that makes meaningful compliance unlikely. A 2007 assessment of HIPAA compliance in fact found widespread confusion and mistakes. The standards in the HIPAA Privacy and Security Rules must be clarified, and their enforcement must be bolstered so that patient privacy and EHR confidentiality are meaningfully protected.

Many states also have medical confidentiality rules that will affect EHR systems. Because the NHIN would be an interstate network allowing data that is entered in one location to be accessed anywhere in the U.S., some of the state standards may cause significant complications and require modification in light of HIT developments.

3. Expense, Time, and Burden

The introduction of EHR systems into medical practice can involve significant costs and difficulties. The purchase of an EHR system is estimated to cost $33,000 per doctor, with an additional $1500

130. Terry & Francis, supra note 11, at 709–10 (discussing how state laws can present challenges for a national EHR system); NCVHS, supra note 114, at 9 (describing the confusion, difficulty, and expense of designing a national health information network to comply with numerous health privacy laws enacted by the states).
a month per doctor for maintenance. According to a study of Pennsylvania hospitals, the median capital spending per bed for HIT in 2006 was $6912, while the median HIT operating cost per bed was $14,528. The cost of achieving a fully interoperable NHIN has been estimated at $156 billion in capital investment and $48 billion in yearly operating expenses over five years.

Transitioning to an EHR system can also place significant administrative burdens upon health care providers. The potential difficulties of EHR implementation include all of the following: (1) office systems must be redesigned; (2) users must adopt uniform ways of recording data to fit system requirements and must forego their own shorthand and terminology; (3) data from paper records must be entered into the electronic system; (4) all staff members must learn to be proficient with the system, and their training takes time away from patient care; and (5) patients may be concerned about providers spending considerable time inputting data into computers during examinations, leaving less time for human interaction between the clinician and the individual being examined.

Even in the long term, use of EHR systems may be time consuming for providers. Typing may take physicians longer than dictating notes. One study found that, during consultation, use of EHRs increased the time that doctors spent on activities other than interacting with patients by as much as twenty-eight percent and that this did not change with improved computer proficiency. Other writers have noted that, in the intensive care unit, where numerous interventions

131. Thomas Goetz, Editorial, Physician, Upgrade Thyself, N.Y. TIMES, May 30, 2007, at A21; see also Baron et al., supra note 70, at 223–24 (reporting that an EHR system cost a four-person medical practice $140,000, including hardware, software, training, and one year of support, and estimating the system’s annual maintenance cost, including support services, to be $40,000).


134. See, e.g., Baron et al., supra note 70, at 223–24 (describing the difficulties one practice faced in implementing a new EHR system); Connolly, supra note 64 (relating that Cedars-Sinai Medical Center in Los Angeles abandoned its $34 million EHR system after staff members found that it was “chunky and slow” and that they could not operate it effectively, because they had received insufficient training); Terry, supra note 111 (describing difficulties associated with EHR implementation).

135. Yong Y. Han et al., Unexpected Increased Mortality After Implementation of a Commercially Sold Computerized Physician Order Entry System, 116 PEDIATRICS 1506, 1510 (2005) (asserting that CPOE systems require more time for order entry than written forms, although this may be mitigated by improved overall efficiency).

136. See Baron et al., supra note 70, at 223–24 (discussing increases in patient waiting times due to the adoption of an EHR system).

must be performed in rapid succession, CPOE systems may increase mortality because staff members must spend significant time at computer terminals rather than at the bedside.138 How time consuming and problematic an EHR system is, however, depends largely upon its user interface design.139 Enhanced designs, including mechanisms such as voice recognition software, allow users to operate systems more quickly and more safely.140

4. Legal Issues

Use of EHR systems may raise important tort litigation questions.141 Addressing all of the issues in detail is beyond the scope of this Article, but some bear mentioning. For example, to what extent will a physician’s reliance on guidance provided through decision support mechanisms insulate her from liability? Will EHR system vendors be included as a matter of course in every lawsuit because the provider’s system might possibly have contributed to the alleged injury?142 If so, will concern about litigation impede NHIN implementation, or will vendors demand immunity?143 Will frequent attempts to prove failures in complex EHR systems through the testimony of costly expert witnesses drive the costs of litigation and malpractice insurance dramatically higher?

Furthermore, a patient harmed by a malfunction or security vulnerability of an EHR system may face difficulties proving her claims. The patient may find it very hard to establish that the system was responsible for her injuries unless the inputs provided to the system, the actions taken by users, and the outputs and actions generated by the system are faithfully recorded in a form that can be understood by an expert. It can be extremely challenging to inspect a complex EHR system’s program code for the defect that was responsible for a failure

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138. See, e.g., Han et al., supra note 135, at 1510.
139. See Michael E. Wiklund, Making Medical Device Interfaces More User-Friendly, in DESIGNING USABILITY INTO MEDICAL PRODUCTS 151–60 (Michael E. Wiklund & Stephen B. Wilcox eds., 2005) (discussing user-interface problems and techniques for enhancing the user-friendliness of medical device interfaces).
141. See, e.g., Burton et al., supra note 43, at 465–66 (discussing the uncertainties regarding legal liability of physicians relying on data from other providers).
143. See ROBERT WOOD JOHNSON FOUND. ET AL., supra note 22, at 45 (noting that “immunity from suit is extremely rare” and that it is possible that HIT will generate new sources of liability).
that harmed a patient. Such a defect might involve only one line of code among many thousands.

Discovery issues might be particularly copious. For example, will printouts of EHRs accurately reflect the providers’ activities? Will fragmented screen displays, physician shortcuts, and system inflexibilities impede discovery and distort the medical record?144 Will EHRs record all of the providers’ activities accurately, comprehensively, and chronologically, or will files be disjointed, confusing, and incomplete? Will e-mail messages exchanged between patients and physicians be captured by the EHR system and become part of the medical record?145

On the other hand, EHRs could significantly facilitate discovery of the truth in litigation. If all medical interventions are faithfully recorded in EHRs, computerized records will be much more comprehensive than paper files built upon dictation of physicians’ summary notes. EHR systems could also ease the burdens of discovery by allowing for electronic searches of medical files.146 Both plaintiffs and defendants could use EHRs to their advantage in litigation.147

III. THE ROLE OF THE LAW AND ADMINISTRATIVE REGULATION

A. Why Are Legal Interventions Necessary?

EHR systems are not currently regulated by any governmental entity despite being crucial to the effective management of patient care in practices that use them.148 There are at least two important reasons for governmental involvement in the realm of EHR systems. First, EHR systems are unlikely to be widely adopted in the near future without governmental intervention. The government should require all health care providers to adopt EHR systems and offer financial support to offset the providers’ costs. Second, individual patients’ lives and public health will depend on the proper functioning of EHR sys-

144. See supra notes 102–13 and accompanying text (discussing the potential for errors generated by EHR systems).
145. See ROBERT WOOD JOHNSON FOUND. ET AL., supra note 22, at 45 (“To the extent that electronic technology makes the meaning of a medical record ambiguous, the scope of discovery could extend beyond the limits now imposed in paper medical record cases.”).
146. See FED. R. CIV. P. 26(b)(2) advisory committee’s note to 2006 amendments (“Electronic storage systems often make it easier to locate and retrieve information.”).
147. See infra Part IV.C.3 (discussing audit trails and capture/replay and their potential role in litigation).
148. See Jason Miller, FDA to Propose Rule on E-Health Records, GOV’T HEALTH IT, June 5, 2007, http://www.govhealthit.com/online/news/102901-1.html (quoting Tim Stitely, the FDA’s chief information officer, as stating that the FDA does not have jurisdiction to regulate EHRs and that he is uncertain as to which agency will regulate them).
tems; therefore, like other goods and services that impact public welfare, EHR systems must be regulated.

1. Financial Support for Universal EHR System Adoption

Although many believe that EHR systems can dramatically improve the quality of health care in the U.S., the majority of health care providers have failed to adopt EHR systems thus far. According to a recent national survey, as of early 2008, only 4% of U.S. physicians in ambulatory care settings had fully functional EHR systems, and 13% had basic systems. A fall 2006 survey by the American Hospital Association concluded that 11% of hospitals had fully implemented EHRs, while 57% had partially implemented EHRs. The survey also found that physicians in only 10% of hospitals routinely used CPOE at least half of the time. A 2006 study of community health centers showed that 26% asserted that they had some EHR capacity, and those serving largely poor and uninsured patients were unlikely to have any EHR capabilities.

Commentators have, in fact, noted a misalignment of incentives. While providers must invest heavily in the purchase and maintenance of EHR systems, it is insurers and self-insured employers who will reap many of the systems’ economic benefits: less frequent duplication of diagnostic tests and fewer medical errors that lead to costly complications.

One way to compel the adoption of EHR systems is to establish a legal mandate requiring their use by all health care providers. We recommend that federal law include such a requirement, which should be phased in over a period of years, with longer deadlines for smaller practices. Health care providers should be required to purchase and

149. See supra Part II.B (discussing the benefits of EHR systems).
150. DesRoches et al., supra note 6, at 54.
151. AM. HOSP. ASS’N, supra note 6, at 3. 5. Survey responses were received from over 1,500 community hospitals, which constitute approximately one-third of all community hospitals in the U.S. Id. at 1. The survey also found that forty-six percent of community hospitals made moderate or high use of HIT, including medication order entry, test result review, and clinical alert mechanisms, and that fifty-one percent of hospitals used real-time drug interaction alerts. Id.
152. Id. at 5.
153. Shields et al., supra note 72, at 1376. The survey also found that “only 13 percent [of community health centers] have the minimum set of functionalities defined by the national HIT Adoption Initiative.” Id.
maintain EHR systems and also to make good faith use of their various components, including decision support, CPOE, and other capabilities. Federal regulations, consequently, should provide specific instructions as to what constitutes acceptable use.

Nevertheless, we also recognize that the imposition of such a mandate would be unjust without financial support for those who must bear the expense of fulfilling it. The federal government has already recognized the problem and begun addressing it through several initiatives. On August 1, 2006, the Centers for Medicare & Medicaid Services ("CMS") and the Office of the Inspector General adopted final regulations that create exceptions and safe harbors to federal fraud and abuse laws in order to encourage the donation of EHR systems.\footnote{42 C.F.R. § 411.357(v)-(w) (2007); 42 C.F.R. § 1001.952(x)-(y) (2007); see Press Release, U.S. Dep’t of Health & Human Servs., New Regulations to Facilitate Adoption of Health Information Technology (Aug. 1, 2006), available at http://www.hhs.gov/news/press/2006pres/20060801.html.}


In addition, several congressional bills have been designed to offer various incentives to health care providers for the adoption of EHR systems. The proposed Wired for Health Care Quality Act of 2007 would provide $139 million in fiscal years 2008 and 2009, as well as further funding in subsequent years for HIT-related grants and loans to health care providers and to states.\footnote{Wired for Health Care Quality Act, S. 1693, 110th Cong. §§ 3008(a)(1), (b)(1), (e)(1) (2007); see Senate HELP Committee Approves Health IT Legislation by Voice Vote, 15 BNA’S HEALTH CARE POL’Y REP. 873 (2007) (reporting that the Senate Health, Education, Labor, and Pensions Committee approved the proposed legislation on June 27, 2007).} Likewise, the Health-e Information Technology Act of 2008 proposes incentive payments of up to $40,000 over five years to physicians and several million dollars to hospitals for HIT adoption.\footnote{Health-e Information Technology Act, H.R. 6898, 110th Cong. §§ 301–302 (2008).} While such incentive programs may
effectively encourage EHR system use, none of the proposed bills has passed thus far.\footnote{Business Leaders, Senators Urge Action on Health IT Bill, Despite Privacy Concerns, 16 BNA’s HEALTH CARE POL’Y REP. 457 (2008); Jeff Day, Legislation to Advance EMR Adoption Unlikely to Move Before Mid-2009, Aide Says, 16 BNA’S HEALTH CARE POL’Y REP. 1475 (2008) (explaining that “Congress is unlikely to take action on federal legislation that would pay doctors to adopt electronic medical record systems until well into 2009” because it will need to focus instead “on the economic crisis, the wars in Afghanistan and Iraq, and on passing fiscal year 2009 appropriations bills.”).}

2. The Need for Quality Control

The federal government must regulate EHR systems because their dependability and usability are crucial to patient welfare. A defect in the software of an EHR system containing hundreds or thousands of medical records, such as a flaw that causes inaccurate recording of patients’ allergies or medications, could adversely affect a very large number of patients. The risk is amplified by the fact that EHR system functionality extends well beyond simple record keeping. Through features such as decision support and order entry, EHR systems already significantly influence the course of patients’ treatments. Moreover, it is possible that, before long, the analytical power of these systems will increase so much that they will assume a key role in medical diagnosis and treatment management.

The potentially devastating effect of system malfunctions is illustrated by the following incident. A hospital pharmacy’s computer program generated erroneous medication order lists, leading to the delivery of the wrong drugs to patients in the wards.\footnote{Cook & O’Connor, supra note 17, at 80–82 (explaining that the problem was rooted in a backup tape that was incomplete and corrupted).} Had the hospital staff not been vigilant and detected the mistakes, the consequences could have been catastrophic for some patients.\footnote{Id.}

A website entitled Bad Health Informatics Can Kill provides various examples of instances in which CPOE led to serious errors as well as other illustrations of how medical mistakes have been caused by technology, though not necessarily through EHR systems.\footnote{EFMI-WG Assessment of Health Information Systems, Bad Health Informatics Can Kill, http://iig.umit.at/efmi/badinformatics.htm (last visited Dec. 19, 2008).} In truth, there is no way to know how many malfunctions have actually occurred because EHR systems are not subject to a governmentally mandated adverse-event-reporting requirement, unlike FDA-regulated drugs and devices.\footnote{See 21 C.F.R. § 803 (2007) (discussing FDA adverse event reporting requirements).}

As noted earlier, the federal government has in fact begun to regulate electronic health information in the areas of privacy and security. HHS has enacted the HIPAA Privacy and Security Rules, under
which a variety of requirements have been established for the use, disclosure, and protection of health information. If the government is to protect patients’ privacy through regulation of HIT, then surely it should also safeguard patients’ health and safety by regulating the quality of EHR systems.

The federal government routinely regulates goods and services that impact public health and welfare. For example, the Department of Transportation regulates pipeline and hazardous material transport, railroads, motor carriers, cargo containers, highway traffic, and other transportation matters. The Federal Aviation Administration (“FAA”) regulates air traffic, air carriers, aircraft manufacturers, crewmembers, pilot schools, airports, and navigational facilities.

Most relevant is the FDA’s extensive regulation of drugs, devices, and biologics. The term “device” is statutorily defined in relevant part as: “an instrument, apparatus, implement, machine . . . which is . . . intended for use in the diagnosis of disease or other conditions, or in the cure, mitigation, treatment, or prevention of disease.” Given that they feature decision support, order entry, and other care delivery and management functions, one might reasonably conclude that EHR systems are as essential to patient care as many regulated devices. Furthermore, their software can be more complicated than that found in many computer-controlled medical devices that are subject to FDA jurisdiction.

Free market advocates might argue that EHR systems should remain unregulated because competitive market forces can safeguard their quality, as low-quality products will fail in the marketplace. This argument, however, is not persuasive for several reasons.

First, government regulation is necessary to prevent market failure due to lack of information available to potential consumers. The


172. See INST. OF MED., supra note 2, at 5 (noting that it is important to recognize the many uses of EHR systems, including care delivery, management, and support processes).

173. See Nayar & Miller, supra note 112, at 49 (discussing the complexity of EHR systems).

174. Cf. CHARLES P. FRIEDMAN & JEREMY C. WYATT, EVALUATION METHODS IN BIOMEDICAL INFORMATICS 357 (2d ed. 2006) (“While having been an entirely unregulated market in the past, the efficacy and safety of clinical information systems are increasingly attracting attention, creating new challenges, opportunities, and requirements for evaluation.”).
market cannot weed out low-quality products if consumers are not informed about the relative quality of the various products available. Without a governmentally mandated adverse event reporting requirement, the public may never find out which products are defective or inferior to others, and thus they will be unable to make educated purchasing decisions. Vendors have little incentive to disclose product flaws to the public voluntarily. Complaints posted on Internet sites or blogs can be unreliable or technically imprecise and, therefore, may not be a trustworthy source for consumer advocacy groups interested in developing consumer reports. Health care providers who use EHR systems may hesitate to disclose adverse events suffered by patients that are associated with EHR systems because of the HIPAA Privacy Rule\textsuperscript{175} or because of fear of lawsuits by vendors. In addition, even if users were inclined to report system defects to publicly available sources, they might still be slow to recognize emergent software problems because of their subtlety or complexity, and they may fail to understand their significance.\textsuperscript{176} Consequently, absent a carefully regulated approval process conducted by experts, many providers might purchase a new EHR system before its defects were widely known.

Second, market forces may be further thwarted by the fact that providers who have already invested in and implemented a faulty EHR system cannot readily take their business elsewhere. Once a provider has adopted an EHR system, it will be disinclined to switch to a new system, even if its current system is faulty. Such a switch could be prohibitively expensive and burdensome, as it would require transferring all existing patient records to a different product and training all staff members to adjust to the new product’s peculiarities.

Third, while the threat of litigation might normally discourage sloppy software engineering, in the realm of complex HIT, liability might be so difficult to prove that vendors will believe they bear little risk of costly judgments or even of plaintiffs initiating suit.\textsuperscript{177} Plaintiffs’ attorneys will realize that they cannot prevail without well qualified experts who invest considerable time in studying the EHR system at issue. Therefore, lawyers may refuse to represent all but the wealthiest clients who can finance the retention of such experts without

\textsuperscript{175} 45 C.F.R. §§ 160.101–164.534 (2007). Clinicians would need to make sure that whatever information they convey about incidents does not identify particular patients and cannot be traced to specific individuals. See id. §§ 164.502–514 (2007) (establishing regulations for the use and disclosure of protected health information).

\textsuperscript{176} See infra notes 194–95 and accompanying text (discussing the lengthy delays that can precede the emergence of a problem in a complex software system).

\textsuperscript{177} See supra Part II.C.4 (discussing proof and discovery problems); infra Part IV.C.3 (discussing recommendations that audit trails and capture/replay be required by regulation to facilitate detection and proof of system failures); see also infra notes 301–02 and accompanying text (suggesting that the regulatory agency make adverse event reports available to the public).
any certainty of recovering the costs through settlement or favorable judgments.

Finally, market forces alone cannot be trusted to ensure the interoperability of EHR systems, which is essential to the systems’ efficacy. Interoperability would likely be disfavored by vendors because it could reduce profits and increase costs.\footnote{178. See infra notes 332–32 and accompanying text (discussing financial incentives working against the adoption of interoperable EHR systems).} Although the earliest electronic hospital information systems emerged in the late 1960s,\footnote{179. BIOMEDICAL INFORMATICS, supra note 1, at 451.} interoperability has yet to be achieved, and no product has come close to gaining a monopoly that would eliminate the need for interoperability among competing products.\footnote{180. See infra note 185 and accompanying text (discussing the numerous EHR products certified for use by providers). In the word-processing area, Microsoft’s Word has nearly achieved such a monopoly.} Furthermore, both the practice of customizing products to accommodate providers’ preferences and the inherent complexity of representing medical information constitute potential obstacles to interoperability.\footnote{181. See infra notes 327–27 and accompanying text.} This important capacity will likely be achieved only through regulatory mandates.

3. The Current Oversight System: CCHIT

Applicants must pay CCHIT for certification, and ambulatory care products are certified for a period of two years, during which CCHIT monitors product changes and requires recertification for products that have been significantly modified. CCHIT, however, is an industry-run organization, and its certification criteria are vulnerable to criticism as being excessively favorable to vendors. There are several areas of concern. First, prior to product testing, applicants are able to access the criteria, testing scenarios, and test scripts on CCHIT’s website. Vendors, therefore, need not be prepared for unanticipated tests that might reveal flaws in the system that they did not encounter in practicing the testing scenarios. Second, all testing for clinical functionality, interoperability, and security occurs during one day. Consequently, inspectors do not observe the system operating over time and in a variety of usage environments. Third, the certification jury is composed of “three clinical experts, at least one of whom must be a practicing physician.” However, jurors cannot confer or deliberate during the demonstration or voting process, so they cannot draw each others’ attention to concerns or product shortcomings.

CCHIT’s single day of testing is particularly troubling because experience indicates that it is unlikely to detect many significant reliability and safety problems. Though there are many examples, a series of incidents involving the Therac-25 radiation therapy machine vividly illustrates this point. Between 1985 and 1987 six patients died of massive radiation overdoses caused by software defects. The machine had passed safety analysis in 1983, which did not include software testing, and it was not recalled until after the sixth incident in 1987. Likewise, flaws in EHR systems may not be initially obvious but could cause life-threatening errors after a period of time. Such errors could include deleting or incorrectly recording information about patient allergies, lists of medications already prescribed to a patient, or electronic medication orders. Patients who receive incor-
rect medications or drug dosages may well suffer serious or fatal harm.

CCHIT published final 2008 criteria for ambulatory care EHR products. These documents are substantial and cover many important areas. However, they also leave significant gaps. For example, they do not specify requirements concerning the reliability or safety of EHR systems.

CCHIT, in fact, recognizes some of its own limitations. Its Certification Handbook states:

[O]ur criteria at this point can only represent broad, basic capabilities, and . . . these may prove insufficient for some practice specialties, or may be inappropriate or excessive for others; . . . our criteria do not assess product usability, implementation service, product maintenance, technical and application support; and other facts.

Admittedly, EHR systems could be required to have almost endless capabilities. Determination of which capabilities should be required will necessitate careful deliberation and input from many interested parties, including physicians, patient representatives, public interest groups, and academic researchers.

B. Who Should Regulate?

If EHR systems are to be regulated, their regulation must be assigned to a particular agency. This Section considers several options. While the FDA might initially seem to be the appropriate regulatory agency, it is not the optimal choice, for reasons elaborated below. The Centers for Medicare & Medicaid Services (“CMS”) would be a bet-


197. The reliability of a system is the probability that it will correctly deliver services over a given interval of use. Ian Sommerville, Software Engineering 48 (8th ed. 2007).

198. A system’s safety is “a judgment of how likely it is that the system will cause damage to people or its environment.” Id.

199. This is true despite the fact that Section 5.6 of the CCHIT 2008 Certification Handbook indicates that the following is an approved description of the CCHIT certification program:

The Certification Commission for Healthcare Information Technology’s (CCHIT®) inspection process is based on real-life medical scenarios designed to test products rigorously against the clinical documentation needs of providers and the quality and safety needs of healthcare consumers and payers.

CCHIT, supra note 196.

200. CERTIFICATION HANDBOOK, supra note 184, at 40.
ter alternative, as would a newly created agency tasked with oversight of health information technology in the U.S.

1. FDA Jurisdiction

As noted above, the FDA thus far has not taken the initiative to regulate EHR systems. The FDA’s authority to regulate devices extends to computer software that is “integral to . . . or closely connected with” any apparatus that delivers patient care, such as a CAT scanner or a respirator. However, its authority to regulate EHR systems is much more dubious.

In 1989 draft guidance, the FDA declined to extend its regulatory authority to software that is “intended for use only in traditional ‘library’ functions, such as storage, retrieval, and dissemination of medical information — functions traditionally carried out through textbooks or journals.” The FDA also exempted software with “general accounting or communication” and educational functions. Of particular significance is the draft policy’s exemption of computer products, such as decision support systems, that involve “competent human intervention before any impact on human health occurs.”

EHR systems serve library, accounting, and communication functions. Furthermore, unlike pacemakers or respirators that operate independently once they are connected to the body, EHR systems have no impact without human input and intervention. Consequently, they would appear to be excluded from active FDA regulation under this policy.

In a 1996 workshop, the FDA recognized the difficulties of determining what constitutes “competent human intervention,” which in turn determines whether medical software should be regulated by the agency. With respect to decision support, “competent human intervention” requires that users have the time, motivation, and ability to reflect upon and challenge computer-generated data and recommendations, which may not be true in the midst of surgery or in the intensive care unit. In addition, medical software is often so complicated that

201. See Miller, supra note 148.
202. See Rosoff, supra note 142, at 121.
203. CTR. FOR DEVICES & RADIOLOGICAL HEALTH, FDA, FDA POLICY FOR THE REGULATION OF COMPUTER PRODUCTS 1 (proposed 1989) [hereinafter 1989 DRAFT FDA POLICY], available at http://www.fda.gov/cdrh/ode/351.pdf. The policy was never formally adopted, but the draft policy informed the FDA’s approach to stand-alone software systems throughout the 1990s. See Randolph A. Miller & Reed M. Gardner, Recommendations for Responsible Monitoring and Regulation of Clinical Software Systems, 4 J. AM. MED. INFORMATICS ASS’N 442, 445–46 (1997).
204. 1989 DRAFT FDA POLICY, supra note 203, at 1.
205. Id. at 3.
207. Id.
users cannot analyze or understand its computations and, therefore, cannot exercise competent human intervention. EHR system complexity, in fact, is likely to increase as more sophisticated functions, such as diagnostic algorithms based on machine learning, are incorporated. Doctors who rely excessively on computer-generated diagnoses and treatment recommendations may fail to perceive that the algorithms did not account for certain conditions that are pertinent to their patients. By the same token, some doctors may unreasonably mistrust EHR system decision support, choosing to follow their intuition, rather than computerized recommendations, to the detriment of their patients. Consequently, “competent human intervention” cannot protect adequately against potentially harmful software defects, since most clinicians will not be able to determine whether these sophisticated tools have formulated the correct approach in a particular instance. The 1996 workshop called for reexamination of the FDA’s criteria for regulatory exemptions relating to software, an initiative that has not been pursued to date.

One option for regulating EHR systems is to include them explicitly within the FDA’s jurisdiction. The FDA might effect such an extension of its jurisdiction by explicitly adopting an interpretive rule that reconstrues its statutory authority over devices to include EHR systems. However, the courts have resisted past efforts by the FDA to expand its authority to cover an area that it has not traditionally regulated. For example, in FDA v. Brown & Williamson Tobacco Corp., the Supreme Court concluded that the Food, Drug, and Cosmetic Act (“FDCA”) did not grant the FDA jurisdiction over tobacco products. When it comes to EHR systems, the HIT industry, like the tobacco industry, could oppose FDA regulatory authority and turn to the courts for relief. Consequently, the extension of the FDA’s authority to EHR systems may require a revision of the FDCA’s definition of “device” to make clear that EHR systems are covered. Statutory amendments, however, are often hindered by special interest lobbying and political, rather than public policy, concerns.

208. Id.

209. “Machine learning” refers to a machine’s ability to learn to perform tasks through examples or analogies to similar, previously-executed tasks and to improve performance based on past experience. Jaime G. Carbonell et al., An Overview of Machine Learning, in MACHINE LEARNING: AN ARTIFICIAL INTELLIGENCE APPROACH 4 (Ryszard S. Cichalski et al. eds., 1985); Tom M. Mitchell, MACHINE LEARNING 1 (1997).


211. 529 U.S. 120, 159–60 (2000).


213. See Antonin Scalia, A Matter of Interpretation 34–35 (1997) (discussing the role of lobbyists and arguing that, because of their involvement, legislative history is not an appropriate tool for statutory interpretation); Joseph Tussman & Jacobus tenBroek, The Equal Protection of the Laws, 37 CAL. L. REV. 341, 350 (1949) (“Everything that emerges from the legislative forum is tainted by its journey through the lobby.”).
Even if the FDA had jurisdiction over EHR systems, regulation by this agency may not be the optimal approach. The regulatory framework that the FDA is likely to apply to EHR systems would be inadequate for these patient management tools.

The FDA classifies devices into three categories based on the level of oversight deemed necessary to assure their safety and efficacy.214 “Class I devices” do not sustain, support, or protect human life or health and do not present an unreasonable risk of human illness or injury.215 These devices are subject only to the FDA’s “general controls,” such as those relating to misbranding or adulteration.216 “Class II devices” are used to support or sustain human life but do not pose the highest risk of injury. Such devices are subject to additional “special controls” at the discretion of the Secretary of HHS.217 “Class III devices” sustain, support, or protect human life or health or present an unreasonable risk of causing human illness or injury.218 Class III devices are subject to all of the above controls as well as to premarket approval (“PMA”) by the FDA.219

The FDA, however, allows manufacturers to avoid the PMA process by showing that their new device is “substantially equivalent”220 to a legally marketed predicate device.221 In order to obtain a finding of substantial equivalence, applicants can submit what is known as a “510(k) application.”222 The FDA will grant a PMA exemption if it determines that the device at issue has the same intended use as the predicate device and the same technological characteristics or that the device is demonstrably as safe and effective as an already marketed device.223 Furthermore, the HHS Secretary is statutorily required to design information requests so that they are minimally

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216. A PRACTICAL GUIDE, supra note 214, at 128.
218. Id. § 360c(a)(1)(C).
219. Id.
220. Id. § 360c(i).
burdensome to 510(k) applicants. Accordingly, the FDA requires clinical data for only a minority of 510(k) reviews.

The 510(k) process has become so popular with manufacturers who wish to avoid the more onerous and lengthy PMA procedure that over seventy-five percent of medical devices are approved through this process. The 2004 Center for Devices and Radiological Health (“CDRH”) annual report shows a consistent ten-to-one ratio of approved 510(k) applications to approved PMA applications from fiscal years 1999 through 2004. Moreover, according to one source that reviewed 510(k) applications in the early 1990s, CDRH generally rejected only two percent of the applications.

In light of this approval framework, it is unlikely that EHR systems would receive adequate scrutiny by the FDA. First, because EHR systems do not directly sustain, support, or protect human life or health, they may well be deemed Class I devices, which receive minimal oversight. Second, even if they are categorized as Class III devices, after the FDA approves the first EHR system, subsequent systems would probably be reviewed under the substantial equivalence standard rather than the more rigorous PMA standard. Two EHR systems produced by different vendors, however, are likely to have very different programming, and hence their reliability may differ dramatically. Thus, the 510(k) process is ill-suited to the approval of new EHR systems and should not be the basis of EHR system regulation.

Finally, the FDA is currently a beleaguered entity. The FDA is subject to budgetary limitations that could constrain its ability to exercise adequate oversight over complicated technological devices. The agency has also been heavily criticized for inadequacies in its approval and monitoring processes and for other shortcomings.

224. Id. § 360c(i)(1)(D) (“[T]he Secretary shall consider the least burdensome means of demonstrating substantial equivalence and request information accordingly.”).
229. See A PRACTICAL GUIDE, supra note 214, at 140–41 (comparing the 510(k) and PMA procedures).
230. Miller & Gardner, supra note 203, at 453.
231. See, e.g., Russell Korobkin, Who Should Protect the Public? The Supreme Court and Medical Device Regulation, 357 NRW ENG. J. MED. 1680, 1680 (2007) (“[T]he FDA’s post-approval monitoring system has been widely considered to be underfunded and hamstrung by the agency’s limited authority.”); Bruce M. Psaty & R. Alta Charo, FDA Responds to Institute of Medicine Drug Safety Recommendations — In Part, 297 JAMA 1917,
2. Oversight by the Center for Medicare & Medicaid Services or a Newly Created Agency

The existing agency that might be best suited to regulate EHR systems is the Center for Medicare & Medicaid Services (“CMS”). According to CMS, as of 2002, 79.3 million individuals were CMS beneficiaries through Medicare, Medicaid, and the State Children’s Health Insurance Program (“SCHIP”), and providers earned approximately thirty-three percent of their revenues from the public programs overseen by CMS. Essentially all hospitals and the overwhelming majority of physicians in the U.S. participate in Medicare, and many participate in Medicaid. Thus, they must follow CMS mandates. CMS has broad regulatory authority and has promulgated numerous federal regulations. Consequently, assigning EHR system oversight to CMS would not subject most providers to regulation by an unfamiliar agency; rather, it would add to the requirements they must already meet in order to achieve CMS compliance. Furthermore, if enforcement provisions include the threat that violators would be denied Medicare, SCHIP, or Medicaid reimbursement, compliance is likely to be high.

In order to extend CMS jurisdiction to the minority of providers that do not participate in any federal health care program, Congress would need to pass enabling legislation that would provide the agency with authority to regulate all EHR systems with respect to all patients,

1917–19 (2007) (noting that the FDA is underfunded even though the products it regulates constitute 25% of the U.S. gross domestic product, that it suffers from a lack of transparency, that the agency relies on a “postmarketing surveillance system that could hardly be weaker,” and that its post-approval enforcement mechanisms are often limited to threats of bad publicity); Sheila Weiss Smith, Sidelining Safety — The FDA’s Inadequate Response to the IOM, 357 NEW ENG. J. MED. 960, 961 (2007) (“[T]he very structure of the FDA marginalizes safety.”); Andrew Pollack, New Sense of Caution at F.D.A., N.Y. TIMES, Sept. 29, 2006, at C1 (discussing the “barrage of criticism” aimed at the FDA).


236. The HHS Secretary has authority to deny payment to skilled nursing facilities that have not met particular requirements. 42 U.S.C. § 1395i–3(h)(2)(B)(i) (2000). A similar penalty could be established for non-compliance with regulatory requirements pertaining to EHR Systems.
regardless of their Medicare, Medicaid, or SCHIP status. This approach would not be unprecedented, because CMS already enforces the HIPAA Security Rule, which governs the security of electronic health information for a broad range of providers, regardless of whether they participate in Medicare, Medicaid, or SCHIP. Furthermore, through its enforcement of the Security Rule, CMS has acquired expertise with respect to HIT. Nevertheless, assigning CMS oversight responsibilities for EHR systems would require increases in the agency’s human, financial, and other resources.

A second option, which has been suggested by HHS, is to create an entirely new regulatory agency that will be responsible for the development, implementation, and regulation of EHR systems and the NHIN. Congress has periodically created new agencies to regulate emerging areas of law. For example, Title VII of the Civil Rights Act of 1964 established the Equal Employment Opportunity Commission, which enforces federal employment discrimination laws. Under the Occupational Safety and Health Act of 1970, the Occupational Safety and Health Administration was established to promote workplace safety, and the Health Care Financing Administration, now the Centers for Medicare & Medicaid Services, was established in 1977 to administer the Medicare and Medicaid programs. Creation of a new agency may encounter resistance because it could be costly and would constitute an expansion of government. However, an adequately funded agency focused exclusively on HIT, with a concentration of technical talent and expertise, could be an effective vehicle for regulating EHR systems.

240. U.S. DEP’T OF HEALTH & HUMAN SERVS., SUMMARY OF NATIONWIDE HEALTH INFORMATION NETWORK (NHIN) REQUEST FOR INFORMATION (RFI) RESPONSES 12 (June 2005), http://www.hhs.gov/healthit/rfisummaryreport.pdf (suggesting that the federal government could create a health information agency to govern, finance, and set standards for the NHIN or could assign these tasks to an existing agency).
IV. RECOMMENDATIONS FOR A REGULATORY FRAMEWORK FOR EHR SYSTEMS

This Part develops recommendations for a regulatory framework to govern EHR systems. First, to achieve universal EHR system adoption, the government will need to provide financial support to resource-poor providers. The proposed regulations also address the design of approval and monitoring processes for EHR systems, standardization of essential system features and capabilities, and the creation of a national databank of de-identified EHRs. These recommendations aim to serve as a model that will initiate a discussion about the need for and potential contours of a regulatory scheme for HIT. They do not seek to perfect all of the details of future regulatory provisions.

A. Addressing the Cost of EHR System Adoption

1. Financial Support

As several legislators and administrative agencies have already recognized, it is unreasonable to expect widespread adoption of EHR systems without financial support. The transition from paper files to EHR systems can be expensive, complicated, and burdensome, especially for smaller medical practices. Given a regulatory requirement that all providers adopt EHR systems, the government should offer financial support in the form of tax credits, incentive payments, or grants to facilitate compliance. As noted above, such inducements have already been suggested in several Congressional bills.

According to many experts, governmental investments in HIT will be well worth their cost. While the expenses of purchasing and implementing EHR systems will likely reduce net savings initially, savings are predicted to rise sharply once the systems have been fully implemented. Assuming a base year of 2004, one study anticipated

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244. See supra notes 156–59 and accompanying text (discussing incentives for EHR system adoption).
245. See supra notes 131–38 and accompanying text (discussing the costs and burdens of EHR system implementation).
246. See CONG. BUDGET OFFICE, supra note 80, at 27 (discussing the funding activities of the federal government and options for further promotion of HIT).
247. See supra notes 160–62 and accompanying text (discussing relevant legislative proposals).
248. See, e.g., Hillestad et al., supra note 61, at 1115 (2005) (“[T]here is substantial rationale for government policy to facilitate widespread diffusion of interoperable HIT.”).
249. See id. at 1114–15; Walker et al., supra note 80, at W5-16.
A program of incentive payments or grants could be administered by the Agency for Healthcare Research and Quality (“AHRQ”), which is HHS’s health research services arm. One of the agency’s functions is to serve as “a major source of funding and technical assistance for health services research and research training at leading U.S. universities and other institutions.” AHRQ, therefore, has considerable experience in administering grant programs and has already provided funding for numerous HIT-related projects.

2. WorldVistA

One approach that could alleviate funding pressures and facilitate development of an NHIN is widespread adoption of the VA’s VistA system. VistA is an open source product. However, it is written in a programming language, MUMPS, that is currently unfamiliar to most programmers, and it is not interoperable with other systems. Furthermore, the VA does not offer assistance with installation and maintenance to those who adopt VistA, and therefore users must hire vendors for these purposes.

252. Id.
255. See Goetz, supra note 131.
258. Kupersmith et al., supra note 40, at w157–58 (describing the VA’s EHR system); The Last Frontier: Bringing the IT Revolution in Healthcare: Hearing Before the H. Comm. on Government Reform, 109th Cong. (2005), (statement of Robert M. Kolodner, M.D., Chief Health Informatics Officer Veterans Health Administration Department of Veterans Affairs), available at http://www.va.gov/OCA/testimony/hgrc/050929RK.asp (stating that “[w]ithout data standards, we might be able to exchange health information, as we do now when we copy and send paper records, but we won’t be able to use it as effectively to deliver safer, higher-quality care” and that “[t]rue interoperability between providers simply cannot be achieved without data standardization”).
259. See VistA Software Alliance, Vendors & Resources, supra note 256 (listing VistA service providers); see also Goetz, supra note 131 (stating that the VA is prohibited by law from straying from its mission to serve veterans and, consequently, it will not assist entities in installing or maintaining the system).
In 2002, a group of VA programmers formed WorldVistA, which aims to extend and modify VistA for use outside the VA system and to assist users in mastering, installing, and maintaining the software.260 The group received a grant from CMS to support its work.261 In May 2007, a WorldVistA product for ambulatory care settings, WorldVistA EHR VOE/ 1.0, attained certification from CCHIT262 and thus could be broadly adopted by physicians.263

Critics note that WorldVistA’s staffing and billing functions are weak.264 In addition, WorldVistA cannot be customized as easily as some other commercially available systems, and some feel its graphical interface is not particularly user-friendly or appealing.265 While these shortcomings are significant, the cost of obtaining a license and support contract for WorldVistA is about ten percent of the cost of obtaining these items for other systems, according to one source.266 However, the costs of installation, training, maintenance, and related activities may not be significantly lower.

The jury is still out as to whether the WorldVistA system can be sufficiently improved to become a broadly adopted, effective, and low cost alternative for health care providers. This option, however, is certainly worth exploring.

B. Regulating Approval and Oversight of EHR Systems

CCHIT has promoted EHR system quality by developing certification criteria and certifying ambulatory care and hospital EHR products through its testing program.267 Without CCHIT, EHR systems would not be subject to oversight of any kind.268 However, assigning certification of EHR systems exclusively to CCHIT, an industry-based association, is inadequate. Instead, we recommend that federal regulations establish a multi-step process that will involve scrutiny by a variety of parties. Regulatory requirements should apply to all parties who develop or modify EHR system software, install it, or integrate it with existing systems. Health care providers who perform these func-
tions themselves should be deemed vendors for legal purposes relating to EHR system activities ordinarily performed by vendors.

The essential components of our recommendations are the following: (1) field testing of all new products for a significant period of time; (2) use of local EHR System Oversight Committees that will in some ways resemble Institutional Review Boards (“IRBs”);269 (3) pre-marketing product approval by the regulatory agency; and (4) ongoing, post-marketing monitoring by the Committees and the regulating agency to ensure that adverse event data is collected, that vendors respond to users’ requests for assistance, and that system failures are promptly investigated and addressed so that adverse health outcomes are avoided or minimized. These elements are developed below.

1. Initial Approval of New Products

New EHR systems should not be available for use without approval by the regulatory agency. To begin the approval process, applicants seeking EHR system approval would submit to the regulating agency270 the following items: project plans; software requirements and specifications; software designs; test plans; test reports; documentation for users and system administrators; and related documents. The material should include guidelines concerning how and to what extent health care providers can safely customize the product, together with a technical justification for why the permissible customizations are considered safe.

Actual testing of the system would commence with “in house” testing by the system developer. In addition, developers may choose to retain CCHIT to conduct the one-day testing program that it currently offers,271 though they would not be required to do so. CCHIT review might be useful because it could alert developers to problems that they had not detected through internal testing prior to launching their products for pilot testing in the field.

Prior to approval, EHR systems would be field tested for a period of at least six months under varied and representative usage conditions.272 Such testing is needed because the occurrence of software failures may be highly dependent on the local operating environment and patterns of usage.273 The FDA recognizes the need to test soft-

270. See supra Part III.B for discussion of which agency should have regulatory authority.
271. See supra notes 190–95 and accompanying text (discussing the CCHIT testing program).
272. See Richards, supra note 20, at 27 (discussing the importance of creating “a real-world test environment”).
273. John Musa et al., The Operational Profile, in HANDBOOK OF SOFTWARE RELIABILITY AND SYSTEM RELIABILITY 167, 167 (Michael R. Lyu ed., 1996) (“A software-based product’s reliability depends on just how a customer will use it.”).
ware in medical devices at the user site.\textsuperscript{274} CCHIT has also recognized the need for systems to be observed in the field. It requires that they be in operation at one or more locations for forty-five days prior to testing.\textsuperscript{275} This requirement, however, is not sufficiently rigorous, because such a limited evaluation does not account for variations in function usage across sites or over time. Indeed, within the first forty-five days, users may not even become thoroughly familiar with a system or use all of its functions.\textsuperscript{276} We recommend that systems designed for hospitals be tested at a small number of medium to large hospitals and that systems designed for ambulatory care settings be tested in a larger number of provider offices.

The regulating agency should publish site-selection and testing-period guidelines and evaluation metrics for different types of EHR systems. The guidelines should be based upon sound survey methodology\textsuperscript{277} so as to ensure that meaningful statistical estimates of adverse incident frequency, software reliability,\textsuperscript{278} and other relevant measures are obtained.

2. The Role of Local System Oversight Committees

Effective approval and monitoring of all EHR systems in the U.S. could not be accomplished solely by the regulatory agency. Rather, it will have to be led by local entities that are sufficiently resourced to achieve thorough and constant oversight. We will call these entities EHR System Oversight Committees ("SOCs"), and we contemplate that they will be similar in some ways to IRBs.\textsuperscript{279} The use of SOCs for oversight of clinical software systems of various kinds was proposed a decade ago in an article written by two medical informatics experts,

\begin{footnotesize}
\begin{enumerate}
\item \textit{Certification Handbook}, supra note 184, at 45 (requiring that products be in production use for forty-five calendar days in at least one location).
\item See Linda M. Culp et al., \textit{Phased Implementation, in Implementing an EHR System}, supra note 20, at 111, 111 (discussing the importance of spreading "the users' learning over time" and "producing several manageable peaks in cognitive load").
\item See \textit{generally Risto Lehtonen & Erikk Parkinen, Practical Methods for Design and Analysis of Complex Surveys} (2004).
\item See Sugoville, supra note 197, at 208–09, 801 (explaining that reliability metrics are used to specify software reliability, that is, the system’s ability to “deliver services as specified”).
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Randolph Miller and Reed Gardner, and several of our recommendations overlap with theirs.

Hospitals and physician networks with sufficient IT resources would have their own SOCs. Local SOCs would also be created to serve resource-poor hospitals or individual providers' offices that wish to join together for SOC purposes. Just as federal regulations govern the composition of IRBs, regulations would specify guidelines for the number, expertise, and diversity of SOC members.

Vendors would need to convince provider facilities to agree to field test new EHR systems. Participating providers would have to enter existing patient records into the EHR system that is to be tested, which can be an onerous task; therefore, vendors would likely find it necessary to offer significant incentives. Providers might be willing to serve as field testers only if they are convinced that the product is superior to others that have already been approved or is equivalent to others but is less expensive. To this end, a positive evaluation from CCHIT based on its one-day testing process might be influential. Furthermore, vendors could offer field testers product discounts, free support services, and other payments or benefits, and they could promise that, in the event their product is not ultimately approved by the regulating agency, they will provide reimbursement for expenses incurred in testing the system.

SOCs would charge vendors a review fee, but this would not constitute a novel or unacceptable requirement. CCHIT charges a fee, as do IRBs that operate for profit and bill for protocol reviews. Drug and device manufacturers seeking FDA approval have also become accustomed to paying the FDA user fees pursuant to the Pre-

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280. See Miller & Gardner, supra note 203, at 450 (recommending review of clinical software systems by Software Oversight Committees, composed of individuals with expertise in “health care informatics, clinical practice, data quality, biomedical ethics, patients' perspectives, and quality improvement”).

281. See the footnotes in this Part for references to relevant proposals in the Miller & Gardner article.

282. See Miller & Gardner, supra note 203, at 450 (suggesting that small practitioners' offices and hospitals could “participate in regional SOCs, or possibly request consultations from local SOCs at larger institutions”).


284. In some cases, facilities may be allowed to test EHR systems using a subset of their patient records rather than all of them. The regulatory agency will need to develop guidelines as to how many records must be included in order to obtain statistically significant field testing results.

285. See supra notes 190–93 and accompanying text (discussing the CCHIT testing program).

286. See CERTIFICATION HANDBOOK, supra note 184, at 66 (detailing fees for CCHIT testing).

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scription Drug User Fee Act\textsuperscript{288} and the Medical Device User Fee and Modernization Act of 2002.\textsuperscript{289} Furthermore, the FDA at times relies on paid third party reviewers during the device approval process. In some circumstances, device manufacturers may request that their facility inspection be conducted by an “accredited person” rather than by an FDA official.\textsuperscript{290}

Despite being paid a fee by vendors, SOCs are more likely to be neutral than CCHIT, because most of their members would not be HIT industry personnel. Rather, their membership would include hospital HIT staff, physicians and other health care workers, community members representing patients, academics, and others. These individuals are likely to prioritize the best interests of practitioners and patients over the interests of industry and thus to subject EHR systems to rigorous evaluation.

The SOCs would oversee testing, review field testing results, and produce a report evaluating the EHR system upon completion of testing. The EHR system vendor would then submit required documentation, including the SOC’s report, to the regulatory agency, which would have ultimate approval authority.\textsuperscript{291}

While this multi-step process may seem onerous, it is no more burdensome than the traditional FDA approval process for new drugs. The FDA approval process entails animal testing, human testing in three separate phases of clinical trials, review of safety and efficacy research by an FDA review team, FDA review of labeling information, and an FDA facility inspection.\textsuperscript{292} EHR systems, which are vital to patient health and welfare, must similarly be subjected to rigorous review.\textsuperscript{293}

EHR systems that are already CCHIT-certified\textsuperscript{294} and are in use at the time the regulations go into effect would not need to be approved

\begin{itemize}
\item \textsuperscript{289} Id. § 379j(a) (detailing fees that those submitting PMAs must pay).
\item \textsuperscript{290} See id. § 360m (authorizing review by accredited persons); see also Accredited Persons Inspection Program, http://www.fda.gov/cdrh/ap-inspection/ap-inspection.html (last visited Dec. 19, 2008) (describing the program and its operation). An “accredited person” is one who is certified through an accreditation program to conduct certain review functions. The qualifications for accredited persons are listed in 21 U.S.C.A. § 360m(b)(3).
\item \textsuperscript{291} See 21 C.F.R. §§ 814.20, 814.40 (2007) (discussing items that must be included in submissions for pre-market approval and the FDA’s authority to approve and disapprove these submissions).
\item \textsuperscript{293} As technology develops, some safety-critical components of EHR system decision support, such as diagnostic algorithms designed to detect various cancers, may need to be separately evaluated. In such cases, traditional clinical trials may be appropriate, and these could be referred to the FDA or overseen by the agency that regulates EHR systems.
\item \textsuperscript{294} See CERTIFICATION HANDBOOK, supra note 184, at 8 (noting that over 100 products have been certified by CCHIT).
\end{itemize}
by the regulating agency. It would be unrealistic and excessively disruptive to require providers to suspend use of EHR systems upon which they already depend in order to subject them to lengthy approval processes. If such demands were made, physicians would have to return temporarily to using paper records and might lose access to critical medical history and other information about their patients. Systems that are already in use would be subjected to the reporting and monitoring requirements outlined below, which should be sufficient to detect any product flaws that require corrective intervention.

3. The Need for Continued Monitoring

The operating conditions that an EHR system encounters when it is broadly deployed may differ from those it encountered during field testing. Furthermore, the system itself may be changed by the vendor or by users, for example, to fix defects, add new features, or accommodate local preferences. Therefore, system monitoring should continue for the operational lifetime of the product.

To facilitate timely recognition of and response to emerging problems, EHR system vendors would be required to provide several mechanisms by which users can report difficulties. These would include a feature that is incorporated into the EHR system itself, such as a button labeled “Report System Problem,” a vendor website through which problem reports can be submitted, and a dedicated e-mail address and phone number for reporting problems.

EHR vendors would notify the SOCs overseeing affected facilities of all problems and categorize problems in terms of severity and potential impact on patients and providers. Early in the process of EHR system implementation, it is likely that a large percentage of problems will be minor ones, resulting from users’ lack of familiarity with the system. Once problems are resolved, vendors would notify SOCs and explain the resolutions. As a safeguard against vendors concealing problems, users could also be encouraged to report significant problems directly to their SOCs through SOC websites or e-mail.

All SOCs, in turn, would provide the regulatory agency with semi-annual reports of significant EHR system problems, their resolu-

295. See infra Part IV.B.3 and accompanying text (discussing continued monitoring of EHR systems).
296. Cf. Elizabeth A. Boyer & Michael W. Soback, Production Support, in IMPLEMENTING AN EHR SYSTEM, supra note 20, at 95, 95 (discussing how an EHR help desk should operate).
297. See id. at 96 (describing a methodology for classifying and tracking problems).
298. See Miller & Gardner, supra note 203, at 450–51 (stating that SOCs should monitor user complaints and ensure that vendors provide users with a help desk and correct software problems); see also CERTIFICATION HANDBOOK, supra note 184, at 43 (discussing CCHIT’s “Purchaser Complaint Process”).
tions, and accounts of vendors’ failures to address serious prob-
lems.299 However, SOCs and vendors would immediately report to the
regulating agency any serious problems that might endanger the
health of patients so that the agency can oversee the remediation proc-
ess and, if necessary, investigate and impose appropriate penalties.
The FDA has established similar adverse event reporting require-
ments for user facilities, importers, and manufacturers of devices.300

The regulatory agency should post confirmed problem reports on
its website so that consumers who are considering purchasing new
EHR systems can evaluate them in light of all available informa-
tion.301 The reports should, however, delete trade secret information,
confidential commercial and financial information, patient informa-
tion, and information about the identities of the users who reported the
adverse events.302 This practice would follow the precedent estab-
lished by the FDA, which has the authority to disclose redacted ad-
verse event reports for medical devices.303

Software vendors routinely modify their systems to repair defects
and add new features.304 Any change to existing software, including
EHR system software, creates the possibility of operational failures
due to newly introduced defects.305 The FDA has indicated that 7.7%
of medical device recalls between 1992 and 1998 were attributable to
software failures, and among these, 79% of recalls were due to defects
introduced by changes made after the software was initially produced
and distributed.306

Vendors would report proposed system modifications to the
SOCs that field tested their products with a good faith assessment of
their potential impact on providers and patients.307 SOCs would have

299. See Miller & Gardner, supra note 203, at 451 (suggesting that SOCs should report
product problems to the FDA).
301. See Miller & Gardner, supra note 203, at 451 (recommending that the FDA “collect
and distribute aggregated, standardized reports of system-specific and global problems”).
302. Cf. 21 C.F.R. § 803.9 (2007) (discussing public disclosure of medical device re-
ports).
303. 21 C.F.R. §§ 803.9, 814.44(d) (2007); see Aaron Kesselheim & Michelle Mello,
Confidentiality Laws and Secrecy in Medical Research: Improving Public Access to Data
on Drug Safety, 26 HEALTH AFF. 483, 489–90 (2007) (calling for regulatory and legislative
changes that would require the FDA to expand its disclosure of safety data so that research-
can independently assess drug safety and efficacy).
304. See SOMMERVILLE, supra note 197, at 488–511 (discussing software evolution).
305. See Elizabeth Boyer et al., System Integration, in IMPLEMENTING AN EHR SYSTEM,
supra note 20, at 89, 94 (“[M]ajor upgrades can create enough data integrity and usability
problems to pose a serious threat to patient safety and workflow efficiency.”); Nayar &
Miller, supra note 112, at 48 (discussing various changes that can threaten the integrity of
EHRs).
306. FDA, supra note 274, at 3.
307. See CERTIFICATION HANDBOOK, supra note 184, at 47–49 (discussing how CCHIT
addresses minor and significant product changes). EHR systems should be designed so that
changes to the system configuration can be made only by authorized system administrators
and not by ordinary users. This constraint should apply even to seemingly minor user-
authority to approve minor changes but would report major changes to the regulatory agency, which in turn could require a new approval process, including field testing.\textsuperscript{308}

Vendors are not the only parties that might alter EHR systems. Health care providers themselves often customize the systems they use, for example, to accommodate their preferred workflows.\textsuperscript{309} While many customizations entail little risk, others, such as customizing decision support rules, can impact patient welfare.\textsuperscript{310} Health care providers who wish to make configuration changes or customizations to EHR systems that do not conform to approved customization guidelines\textsuperscript{311} or that directly impact patient safety would report their proposed alterations to their SOCs. The SOCs would scrutinize the proposals to determine their potential impact on patient care and approve or disapprove them. While both SOCs and the regulatory agency would oversee significant system changes made by vendors,\textsuperscript{312} the SOCs alone can oversee configuration changes and customizations made by health care providers.

The need to monitor technologically sophisticated devices has been acknowledged by industry and government. CCHIT has recognized the need for periodic recertification of products.\textsuperscript{313} Likewise, Congress has authorized the Secretary of HHS to order post-marketing studies of devices whose malfunctions could lead to “serious adverse health consequences.”\textsuperscript{314} EHR systems are life-critical devices that demand similar attention.

Finally, the regulatory agency could maintain a feature on its website by which users can post comments concerning EHR systems that regulators will consider for purposes of future policy setting.

interface changes, such as moving windows, because such changes could obscure clinically relevant information.

308. See \textit{id}. Changes designed to fix system bugs, however, should be deployed before they are approved by an SOC or the regulatory agency.

309. See Jean A. Adams et al., \textit{Workflow Assessment and Redesign, in IMPLEMENTING AN EHR SYSTEM, supra} note 20, at 36, 36–39 (discussing tailoring workflows for particular organizations).

310. For example, alerts and reminders that appear at the wrong time during the treatment encounter might fail to influence care decisions and improve health outcomes. See James M. Walker & Stephen T. Tingley, \textit{Clinical Decision Support, in IMPLEMENTING AN EHR SYSTEM, supra} note 20, at 67, 70 (“If the reminder can only be presented after the physician has decided on a course of action and recommended it to the patient, it is likely to be ignored.”).

311. See \textit{supra} note 270 and accompanying text (discussing customization features and their approval).

312. See Boyer et al., \textit{supra} note 305, at 93–94 (advocating a “structured approach” to large system upgrades).

313. \textit{CERTIFICATION HANDBOOK, supra} note 184, at 3.

HHS and CMS already maintain interactive sites that allow the public to submit questions and feedback.\textsuperscript{315} While the proposed regulatory scheme may appear to entail the creation of a large and costly government bureaucracy, this need not be the case. CCHIT certified fewer than sixty-five products under its 2007 criteria.\textsuperscript{316} Thus, the number of EHR systems for which approval is sought at any given time is likely to be limited. In addition, if more stringent approval and monitoring requirements are implemented, vendors may be even more cautious and selective in attempting to introduce new products to the market.

\section*{C. EHR System Standards and Criteria}

Regulators with specialized expertise will need to formulate the regulations carefully, in light of input received from various stakeholders through the statutorily mandated notice and comment period.\textsuperscript{317} The agency will also likely find it necessary to periodically augment and revise the regulations and issue interpretive guidance to respond to the rapid pace of technological change. In this Section, we highlight only a few standards and requirements that deserve special emphasis and explanation.

\subsection*{1. Best Practices Standard}

The task of crafting clear guidance concerning health information technology, software engineering methodology, and computer security practices is particularly challenging. These domains are continually changing, and thus it is very difficult to create static rules to govern them.\textsuperscript{318} Consequently, we recommend the adoption of a “best practices” standard. Specifically, the regulations should require EHR system vendors and health care providers to make reasonable efforts to identify and employ best practices relating to all of the following: hazard and risk analysis and mitigation; software development, validation,
and maintenance; security measures; and system integration and operation. The practices identified should be either commonly used by organizations doing similar work or clearly superior to best common practices. The best practices standard is intended to motivate EHR system vendors to continually maximize the dependability of their products.

Vendors and health care providers could refer to consensus guidelines formulated by well respected professional organizations, such as the International Organization for Standardization (“ISO”), or they could refer to HIT and software engineering publications. Regulators may choose to incorporate certain consensus guidelines by explicit reference in the regulations. In addition, on its website, the regulating agency could maintain a list of resources from which vendors and health care providers could draw guidance concerning best practices.

2. Interoperability

The federal regulations must address interoperability because it is essential to fully realizing the potential benefits of EHR systems for both clinical operations and medical research.

Efforts to achieve HIT interoperability have been underway for many years. For example, in 1987, an ad hoc standards group called Health Level 7 (“HL7”) was established to provide a standard for the exchange of information among hospital computer systems. Now HL7 has in excess of 500 organizational members and 2200 individual members, and its data messaging standard is in use at over 1500 medical facilities. Yet, despite HL7 and a number of other long-term efforts to achieve full interoperability of health information systems, progress has been slow.
The most relevant form of interoperability for our purposes is semantic interoperability, by which we mean “the ability of information systems to exchange information on the basis of shared, pre-established and negotiated meanings of terms and expressions.” In the context of EHR systems, this definition implies that all or part of an EHR created or updated on one system can be transmitted to other vendors’ systems in a way that permits the receiving systems to interpret and utilize the transmitted data as efficiently and effectively as they use their own internally created EHRs.

One obstacle to achieving semantic interoperability between EHR systems is the fact that medical terminology is complex, variable, and evolving. Terminology varies between medical specialties, locales, and health care facilities, and it also varies with clinical context. For example, the abbreviation “MS” stands for “mitral stenosis” in cardiology, “multiple sclerosis” in neurology, “morphine sulfate” in anesthesia, and “magnesium sulfate” in obstetrics. EHR systems that use different medical terminologies cannot communicate effectively with each other without an accurate translation between their terminologies.

Another barrier to achieving semantic interoperability is the fact that existing EHR systems produced by different vendors employ proprietary internal representations of medical information that are generally incompatible with one another. To address this problem, it is necessary for all vendors to support what we will call a “common exchange representation” (“CER”) for EHRs. A CER is an artificial language for representing the information in EHRs, which has well defined syntax and semantics and is capable of unambiguously repre
senting the information in any EHR from a typical EHR system. EHRs using the CER should be readily transmittable between EHR systems of different vendors. The CER should make it easy for vendors of EHR systems to implement a mechanism for translating accurately and efficiently between the CER and the system’s internal EHR format.330 A CER should be based on a standardized clinical terminology such as SNOMED-CT.331

Financial disincentives constitute a further impediment to interoperability. Interoperability may be disfavored by providers because it makes it easier for patients to change doctors by allowing complete patient files to be shared or transferred electronically to other facilities.332 Additionally, clinicians may be resistant to facilitating the sharing of patient data because they are sensitive to confidentiality issues and will worry that electronically transmitted EHRs will be accessed by unauthorized personnel or inadvertently distributed to persons with whom they should not be shared.333 At the same time, some providers may be concerned that other clinicians who scrutinize their EHRs may accuse them of malpractice.

EHR system vendors may also find interoperability unappealing because it makes it easier for providers who have one EHR system to switch to another by enabling patient EHRs to be easily transferred between systems. Without interoperability, the difficulty of transferring hundreds or thousand of EHRs between different systems may deter providers from changing their EHR vendors.

Although HIT has been developing over several decades, interoperability is an elusive goal, and the industry has seen a proliferation of non-interoperable products.334 Today, we are far from achieving a

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332. David J. Brauner, Interoperability: The Key to the Future Health Care System, 25 HEALTH AFF. W5-19, W5-20 (2005), (noting that without interoperability a health care enterprise “hopes to gain comparative advantage by imposing high costs on consumer switchover and by exercising market leverage over small-niche players such as solo physicians and community hospitals”).


334. See supra text accompanying notes 178–81 (discussing obstacles to interoperability).
fully interoperable NHIN. According to some commentators, “the strategy of building the network from the bottom up by establishing many RHIOs throughout the country is not working.” Because of funding shortages, only a handful of RHIOs are fully operational and self-sustaining. The only mechanism that is likely to achieve true nationwide interoperability, other than a monopoly of the EHR market, is a federal mandate that any EHR system that is approved for clinical use must support a specified CER.

3. Audit Trails and Capture/Replay

Because EHR systems are extremely complex, regulators and litigants might find it impossible to discern certain system malfunctions without audit trails or capture/replay, even if they employ knowledgeable experts. A computer system audit trail is a “generalized recording of ‘who did what to whom, when, and in what sequence.’” It is also possible to design software to capture its interaction with users or with another system in such a way that the interaction can be replayed exactly as it happened, including graphical, as opposed to only textual, output. Requiring either mechanism for EHR systems would be analogous to the HIPAA Security Rule’s requirement of audit controls for systems that process electronic health information and to the Federal Aviation Administration’s mandate that certain airplanes be equipped with flight data recorders.

Audit trails and capture/replay would enable experts to determine whether and why EHR system malfunctions occurred and to implement appropriate interventions. Such mechanisms could also assist both defendants and plaintiffs in litigation by facilitating the reconstruction of facts. Furthermore, they could ease the burdens of discovery by allowing for electronic rather than manual searches of records.

335. See Day, supra note 35, at 1011 (explaining that “very few systems today are interoperable” and that EHR exchanges will be limited to local and regional RHIOs rather than to an NHIN for “some time to come”).

336. CASTRO, supra note 57, at 10.

337. See id.; Julia Adler-Millstein et al., The State of Regional Health Information Organizations: Current Activities and Financing, 27 HEALTH AFF. w60, w63, w65–w66 (reporting on a survey of 138 RHIOs that found that 26% were defunct, “only twenty were functioning at even a modest scale, and only fifteen were doing so for a broad set of patients”).

338. See PRESIDENT’S INFO. TECH. ADVISORY COMM., supra note 331, at 24–25 (discussing the importance of developing “a single set of data standards for the most common forms of clinical information”).


341. 45 C.F.R. § 164.312(b) (2007).

Because of the safety-critical nature of EHR systems, there should be a regulatory requirement specifying that the systems include an audit-trail function that details all interactions between systems and their users and all interactions among systems. In order to permit effective system validation and problem diagnosis and resolution, such audit trails ought to include all system input and output that could affect clinical actions or that could reflect the reliability, safety, usability, and security of the system. It must be noted that the accuracy of audit logs may be partially compromised by errors in user input, such as inaccurate recording of body temperature or failure to include physicians’ observations concerning patient symptoms. However, in the future, many clinical measurements such as temperature and blood pressure readings could be transmitted directly from instruments to EHRs.

We further recommend that all EHR system vendors be required to support capture/replay capability within a reasonable time after the enactment of the regulations, unless vendors provide compelling technical evidence that doing so would harm the utility or safety of their systems. A reasonable implementation period might be five years, which would give vendors ample time to retrofit capture/replay capability to existing systems, a task that is likely to be more difficult than incorporating this capability into a new design.343 Vendors, however, should be required to support at least textual audit trails within a much shorter period of time, perhaps one year.

4. Addressing Privacy and Security Concerns

The extraordinarily sensitive nature of personal health information makes it essential for EHR systems to be designed and operated in a way that protects the privacy of patients. In previous work, we have critiqued the HIPAA Security Rule, which governs the security of electronic health information, and have made detailed recommendations for enhancing and clarifying its requirements.344 However, even if these recommendations were adopted in EHR regulations, additional steps would be necessary to address fully the special privacy and security issues raised by interoperability. Interoperability between EHR systems requires a CER.345 It also requires a common, standard-

343. Retrofitting capture/replay capability into an existing system may be difficult for a vendor if the system’s external interfaces are excessively complex, if they are no longer well understood due to turnover among the vendor’s programming staff, or if the changes negatively affect the efficiency of the system. Also, there is a risk that new defects could be inadvertently introduced into the system, so substantial additional testing is necessary.

344. Hoffman & Podgurski, supra note 121, at 359–84 (offering a variety of recommendations for revision of the HIPAA Security Rule to achieve greater data security); Hoffman & Podgurski, supra note 115, at 11–14 (developing recommendations and illustrating how they could be implemented); see also supra notes 114–28 and accompanying text.

345. See supra notes 329–30 and accompanying text (discussing the CER).
ized mechanism by which a provider with a particular EHR system can expeditiously request and receive patient information that is stored on a remote EHR system, even if the two systems were developed by different vendors. This capability in turn requires standardized policies and mechanisms for each of the following: identifying patients and providers; obtaining patients’ consent for EHR access; granting appropriate access authorization and privileges to providers; authenticating access requests; and employing cryptographic techniques in order to protect the confidentiality and integrity of EHRs during transmission.346

As is true for a common exchange format, standardized security policies and mechanisms are unlikely to be adopted by vendors and providers without a regulatory mandate. In order to facilitate compliance and provide vendors with clear guidance, the regulatory mandate might incorporate, by explicit reference, some established and emerging security standards, such as the Internet Engineering Task Force’s Transport Layer Security (“TLS”) standard347 or its Public-Key Infrastructure (X.509) standard.348

The prospect of an NHIN has sounded alarms among privacy advocates. Some have suggested that individuals should have the choice of opting out of the NHIN system entirely or of controlling access to their records. For example, the regulations could require that patients give specific consent to disclosure of certain types of data, such as mental health histories.349

In principle, we oppose this approach. A comprehensive NHIN and full computerization of all health records could not be achieved if individuals were able to opt out fully or partially. A system that included such a choice could be chaotic, in that records would be divided among paper and electronic files and physicians would be unable to access needed information quickly. Moreover, the option


349. Terry & Francis, supra note 11, at 725–30 (proposing various approaches to incorporating patient choice into EHR systems, including data carve-outs and secure envelopes); see also NCVHS, supra note 114, at 7 (discussing “[m]ethods of individual control”).
could degrade medical care, because physicians, not realizing that patients have carved out certain information, might rely on incomplete medical files. The opt-out alternative could also hinder the transfer of medical data to additional providers when their expertise is needed on an emergency basis, and it could prevent hospital emergency rooms from obtaining information that could save patients’ lives. However, we leave open the possibility of allowing patients to sequester sensitive information so long as adequate safeguards are implemented. Such safeguards might include notations in EHRs that information is missing, emergency access to information if patients are unable to provide consent, and the availability of complete medication lists for purposes of ascertaining drug interactions.350

Government mandates concerning patient records that limit patient choice are not unprecedented. In Whalen v. Roe,351 the Supreme Court evaluated a constitutional challenge to a New York statute that required that the state be provided with copies of all prescriptions for certain drugs and that specified detailed security measures for the storage of that information. The Court upheld the constitutionality of the statute, finding that it called for a legitimate exercise of the state’s police power and that its mandates would not constitute an impermissible invasion of privacy or violation of any Fourteenth Amendment right.352 Following this precedent, one might reason that government regulations requiring the computerization of all patient records and their inclusion in an NHIN would also be deemed a lawful and constitutional exercise of federal executive power under the Fifth Amendment.353

5. Decision Support

Federal regulations should require EHR systems to feature state of the art decision support capabilities.354 These would include prompts, alerts, treatment suggestions, links to medical literature, and, as technology develops, increasingly sophisticated diagnostic and analytical tools.

To the extent possible, decision support would be based on widely accepted clinical practice guidelines (“CPGs”), which are “[s]ystematically developed statements to assist practitioner and pa-

352. Id. at 602, 606.
353. U.S. CONST. amend. V.
354. See supra Part II.B.2 (discussing decision support).
355. See CPRS USER GUIDE, supra note 39 (detailing features available on the VA’s CPRS system).
tient decisions about appropriate health care for specific clinical circumstances." For example, a CPG for the treatment of asthma could be incorporated into an EHR system as a checklist that appears when a physician enters information indicating that a particular patient has symptoms consistent with asthma. The feature would alert physicians as to tests that they should conduct, and it would supply treatment suggestions. CPGs have been developed by various organizations, including: professional societies, such as the American Medical Association and other physician specialty boards; governmental entities, such as the AHRQ and various state programs; and health care payers, including health maintenance organizations and health insurers. 

At this time, over 2000 CPGs have been published. The CPGs vary in quality, and some may be designed to suit a specific agenda, such as cost-cutting. EHR system vendors cannot be expected to incorporate large numbers of competing and possibly irreconcilable CPGs into their systems, and there is no significant consensus as to which CPGs are the most useful or reliable. Consequently, we recommend that the AHRQ adopt a certification program for CPGs such as the process proposed by Professor Arnold Rosoff. AHRQ would not be the first to endorse guidelines. The FDA recognizes a large number of device-specific consensus standards. It allows applicants seeking device approval to submit abbreviated 510(k) applications when the “FDA has recognized a relevant consensus standard.” Furthermore, the FDA will approve devices partly based on conformity to recognized standards. AHRQ could maintain a website list-

356. BIOMEDICAL INFORMATICS, supra note 1, at 924.
361. Mello, supra note 358, at 651.
364. See supra notes 220–24 and accompanying text (discussing 510(k) applications).
366. Id.
ing certified CPGs, much as the FDA maintains a website listing its recognized consensus standards.\(^\text{367}\)

EHR system vendors would be expected to incorporate appropriate certified CPGs into their systems, and these could be automatically updated as CPGs change, much as other software updates are automatically downloaded. For example, an EHR system tailored for use in an endocrinologist’s office would base decision support on the most up-to-date CPGs for endocrinology, while systems designed for internists or emergency rooms would need to incorporate a broad range of CPGs.

The regulations should require EHR system vendors to use available technology to maximize the efficacy and safety of decision support features. Some researchers have found that decision support does not always change provider behavior.\(^\text{368}\) Some physicians may distrust computerized suggestions, may not appreciate a computer telling them how to practice medicine, or may be too busy to consider computerized recommendations carefully,\(^\text{369}\) and they may too easily erase prompts by hitting the escape key.\(^\text{370}\) The efficacy of decision support can be enhanced through mechanisms such as automatic prompts that do not need to be deliberately initiated, highlighting, periodic reminders, and carefully selected default settings.\(^\text{371}\) As a resource for vendors, the regulating agency could include on its website links to literature providing suggestions for maximizing the benefit of decision support mechanisms.

6. Enforcement

The regulations would need to include enforcement provisions in order to ensure compliance. Both EHR system vendors and health

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\(^{367}\) See Recognized Consensus Standards, supra note 363.

\(^{368}\) Amit X. Garg et al., Effects of Computerized Clinical Decision Support Systems on Practitioner Performance and Patient Outcomes, 293 JAMA 1223, 1231–32 (2005) (stating that the systems’ effects on patient outcomes are not sufficiently studied and are inconsistent when they are examined); Handler et al., supra note 60, at 1136 (stating that the benefit of decision support is unclear and often does not seem to affect clinicians’ adherence to recommended guidelines).

\(^{369}\) See Usha Subramanian et al., A Controlled Trial of Including Symptom Data in Computer-Based Care Suggestions for Managing Patients with Chronic Heart Failure, 6 Am. J. Med. 375, 379–80 (2003) (noting that two thirds of suggestions were disregarded).

\(^{370}\) William M. Tierney et al., Can Computer-Generated Evidence-Based Care Suggestions Enhance Evidence-Based Management of Asthma and Chronic Obstructive Pulmonary Disease? A Randomized, Controlled Trial, 40 HEALTH SERV. RES. 477, 492 (2005). When the escape key was disabled, provider adherence to suggestions increased significantly. Dexter et al., supra note 62, at 968.

\(^{371}\) Dexter et al., supra note 62, at 968 (noting that displaying a banner on the screen that stated suggestions were available and then requiring physicians to make a deliberate choice to view reminders was ineffective); Garg et al., supra note 368, at 1234; McDonald et al., supra note 37, at 244–47 (discussing the Regenstrief system’s automatic suggestions, which are triggered by various types of data input).
care providers must be subject to regulatory enforcement. Vendors would need to ensure that their products conform to regulatory standards and to comply with approval and reporting procedures. The providers would need to adopt approved EHR systems by a specified date and to use them properly in providing clinical care.

EHR system regulation would require the formulation of an enabling statute, and the enabling statute or the implementing regulations would need to include both civil and criminal penalties. The regulatory agency should also be empowered to investigate complaints of non-compliance and to initiate compliance reviews on its own, just as HHS and CMS may investigate covered entities that are suspected of failing to comply with the HIPAA Privacy Rule. If CMS becomes the regulatory agency, the statute and regulations could also provide that noncompliant health care providers will be denied payment for services covered by Medicare, Medicaid, and SCHIP.

The Joint Commission, formerly the Joint Commission on Accreditation of Healthcare Organizations, could also contribute to enforcement efforts. The Joint Commission is a not-for-profit organization that accredits almost 15,000 U.S. health care organizations and programs according to standards that it develops. Once EHR system adoption becomes mandatory, the Joint Commission could add standards related to EHR systems to its accreditation criteria in order to monitor entities’ adoption and effective use of these mechanisms.

372. See supra Part IV.B.
373. Regulatory authority could be included in new legislation or as an amendment to existing legislation, such as HIPAA or the Public Health Service Act. See S. 1693, 110th Cong. (2007) (proposing to amend the Public Health Services Act to add HIT provisions).
374. The penalty system could be based on the system that has already been established for HIPAA Privacy Rule violations. See 42 U.S.C. §§ 1320d-5 to 1320d-6 (2000); 45 C.F.R. §§ 160.400–.426 (2007) (establishing civil penalties for violations of the HIPAA Privacy Rule).
376. Id.; see, e.g., Jaikumar Vijayan, HIPAA Audit Rules Health IT: Medical Industry on Edge After Feds Examine Hospital’s Security Procedures, COMPUTERWORLD, June 18, 2007, at 1, 1 (reporting that HHS initiated a HIPAA Security Rule audit of Piedmont Hospital in Atlanta in March 2007).
377. See 42 U.S.C. § 1395i-3(h)(2)(B)(i) (2000) (authorizing the HHS Secretary to deny payment to skilled nursing facilities that have not met particular requirements); 42 C.F.R. § 488.417 (2007) (providing that noncompliant long term care facilities may be denied Medicare and Medicaid payments for new admissions).
Furthermore, the threat of product liability or medical malpractice litigation could deter misconduct by both EHR system vendors and health care providers. Plaintiffs may sue providers if they suspect that they suffered poor outcomes because providers failed to implement or properly use EHR systems, for example, by neglecting to utilize decision-support features that may have averted a medical mistake. Likewise, plaintiffs might name EHR system vendors as defendants if they believe the harm is rooted at least partly in a design flaw, and health care providers might bring in vendors as third party defendants if they believe the vendors to be partially at fault. Audit logs and capture/replay would be helpful to all parties in investigating and proving their claims concerning system failures and provider negligence or lack thereof.

HHS has been accused of providing only anemic enforcement for the HIPAA Privacy Rule and HIPAA Security Rule. Whatever agency is charged with regulating EHR systems will need sufficient funding to engage in robust enforcement activities. However, because plaintiffs can already sue both health care providers and EHR system vendors through the tort system, the statute need not offer a private cause of action to aggrieved individuals. In 2008, the Supreme Court held that federal legislation pre-empts common law claims that challenge the safety or efficacy of medical devices that have received FDA premarket approval. Because software defects can manifest for the first time long after EHR systems are initially approved, similar preemption of common law claims would be inappropriate for these systems.

381. See Fed. R. Civ. P. 14 (discussing third-party practice). At the same time, EHR system failures might be very difficult to prove because of the products’ complexities, and thus the threat of litigation alone might be of somewhat limited value as a deterrent to malfeasance by vendors. See supra note 177 and accompanying text.

382. See supra Part IV.C.3.

383. See Hoffman & Podgurski, supra note 121, at 356–57 (discussing HHS enforcement activities); see also Office of Inspector Gen., U.S. Dep’t of Health & Human Servs., Nationwide Review of the Centers for Medicare & Medicaid Services Health Insurance Portability and Accountability Act of 1996 Oversight i–ii (2008), available at http://oig.hhs.gov/oas/reports/region4/40705064.pdf (finding that “CMS relied on complaints to identify any noncompliant covered entities that it might investigate. As a result, CMS had no effective mechanism to ensure that covered entities were complying with the HIPAA Security Rule or that [electronic protected health information] was being adequately protected.”); Baldas, supra note 125, at 4 (stating that, according to some lawyers, “the government is finally putting teeth into a law that has yielded more than 26,000 complaints, but only four convictions”).


385. See supra notes 194–95 and accompanying text.
D. Improving Health Care Through EHR-based Research

Commentators have noted that the contemporary medical world is characterized by a startling degree of uncertainty. According to some estimates, as few as twenty to twenty-five percent of treatments have been definitively proven effective. EHR systems could contribute significantly to the advancement of medical knowledge by facilitating extensive research initiatives.

The federal regulations could provide for the creation of a vast database consisting of de-identified patient records from hospitals, providers of ambulatory care, long term health care facilities, and all other health care settings. Providers would be required to upload records onto the site on a periodic basis, and the database would be overseen and operated by the designated regulatory agency.

Electronic records can be “sanitized” automatically to remove identifying information, but the federal regulations would need to define what constitutes sufficient de-identification. In doing so, they would seek to ensure that data mining techniques cannot be used to infer patient identities from a combination of sanitized records and

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386. See, e.g., CROSSING THE QUALITY CHASM, supra note 68, at 145 (asserting that it takes 15 to 20 years to translate the discovery of a more efficacious treatment into “routine patient care” and that “adherence of clinical practice to the evidence is highly uneven”); David A. Hyman & Charles Silver, The Poor State of Health Care Quality in the U.S.: Is Malpractice Liability Part of the Problem or Part of the Solution?, 90 CORNELL L. REV. 893, 952 (2005) (observing that a “great deal of uncertainty exists about the ‘best’ treatment for particular clinical conditions, and about the ‘best’ way to perform those treatments” and that the “efficacy of most medical treatments has never been proven”); see also Blue Cross Health Plans Recommend Institute to Study Treatments’ Effectiveness, 6 MED. RESEARCH L. & POL’Y 278, 278 (2007) (reporting that Blue Cross urged Congress “to establish an independent public/private institute to fund research on the comparative effectiveness of various medical treatments, medications, and medical devices”).

387. John Carey, Medical Guesswork: From Heart Surgery to Prostate Cancer, the Health Industry Knows Little About Which Common Treatments Really Work, BUSINESSWEEK, May 29, 2006, at 72, 72 (asserting that many physicians “say the portion of medicine that has been proven effective is still outrageously low — in the range of 20% to 25%”).


389. Matt Bishop et al., How to Sanitize Data, 2004 PROC. 13TH IEEE INT’L WORKSHOPS ON ENABLING TECHS.: INFRASTRUCTURE FOR COLLABORATIVE ENTERS. 217, 217, available at http://nob.cs.ucdavis.edu/~bishop/papers/2004-wetice/basicsani.pdf (explaining that when sanitization is implemented, “the raw data is presented for others to analyze, but the data is transformed so that sensitive items are suppressed,” as is the case when researchers are given patient records from which identifying information, such as name, address, and phone number are expunged).

390. 45 C.F.R. § 164.514(a)–(b) (2007) (stating the HIPAA Privacy Rule’s specifications of what constitutes de-identified data).
other available data. Although patients should not be allowed to opt out of inclusion in EHR systems and the NHIN, they should be provided a choice concerning inclusion in the research database. Patients would be asked to sign a consent form at the time of their initial visit to a provider or admission to a health care facility indicating their agreement or refusal to have their de-identified EHRs entered into the national research database. With sufficient reassurance that records will in fact be de-identified and that their confidentiality will be protected, many patients may consent to inclusion of their records in the database.

Research using this information could be conducted with few regulatory burdens. De-identified records do not require IRB review and are not subject to coverage by the HIPAA Privacy Rule. The databank would be accessible to qualified researchers who register with the regulatory agency and meet its criteria for approval. Agency review committees could scrutinize applications, and the agency could require applicants to prove their identities and affiliations and to provide a limited description of the planned research projects, along with other relevant information. Access to the databank would be granted for a period limited to the duration of the study.

The scientific community is already familiar with the Coriell Institute for Medical Research, which maintains one of the world’s largest repositories of human cells. The institute has distributed over 160,000 cell lines and over 50,000 DNA samples a year to researchers in sixty-two countries. The proposed databank would constitute a similar resource, containing health records rather than biological samples.

391. Vassilios S. Verykios et al., State-of-the-Art in Privacy Preserving Data Mining, 33 SIGMOD Rec. 50, 50–57 (2004), available at http://www.sigmod.org/record/issues/0403/B1.bertrion-sigmod-record2.pdf ("[S]ensitive knowledge which can be mined from a database by using data mining algorithms, should also be excluded, because such a knowledge can equally well compromise data privacy.").

392. See supra text accompanying note 350.

393. Patients should also be able to withdraw consent to having new information submitted to the databank. However, it might not be at all feasible to expunge existing medical records concerning a particular patient, because they may be in use by various researchers.

394. The federal regulations that require IRB review cover only research on human subjects and define “human subject” as “a living individual about whom an investigator . . . obtains (1) data through intervention or interaction with the individual, or (2) identifiable private information.” 45 C.F.R. § 46.102 (2007); see also 45 C.F.R. § 46.101(b)(4) (2007) (exempting research “involving the collection or study of existing data, documents, [or] records . . . if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects”). Likewise, the HIPAA Privacy Rule covers only “individually identifiable health information.” See 45 C.F.R. § 160.103 (2007) (defining “protected health information”).


396. Id.
The databank would enable researchers to conduct comprehensive, non-experimental studies based on the actual clinical experience of patients and caregivers. The importance of such research capabilities has already been recognized by the federal government. In 2007, Congress authorized the FDA to oversee the creation of a national data network, the Sentinel System. This project aims ultimately to make the data of 100 million Americans available for purposes of post-marketing drug surveillance and safety analysis. The data will be drawn from records from Medicare, the military, private insurance claims, pharmaceutical purchases, and elsewhere.

The research databank proposed in this Article would go much further than this initiative. It could potentially include the records of all Americans, be accessible to government and to private researchers, and be used to study all treatments rather than focusing only on those involving pharmaceutical products. Once created, this databank could replace all smaller-scale data collections.

While research derived from the proposed national databank would not be a substitute for clinical trials, it would constitute an invaluable supplement to them. Researchers would be able to verify the success or failure of treatment protocols as they are applied to different patient populations, based on review of millions of patient files covering many years.

V. CONCLUSION

EHR systems offer great promise for significantly improving health care in the U.S. and around the world. The technology could address many of the health care system’s shortcomings and have far-reaching positive impacts on patient welfare. For example, HIT could do all of the following: decrease medical errors; enhance preventive care; facilitate communication between doctors and patients and among medical team members; reduce health disparities; and advance biomedical research capabilities.

The complexity of EHR systems, however, generates many risks of software and hardware failures and adverse patient outcomes. Consequently, they require rigorous regulation. Some risks can stem from system defects and others from usability problems. Advanced EHR systems that will be developed in the future could improve health out-

397. See supra notes 84–100 and accompanying text (comparing experimental and non-experimental studies).
399. See supra Part II.B (detailing the benefits of EHR systems).
comes to an even greater extent, but they may also pose more serious risks because of increased complexity.

Although EHR system regulation is needed, it is a challenging and sensitive undertaking. A tension exists between the goals of regulating EHR systems comprehensively and facilitating their widespread and imminent adoption. The more extensive and burdensome the regulations, the more providers will resist purchasing EHR systems. We have attempted to craft a balanced approach that provides incentives for EHR system development and adoption while safeguarding patient welfare and deterring misconduct on the part of the software and health care industries. As laws and regulations are promulgated in this area, policy makers will need to continue to consider carefully the competing goals and to balance oversight with promotion of HIT.

Innumerable details and requirements could be included in the federal regulations. We have not offered comprehensive suggestions or specific regulatory language. Rather, we outlined a regulatory framework and focused on what we believe to be some of the essential issues in the realm of EHR system oversight. The task of EHR system regulation, however, must commence at the earliest opportunity. It is only with appropriate statutory and regulatory interventions that the full benefits of this potentially transformative medical technology can be realized.