3

Electronic Health Records

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Learning Objectives

After reading this chapter the reader should be able to:

- State the definition and history of electronic health records
- Describe the limitations of paper-based health records
- Identify the benefits of electronic health records
- List the key components of an electronic health record
- Describe the ARRA-HITECH programs to support electronic health records
- Describe the benefits and challenges of computerized order entry and clinical decision support systems
- State the obstacles to purchasing and implementing an electronic health record
- Enumerate the steps to purchase an EHR

Introduction

There is no topic in health informatics as important, yet controversial, as the electronic health record (EHR). In spite of their significance, the history of EHRs in the United States is relatively short. The Problem Oriented Medical Information System (PROMIS) was developed in 1976 by The Medical Center Hospital of Vermont in collaboration with Dr. Lawrence Weed, the originator of the problem oriented record and SOAP formatted notes. Ironically, the inflexibility of the concept led to its demise.[1] In a similar time frame the American Rheumatism Association Medical Information System (ARAMIS) appeared. All findings were displayed as a flow sheet. The goal was to use the data to improve the care of rheumatologic conditions.[2] Other EHR systems began to appear throughout the US: the Regenstrief Medical Record System (RMRS) developed at Wishard Memorial Hospital, Indianapolis; the Summary Time Oriented Record (STOR) developed by the University of California, San Francisco; Health Evaluation Through Logical Processing (HELP) developed at the Latter Day Saints Hospital, Salt Lake City and The Medical Record developed at Duke University[3], the Computer Stored Ambulatory Record (COSTAR) developed by Octo Barnett at Harvard and the De-Centralized Hospital Computer Program (DHCP) developed by the Veterans Administration.[4]

In 1970 Schwartz optimistically predicted "clinical computing would be common in the not too distant future."[5] In 1991 the Institute of Medicine (IOM) recommended electronic health records as a solution for many of the problems facing modern medicine.[6] Since the IOM recommendation, little progress has been

made during the last decade for multiple reasons. As Dr. Donald Simborg stated, the slow acceptance of electronic health records is like the "wave that never breaks."[7]

The American Recovery and Reimbursement Act (ARRA) of 2009 was a major game changer for electronic health records, with reimbursement for the Meaningful Use of certified EHRs, as well as other programs that supported EHR education and health information exchange. Reimbursement details will be discussed in more detail later in this chapter.

We will primarily discuss outpatient (ambulatory) electronic health records. Inpatient EHRs share many similarities to ambulatory EHRs but the scope, price and complexity are different. The logical steps to selecting and implementing an EHR are found in Appendix 3.3 at the end of the chapter.

Electronic Health Record Definitions

There is no universally accepted definition of an EHR. As more functionality is added the definition will need to be broadened. Importantly, EHRs are also known as electronic medical records (EMRs), computerized medical records (CMRs), electronic clinical information systems (ECIS) and computerized patient records (CPRs). Throughout this book we will use electronic health record as the more accepted and inclusive term, but either term is acceptable.

Figure 3.1 demonstrates the relationship between EHRs, EMRs and personal health records (PHRs).[8] As indicated in the diagram, PHRs can be part of the EMR/EHR system which may cause confusion.

Figure 3.1: Relationship between EHR, PHR and EMR

In 2008 the National Alliance for Health Information Technology released the following definitions in an effort to standardize terms used in HIT:

- Electronic Medical Record: "An electronic record of health-related information on an individual that can be created, gathered, managed and consulted by authorized clinicians and staff within one healthcare organization."[9]
- Electronic Health Record: "An electronic record of health-related information on an individual that conforms to nationally recognized interoperability standards and that can be created, managed and consulted by authorized clinicians and staff across more than one healthcare organization."[9]
- Personal Health Record: "An electronic record of health-related information on an individual that conforms to nationally recognized interoperability standards and that can be drawn from multiple sources while being managed, shared and controlled by the individual."[9]

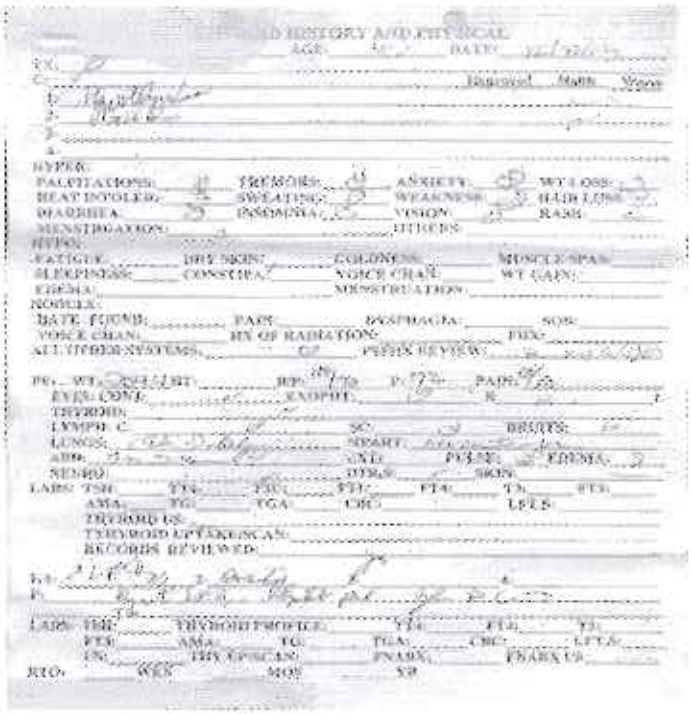
Need for Electronic Health Records

The following are the most significant reasons why our healthcare system would benefit from the widespread transition from paper to electronic health records:

Paper Records Are Severely Limited

Much of what can be said about handwritten prescriptions can also be said about handwritten office notes. Figure 3.2 illustrates the problems with a paper record. In spite of the fact that this clinician used a template, the handwriting is illegible and the document cannot be electronically shared or stored. It is not structured data that is computable and hence sharable with other computers and systems. Other shortcomings of paper: expensive to copy, transport and store; easy to destroy; difficult to analyze and determine who has seen it; and the negative impact on the environment. Electronic patient encounters represent a quantum leap forward in legibility and the ability to rapidly retrieve information. Almost every industry is now computerized and digitized for rapid data retrieval and trend analysis. Look at the stock market or companies like Walmart or Federal Express. Why not the field of medicine?

Figure 3.2: Outpatient paper-based patient encounter form



With the relatively recent advents of pay-for-performance, patient centered medical home model and accountable care organizations there are new reasons to embrace technology in order to aggregate and report results in order to receive reimbursement. It is much easier to retrieve and track patient data using EHRs and patient registries than to use labor intensive paper chart reviews. EHRs are much better organized than paper charts, allowing for faster retrieval of lab or x-ray results. It is also likely that EHRs will have an electronic problem summary list that outlines a patient's major illnesses, surgeries, allergies and medications. How many times does a physician open a large paper chart, only to have loose lab results fall out? How many times does a physician re-order a test because the results or the chart is missing? It is important to note that paper charts are missing as much as 25% of the time, according to one study.[10] Even if the chart is available; specifics are missing in 13.6% of patient encounters, according to another study.[11]

Table 3.1 shows the types of missing information and its frequency. According to the President's Information Technology Advisory Committee, 20% of laboratory tests are re-ordered because previous studies are not accessible.[12] This statistic has great patient safety, productivity and financial implications.

Table 3.1: Types and frequencies of missing information

Information Missing During Patient Visits	% Visits
Lab results	45%
Letters/dictations	39%
Radiology results	28%
History and physical exams	27%
Pathology results	15%

EHRs allow easy navigation through the entire medical history of a patient. Instead of *pulling paper chart volume 1 of 3* to search for a lab result, it is simply a matter of a few mouse clicks. Another important advantage is the fact that the record is available 24 hours a day, seven days a week and doesn't require an employee to pull the chart, nor extra space to store it. Adoption of electronic health records has saved money by decreasing full time equivalents (FTEs) and converting records rooms into more productive space, such as exam rooms. Importantly, electronic health records are accessible to multiple healthcare workers at the same time, at multiple locations. While a billing clerk is looking at the electronic chart, the primary care physician and a specialist can be analyzing clinical information simultaneously. Moreover, patient information should be available to physicians on call so they can review records on patients who are not in their panel. Furthermore, it is believed that electronic health records improve the level of coding. Do clinicians routinely submit a lower level of care for billing purposes because they know that handwritten patient notes are short and incomplete? Templates may help remind clinicians to add more history or details of the physical exam, thus justifying a higher level of coding (templates are disease specific electronic forms that essentially allow you to point and click a history and physical exam). A study of the impact of an EHR on the completeness of clinical histories in a labor and delivery unit demonstrated improved documentation, compared to prior paper-based histories.[13] Lastly, EHRs provide clinical decision support such as alerts and reminders, which we will cover later in this chapter.

Need for Improved Efficiency and Productivity

The goal is to have patient information available to anyone who needs it, when they need it and where they need it. With an EHR, lab results can be retrieved much more rapidly, thus saving time and money. It should be pointed out however, that reducing duplicated tests benefits the payers and patients and not clinicians so there is a misalignment of incentives. Moreover, a study in 1987 using computerized order entry showed that simply displaying past results reduced duplication and the cost of testing by only 13%.[14] If lab or x-ray results are frequently missing, the implication is that they need to be repeated which adds to this country's staggering healthcare bill. The same could be said for duplicate prescriptions. It is estimated that 31% of the United States $2.3 trillion dollar healthcare bill is for administration.[15] EHRs are more efficient because they reduce redundant paperwork and have the capability of interfacing with a billing program that submits claims electronically. Consider what it takes to simply get the results of a lab test back to a patient using the old system. This might involve a front office clerk, a nurse and a physician. The end result is frequently placing the patient on hold or playing *telephone tag*. With an EHR, lab results can be forwarded via secure messaging. Electronic health records can help with productivity if templates are used judiciously. As noted, they allow for point and click histories and physical exams that in some cases may save time. Embedded educational content for clinicians is one of the newest features of a comprehensive EHR. Clinical practice guidelines, linked educational content and patient handouts can be part of the EHR. This may permit finding

the answer to a medical question while the patient is still in the exam room. Several EHR companies also offer a centralized area for all physician approvals and signatures of lab work, prescriptions, etc. This should improve work flow by avoiding the need to pull multiple charts or enter multiple EHR modules.

Quality of Care and Patient Safety

As we have previously suggested, an EHR should improve patient safety through many mechanisms: (1) Improved legibility of clinical notes (2) Improved access anytime and anywhere (3) Reduced duplication (4) Reminders that tests or preventive services are overdue (5) Clinical decision support that reminds us of patient allergies, the correct dosage of drugs, etc. (6) Electronic problem summary lists provide diagnoses, allergies and surgeries at a glance. In spite of the before mentioned benefits, a study by Garrido of quality process measures before and after implementation of a widespread EHR in the Kaiser Permanente system, failed to show improvement.[16]

To date there has only been one study published that suggested use of an EHR decreased mortality. This particular EHR had a disease management module designed specifically for renal dialysis patients that could provide more specific medical guidelines and better data mining to potentially improve medical care. The study suggested that mortality was lower compared to a pre-implementation period and compared to a national renal dialysis registry.[17]

It is likely that we are only starting to see the impact of EHRs on quality. Based on internal data Kaiser Permanente determined that the drug Vioxx had an increased risk of cardiovascular events before that information was published based on its own internal data.[18] Similarly, within 90 minutes of learning of the withdrawal of Vioxx from the market, the Cleveland Clinic queried its EHR to see which patients were on the drug. Within seven hours they deactivated prescriptions and notified clinicians via e-mail.[19]

Quality reports are far easier to generate with an EHR compared to a paper chart that requires a chart review. Quality reports can also be generated from a data warehouse or health information organization that receives data from an EHR and other sources.[20] Quality reports are the backbone for pay-for-performance which we will discuss further in another chapter.

Public Expectations

According to a 2006 Harris Interactive Poll for the Wall Street Journal Online, 55% of adults thought an EHR would decrease medical errors; 60% thought an EHR would reduce healthcare costs and 54% thought that the use of an EHR would influence their decision about selecting a personal physician.[21] The Center for Health Information Technology would argue that EHR adoption results in better customer satisfaction through fewer lost charts, faster refills and improved delivery of patient educational material. [22]

Governmental Expectations

EHRs are considered by the federal government to be transformational and integral to healthcare reform. As an example, EHR reimbursement is a major focal point of the HITECH Act. It is the goal of the US Government to have an interoperable electronic health record by 2014. In addition to federal government support, states and payers have initiatives to encourage EHR adoption. Many organizations state that we need to move from the *cow path* to the *information highway*. CMS is acutely aware of the potential benefits of EHRs to help coordinate and improve disease management in older patients.

Financial Savings

The Center for Information Technology Leadership (CITL) has suggested that ambulatory EHRs would save $44 billion yearly and eliminate more than $10 in rejected claims per patient per outpatient visit. This organization concludes that not only would there be savings from eliminated chart rooms and record clerks;

there would be a reduction in the need for transcription. There would also be fewer callbacks from pharmacists with electronic prescribing. It is likely that copying, faxing and mail expenses, chart pulls and labor costs would be reduced with EHRs, thus saving full time equivalents (FTEs). More rapid retrieval of lab and x-ray reports results in time/labor saving as does the use of templates. It appears that part of the savings is from improved coding. More efficient patient encounters mean more patients could be seen each day. Improved savings to payers from medication management is possible with reminders to use the *drug of choice* and generics. [23]

EHRs should reduce the cost of transcription if clinicians switch to speech recognition and/ or template use. Because of structured documentation with templates, they may also improve the coding and billing of claims.

It is not known if EHR adoption will decrease malpractice, hence saving physician and hospital costs. A 2007 Survey by the Medical Records Institute of 115 practices involving 27 specialties showed that 20% of malpractice carriers offered a discount for having an EHR in place. Of those physicians who had a malpractice case in which documentation was based on an EHR, 55% said the EHR was helpful. [24]

Technological Advances

The timing seems to be right for electronic records partly because the technology has evolved. The internet and World Wide Web make the application service provider (ASP) concept for an electronic health record possible. An ASP option means that the EHR software and patient data reside on a remote web server that you access via the internet from the office, hospital or home. Computer speed, memory and bandwidth have advanced such that digital imaging is also a reality, so images can be part of an EHR system. Standard PCs, laptops and tablet PCs continue to add features and improve speed and memory while purchase costs drop. Wireless and mobile technologies permit access to the hospital information system, the electronic health record and the internet using a personal digital assistant, smartphone or laptop computer. The chapter on health information exchange will point out that health information organizations can link EHRs together, in order to share information and services.

Need for Aggregated Data

In order to make evidence based decisions, we need high quality data that should derive from multiple sources: inpatient and outpatient care, acute and chronic care settings, urban and rural care and populations at risk. This can only be accomplished with electronic health records and discrete structured data. Moreover, we need to combine or aggregate data to achieve statistical significance. Although most primary care is delivered by small practices, it is difficult to study because of relatively small patient populations, making aggregation necessary. [25]

EHR is a Transformational Tool

It is widely agreed that US Healthcare needs reform in multiple areas. To modernize its infrastructure we would need to have widespread adoption of EHRs. Large organizations such as the Veterans Health Administration and Kaiser Permanente use robust EHRs (VistA and Epic) that generate enough data to change the practice of medicine. In 2009 Kaiser Permanente reported two studies, one pertaining to the management of bone disease (osteoporosis) and the other chronic kidney disease. They were able to show that with their EHR they could focus on patients at risk and use all of the tools available to improve disease management and population health. [26-27] In a study reported in 2009 Kaiser-Permanente reported that electronic visits that are part of the electronic health record system were likely responsible for a 26.2% decrease in office visits over a four year period. They posited that this was good news for a system that aligns incentives with quality, regardless whether the visit was virtual or face-to-face. [28] Other fee-for-service organizations might find this alarming if office visits decreased and e-visits were not reimbursed.

Need for Coordinated Care

According to a Gallup poll it is very common for older patients to have more than one physician: no physician (3%), one physician (16%), two physicians (26%), three physicians (23%), four physicians (15%), five physicians (6%) and six or more physicians (11%). [29]

Having more than one physician mandates good communication between the primary care physician, the specialist and the patient. This becomes even more of an issue when different healthcare systems are involved. O'Malley et al. surveyed 12 medical practices and found that in-office coordination was improved by EHRs but the technology was not mature enough to improve coordination of care with external physicians.[30] Electronic health records are being integrated with health information organizations so that inpatient and outpatient patient-related information can be accessed and shared, thus improving communication between disparate healthcare entities. Home monitoring (telehomecare) can transmit patient data from home to an office's EHR also assisting in the coordination of care.

Institute of Medicine's Vision for EHRs

The history and significance of the Institute of Medicine (IOM) is detailed in chapter 1. They have published multiple books and monographs on the direction US Medicine should take, including *The Computer-Based Patient Record: An Essential Technology for Health Care*. This visionary work was originally published in 1991 and was revised in 1997 and 2000.[31] In this book and their most recent work *Key Capabilities of an Electronic Health Record System: Letter Report* (2003) they outline eight core functions all EHRs should have:

- Health information and data: In order for the medical profession to make evidence based decisions, you need a lot of accurate data and this is accomplished much better with EHRs than paper charts; *if you can't measure it, you can't manage it*
- Result management: Physicians should not have to search for lab, x-ray and consult results. Quick access saves time and money and prevents redundancy and improves care coordination
- Order management: CPOE should reduce order errors from illegibility for medications, lab tests and ancillary services and standardize care
- Decision support: Should improve overall medical care quality by providing alerts and reminders
- Electronic communication and connectivity: Communication among disparate partners is essential and should include all tools such as secure messaging, text messaging, web portals, health information exchange, etc.
- Patient support: Recognizes the growing role of the internet for patient education as well as home telemonitoring
- Administrative processes and reporting: Electronic scheduling, electronic claims submission, eligibility verification, automated drug recall messages, automated identification of patients for research and artificial intelligence can speed administrative processes
- Reporting and population health: We need to move from paper-based reporting of immunization status and biosurveillance data to an electronic format to improve speed and accuracy [32]

Electronic Health Record Key Components

Many current EHRs have more functionality than the eight core functions recommended by IOM and this will increase as time goes by. The following components are desirable in any EHR system. One of the

advantages of certification for Meaningful Use is that it helped standardize what features were important. The following are features found in most current EHRs:

- Clinical decision support systems (CDSS) to include alerts, reminders and clinical practice guidelines. CDSS is associated with computerized physician order entry (CPOE). This will be discussed in more detail in this chapter and the patient safety chapter
- Secure messaging (e-mail) for communication between patients and office staff and among office staff. May include messaging that is part of the Direct Project, explained in the chapter on health information exchange. Telephone triage capability is important
- An interface with practice management software, scheduling software and patient portal (if present). This feature will handle billing and benefits determination. We will discuss this further in the chapter on practice management systems
- Managed care module for physician and site profiling. This includes the ability to track Health plan Employer Data and Information Set (HEDIS) or similar measurements and basic cost analyses
- Referral management feature
- Retrieval of lab and x-ray reports electronically
- Retrieval of prior encounters and medication history
- Computerized Physician Order Entry (CPOE). Primarily used for inpatient order entry but ambulatory CPOE also important. This will be discussed in more detail later in this chapter
- Electronic patient encounter. One of the most attractive features is the ability to create and store a patient encounter electronically. In seconds you can view the last encounter and determine what treatment was rendered
    - Multiple ways to input information into the encounter should be available: free text (typing), dictation, voice recognition and templates
- The ability to input or access information via a smartphone or tablet PC
- Remote access from the office, hospital or home
- Electronic prescribing
- Integration with a picture archiving and communication system (PACS), discussed in a separate chapter
- Knowledge resources for physician and patient, embedded or linked
- Public health reporting and tracking
- Ability to generate quality reports for reimbursement, discussed in the chapter on quality improvement strategies
- Problem summary list that is customizable and includes the major aspects of care: diagnoses, allergies, surgeries and medications. Also, the ability to label the problems as acute or chronic, active or inactive. Information should be coded with ICD-9/10 or SNOMED CT so it is structured data
- Ability to scan in text or use optical character recognition (OCR)
- Ability to perform evaluation and management (E & M) determination for billing
- Ability to create graphs or flow sheets of lab results or vital signs

- Ability to create electronic patient lists and disease registries. Discussed in more detail in the chapter on disease management
- Preventive medicine tracking that links to clinical practice guidelines
- Security and privacy compliance with HIPAA standards
- Robust backup systems
- Ability to generate a Continuity of Care Document (CCD) or Continuity of Care Record (CCR), discussed in the data standards chapter
- Support for client server and/or application service provider (ASP) option [33]

Computerized Physician Order Entry (CPOE)

CPOE is an EHR feature that processes orders for medications, lab tests, x-rays, consults and other diagnostic tests. The majority of articles written about CPOE have discussed medication ordering only, possibly giving readers the impression that CPOE is the same as electronic prescribing. The reality is that CPOE has a great deal more functionality as we will later point out, in this and other chapters. Many organizations such as the Institute of Medicine and Leapfrog see CPOE as a powerful instrument of change. There is limited evidence that CPOE will reduce medication errors, cost and variation of care. This is discussed in the following sections.

Reduce Medication Errors

CPOE has the potential to reduce medication errors through a variety of mechanisms.[34] Because the process is electronic, you can embed rules (clinical decision support) that check for allergies, contraindications and other alerts. Koppel et al. lists the following advantages of CPOE compared to paper-based systems for patient safety: overcomes the issue of illegibility, fewer errors associated with ordering drugs with similar names, more easily integrated with decision support systems than paper, easily linked to drug-drug interaction warning, more likely to identify the prescribing physician, able to link to adverse drug event (ADE) reporting systems, able to avoid medication errors like trailing zeros, creates data that is available for analysis, can point out treatment and drugs of choice, can reduce under and over-prescribing, prescriptions reach the pharmacy quicker. [35]

- Inpatient CPOE: This functionality was recommended by the IOM in 1991. Most studies so far have looked primarily at inpatient CPOE and not ambulatory CPOE. A 1998 study by David Bates in JAMA showed that CPOE can decrease serious inpatient medication errors by 55% (relative risk reduction).[36] Many of the studies showing reductions in medication errors by the use of technology were reported out of the same institution. Other hospital systems are unlikely to experience the same optimistic results. A 2008 systematic review of CPOE with CDSS by Wolfstadt et al. only found 10 studies of high quality and those dealt primarily with inpatients. Only half of the studies were able to show a statistically significant decrease in medication errors, none were randomized and seven were homegrown systems, so results are difficult to generalize.[37]

  With the inception of CPOE we are seeing evidence of new errors that result from technology. A 2005 article reported that the mortality rate increased 2.8%- 6.5% after implementing a well-known EHR. [38] In a 2006 article also from a children's hospital implementing the same EHR they found no increase in mortality. It appears that this was due to better planning and implementation. One of the authors stated that the CPOE system eliminated handwriting errors, improved medication turnaround time and helped standardize care.[39] Nebeker reported on substantial ADEs at a VA hospital following the adoption of CPOE that lacked full decision

support, such as medication alerts.[40] On the other hand, another inpatient study showed a reduction in preventable ADEs (46 vs. 26) and potential ADEs (94 vs. 35) compared to pre-EHR statistics.[41] Suffice it to say, clinicians and staff must be properly trained in CPOE; otherwise errors will likely increase, at least in the short term.

- Outpatient CPOE: Americans made 906.5 million outpatient visits in the year 2000. By sheer numbers there is more of a chance for a medication error written for outpatients. According to an optimistic report by the Center for Information Technology Leadership, adoption of an ambulatory CPOE system (ACPOE) will likely eliminate about 2.1 million ADEs per year in the USA. This could potentially prevent 1.3 million ADE-related visits, 190,000 hospitalizations and more than 136,000 life-threatening ADEs.[42] However, a systematic review by Eslami was not as optimistic as he concluded that only one of four studies demonstrated reduced ADEs and only three of five studies showed decreased medical costs. Most showed improved guideline compliance, but it took longer to electronically prescribe and there was a high frequency of ignored alerts.[43] Kuo et al. reported medication errors from primary care settings. He concluded that 70% of medication errors were related to prescribing and that 57% of errors might have been prevented by electronic prescribing.[44]

Reduce Costs

Several studies have shown reduced length of stay and overall costs in addition to decreased medication costs with the use of CPOE.[45] Tierney was able to show in 1993 an average savings of $887 per admission when orders were written using guidelines and reminders, compared to paper-based ordering that was not associated with clinical decision support.[46]

Reduce Variation of Care

One study showed excellent compliance by the medical staff when the drug of choice was changed using decision support reminders.[47] Study conclusions should be interpreted with some note of caution. Many of the studies were conducted at medical centers with well-established health informatics programs where the acceptance level of new technology is unusually high. Several of these institutions such as Brigham and Women's Hospital developed their own EHR and CPOE software. Compare this experience with that of a rural hospital trying CPOE for the first time with potentially inadequate IT, financial and leadership support. It is likely that smaller and more rural hospitals and offices will have a steep learning curve.

On the surface CPOE seems easy, just replace paper orders with an electronic format. The reality is that CPOE represents a significant change in work flow and not just new technology. An often repeated phrase is "it's not about the software, dummy," meaning, regardless which software program is purchased, it requires change in work flow and extensive training.

Adoption of CPOE has been slow, partly because of cost and partly because inputting is slower than scribbling on paper.[48] Although physicians have been upset by new changes that do not shorten their work day, many authorities feel EHRs greatly improve numerous hospital functions. There has been less resistance traditionally in teaching hospitals with a track record of good informatics support. Also, young house staff who work in teaching hospitals and who write the majority of orders are more likely to be tech savvy and amenable to change. It does require great forethought, leadership, planning, training and the use of physician champions in order for CPOE to work. According to some, CPOE should be the last module of an EHR to be turned on and alerts should be phased in to bring about change more gradually. Others have recognized nurses as more accepting of change and willing to teach docs *one-on-one* on the wards.

For more information on CPOE we refer you to a monograph "A Primer on Physician Order Entry" and an article "CPOE: benefits, costs and issues."[49-50]

Clinical Decision Support Systems (CDSS)

Traditionally, CDSS meant computerized drug alerts and reminders to perform preventive tests as part of computerized physician order entry (CPOE) applications. Most of the studies in the literature evaluated those two functions. However, according to Hunt, CDSS is "any software designed to directly aid in clinical decision making in which characteristics of individual patients are matched to a computerized knowledge base for the purpose of generating patient specific assessments or recommendations that are then presented to clinicians for consideration."[51] Therefore, CDSS should have a broader definition than just alerts and reminders.

Two 2005 papers addressed the effects of CDSS on clinical care. Garg and co-authors concluded that overall, CDSS improved performance in 64% of the 97 studies but only 13% of the 52 studies analyzed reported improvement in actual patient outcomes.[52] Kawamoto et al. looked at those factors that contributed to the success of CDSS: automatic CDSS that was part of clinician work flow; recommendations and not just assessments; provision of CDSS at the point of care and computer-based CDSS (not paper-based). When these four features were present, CDSS improved clinical care about 94% of the time.[53]

According to a 2009 article, clinical decision support by nine commercial EHRs was extremely variable and tended not to offer choices.[54] Clearly, the most sophisticated CDSS are developed at medical centers with home grown EHRs and a long record of extensive HIT adoption. With Meaningful Use criteria, certified EHRs will have to conform to CDSS standards which may reduce variability.

Sheridan and Thompson have discussed various levels of CDSS: (level 1) all decisions by humans, (level 2) computer offers many alternatives, (level 3) computer restricts alternatives, (level 4) computer offers only one alternative, (level 5) computer executes the alternative if the human approves, (level 6) human has a time line before computer executes, (level 7) computer executes automatically, then notifies human, (level 8) computer informs human only if requested, (level 9) computer informs human but is up to computer and (level 10) computer makes all decisions.[55] Most EHR systems may offer alternatives and provide reminders but make no decisions on their own. With artificial intelligence and natural language processing becoming more sophisticated, this could change in the future.

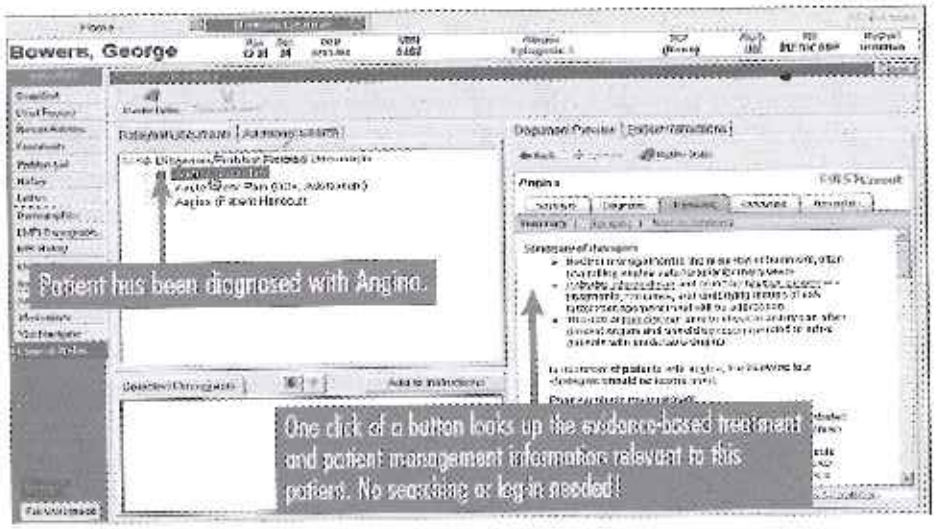
Table 3.2 outlines some of the clinical decision support available today. Calculators, knowledge bases and differential diagnoses programs are primarily standalone programs but they are slowly being integrated into EHR systems.

- Knowledge support. Numerous digital medical resources are being integrated with EHRs. As an example, the American College of Physician's PIER resource is integrated into Allscript's Touch Chart.[56] The comprehensive online reference UpToDate has been integrated into six EHRs.[57] iConsult (offered by Elsevier) is a primary care information database available for integration into EHRs. Diagnostic (ICD-9) codes can be hyperlinked to further information or you can use *infobuttons*. Other products such as Dynamed, discussed in the chapter on online medical resources are available as *infobuttons*. Figure 3.3 shows an example of iConsult integrated with the Epic EHR.[58] Another interesting integrated knowledge program is the Theradoc Antibiotic Assistant. The program integrates with an inpatient EHR's lab, pharmacy and radiology sections to make suggestions as to the antibiotic of choice with multiple alerts. Clinicians can be alerted via cell phones, pagers or e-mail. Other modules include Adverse Drug Event (ADE) Assistant, Infection Control Assistant and Clinical Alerts Assistant.[59] A study in the New England Journal of Medicine (NEJM) using this product showed considerable improvement in the prescription of appropriate antibiotics resulting in cost saving, reduced length of stay and fewer adverse drug events.[60]

Table 3.2: Clinical decision support

Type of CDSS	Examples
Knowledge	iConsult®, Theradoc®
Calculators	Medcalc 3000®
Trending/Patient tracking	Flow sheets, graphs
Medications	CPOE and drug alerts
Order sets/protocols	CPGs and order sets
Reminders	Mammogram due
Differential diagnosis	Dxplain®
Radiology CDSS	What imaging studies to order?
Laboratory CDSS	What lab tests to order
Public health alerts	Infection disease alerts

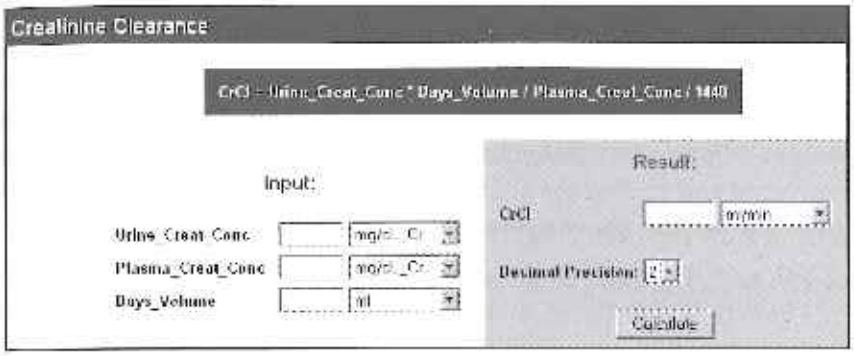
Figure 3.3: iConsult integrated with Epic EHR (Courtesy iConsult)



- Calculators. It is likely with time that more calculators will be embedded into the EHR, particularly in the medication and lab ordering sections. Figure 3.4 shows the standalone online and Pocket PC-based program Medcalc3000 with over 100 calculations available. They now offer a *Connect* option that will integrate with EHRs by linking calculators, clinical criteria tools, labs and decision trees.[61] Important calculations, such as kidney function (creatinine clearance) should be calculated on all patients.

- Flow sheets, graphs, patient lists and registries. The ability to track and trend lab results and vital signs, for example, in diabetic patients will greatly assist in their care. Furthermore, the ability to use a patient list to contact every patient taking a recalled drug will improve patient safety. Registries will be covered in more detail in the disease management chapter.

Figure 3.4: Medcalc3000 (Courtesy Medcalc3000)



- Medication ordering support. Decision support as part of CPOE possesses several rules engines to detect known allergies, drug-drug interactions, drug-condition and drug-food allergies, as well as excessive dosages. As EHRs and CPOE mature, they will factor in age, gender, weight, kidney (renal) and liver (hepatic) function of the patient, known contraindications based on known diagnoses, as well as the pregnancy and lactation status. Incorporation of these more robust features is complicated and best implemented at medical centers with an established track record of CDSS and CPOE development. As has been pointed out, there are programs that improve antibiotic ordering based on data residing in the EHR.[62] Computerized drug alerts have obvious potential in decreasing medication errors but have not been universally successful to date. According to a systematic review by Kawamoto et al. successful alerts need to be automatic, integrated with CPOE, require a physician response and make a recommendation.[63] Four studies have been published from the Brigham and Women's Hospital showing mediocre compliance, even for black-box type warnings.[64-67] An excellent review by Kuperman et al. describes basic and advanced medication-related CDSS.[68] Further information about alerts is included in the chapters on patient safety and e-prescribing.

- Reminders. Computerized reminders that are part of the EHR assist in tracking the yearly preventive health screening measures, such as mammograms. Shea performed a meta-analysis and concluded that there was clear benefit for vaccinations, breast cancer and colorectal screening, but not cervical cancer screening.[69] A well-designed system should allow for some customization of the reminders as national recommendations change. Reminders are not always heeded by busy clinicians who may choose to ignore them. As a possible solution, preventive reminders could be reviewed by the office nurse and overdue tests ordered prior to the visit with the physician.

- Order sets and protocols. Order sets are groups of pre-established inpatient orders that are related to a symptom or diagnosis. For instance, you can create an order set for pneumonia that might include the antibiotic of choice, oxygen, repeat chest x-ray, etc. that saves keystrokes and time. Order sets can also reflect best practices (clinical practice guidelines), thus offering better and less expensive care. Over one hundred clinical practice guidelines are incorporated into the electronic health record at Vanderbilt Medical Center.[70] For more information on order sets we refer you to this reference.[71]

- Differential Diagnoses. Dxplain is a differential diagnosis program developed at Massachusetts General Hospital. When you input the patient's symptoms it generates a differential diagnosis (the diagnostic possibilities). The program has been in development since 1984 and is currently web-based. A licensing fee is required to use this program. At this time it cannot be integrated into an EHR.[72] In spite of the potential benefit, an extensive 2005 review of CDSSs revealed that only 40% of the 10 diagnostic systems studied showed benefit, in terms of improved clinician

performance.[73] Artificial intelligence continues to improve so it is likely that EHRs will have the ability to assist with differential diagnosis in the future.

- Radiology CDSS. Physicians, particularly those in training, may order imaging studies that are either incorrect or unnecessary. For that reason, several institutions have implemented clinical decision support to try to improve ordering. Appropriateness criteria have been established by the American College of Radiologists. Massachusetts General Hospital has had radiology order entry since 2001 and studied the addition of decision support. They noted a decline in low utility exams from 6% down to 2% as a result of decision support.[74]
- Laboratory CDSS. It should be no surprise that clinicians occasionally order inappropriate lab tests, for a variety of reasons. It would be helpful if clinical decision support would alert them to the indications for a test, as well as the price. A Dutch study of primary care demonstrated that 20% fewer lab tests were ordered when clinicians were alerted to lab clinical guidelines.[75]
- Public Health Alerts. The New York Department of Health and Mental Hygiene used Epic EHR's "Best Practice Advisory" to alert New York physicians about several infectious disease issues. The EHR-based alert also hyperlinked to disease specific order sets for educational tips, lab and medication orders.[76]

How well clinicians use CDSS programs such as those discussed, remains to be seen. They will have to be intelligently designed and rigorously tested in order to be accepted. For more information on CDSS, we refer you to the resources cited in references.[77-80]

Electronic Health Record Adoption .

Outpatient (Ambulatory) EHR Adoption

In 2006 the adoption rate of ambulatory EHRs was reported to be in the 10% to 20% range, depending on which study you read and what group was studied.[81] Many of the commonly quoted statistics came from surveys, with their obvious shortcomings. It is also important to realize that many outpatient practices may have EHRs but continue to run dual paper and electronic systems or may use only part of the EHR. Furthermore, a significant concern is that small and/or rural practices are more likely to lack the finances and information technology support to purchase and implement EHRs.

In 2008, a seminal article reported on the adoption rate of outpatient EHRs. In this study a sample of 5000 physicians was selected from the AMA master file but Osteopaths, residents and federal physicians were excluded. The most significant finding was that only 4% of respondents reported using a comprehensive EHR (order entry capability and decision support), whereas 13% reported using a basic EHR system. As has been reported before, the adoption rate was higher for large medical groups or medical centers. Responding physicians did report multiple beneficial effects of using EHRs. Given the fact that most experts believe only comprehensive EHRs will impact patient safety and improve the quality of medical care, the 4% adoption rate was disturbing.[83] The 2009 National Ambulatory Medical Care Survey reported that 44% of respondents had a full or partial EHR (that could include paper and electronic) but only 20% had a basic system and 6% had a fully functioning EHR.[84] In summary, very few practices (particularly small rural primary care) have a comprehensive EHR with robust order entry, clinical decision support and reporting capability. With the federal EHR reimbursement program the adoption rate is clearly rising, so follow up studies are needed to determine current adoption rates.

Inpatient EHR Adoption

The American Hospital Association reported on the 2006 use of EHRs with more than 1,500 community hospitals responding. They noted that 68% of the hospitals surveyed had installed inpatient EHRs, but only

1% were fully implemented and these were mainly by large urban and/or teaching hospitals. In only 10% were physicians using computerized physician order entry (CPOE) to order medications, at least 50% of the time.[85]

In 2009 an article by the same authors of the ambulatory NEJM study cited above showed that 7.6% of the respondents reported a basic EHR system and only 1.5% reported a comprehensive EHR. Again, large urban and/or academic centers had the highest adoption rates. User satisfaction rates were not reported.[86]

HIMSS Analytics studies have looked at data from over 5,000 US hospitals to determine the actual level of EHR adoption in 2008, 2009 and 2010. The scale they used rated hospitals from 0, meaning hospitals with an EHR with no functionality installed, to seven indicating a fully functional paperless system that is interoperable and capable of advance reporting.[87] (see Table 3.3) The results indicate that very few hospital systems have achieved an advanced level of EHR sophistication.

One can only speculate why the medical profession has been willing to tolerate the lack of legible and accessible information for so many years. Many physicians believe that purchasing an EHR is not their responsibility and therefore someone else should pick up the tab. Others are concerned that they will purchase the wrong system and waste money and others are simply overwhelmed with the task of implementing and training for a completely different system. Physicians are not noted for embracing innovation but in their defense new technologies should be shown to improve patient care, save time or money in order to be accepted.

There are more than 300 EHR vendors but only about twenty seem to be consistently successful in terms of a large client base. If the selection and purchase of EHRs was easy they would already be universal. As the reader will see later in this chapter, there are issues such as workflow, implementation and training that are just as important as the decision which EHR to purchase.

Table 3.3: EHR adoption statistics by stage in US (Courtesy HIMSS Analytics)

Stage	Cumulative Capabilities	2008	2009	2010
7	Paperless system. Able to generate Continuity of Care Document (CCD). Data warehousing in use	0.3%	0.7%	0.8%
6	Physician documentation (structured templates), full clinical decision support systems (CDSS) and computerized physician order entry. Full picture archiving and communication systems (PACS)	0.5%	1.6%	2.6%
5	Closed loop medication administration	2.5%	3.8%	3.2%
4	CPOE and CDSS	2.5%	7.4%	9.7%
3	Clinical documentation (flow sheets), CDSS, PACS available outside radiology	35.7%	50.9%	50.2%
2	Clinical data repository (CDR), CDSS, document imaging	31.4%	16.9%	15.5%
1	Lab, radiology and pharmacy modules installed	11.5%	7.2%	6.8%
0	Lab, radiology and pharmacy modules not installed	15.6%	11.5%	11.2%

International EHR Adoption

Until recently, the US lagged behind many other developed countries in its adoption of EHRs. In fact, a 2006 study indicated that we were as much as a dozen years behind other industrialized countries in HIT adoption.[88] A 2008 study pointed out that the United Kingdom, Netherlands, Australia and New Zealand had nearly 100% adoption of ambulatory EHRs by primary care physicians (>90% each) while adoption amongst

US primary care physicians was in the 10% to 30% range. No country at that time had significant adoption of comprehensive in-patient EHRs, all being less than 10%.[89] A 2009 study showed that we continued to lag in EHR adoption among primary care physicians.[90]

A major difference between the US and these high EHR adopter countries has been, until recently, the degree of government involvement. Other countries' governments invested heavily in HIT. The United Kingdom, with 20% of the population of the US, committed $17 billion through its National Program for IT (NPfIT). Australia has provided subsidies to adopting physicians and has the National E-Health Transition Authority (NEHTA). Germany has a public-private partnership involved in promoting interoperability standards and certifying EHRs called Gematik. Denmark, long thought to be the international leader in health IT, has a very high EHR adoption rate and the most interoperable system of any country.[91]

All is not wonderful in other countries however. On Sept 23, 2011 UK officials announced that they planned to dismantle their $17 billion health IT project. They stated that some of the nearly $10 billion that they had invested to date was wasted and that their main vendor, Computer Sciences Corporation would not be able to provide the software that was promised.[92]

The HITECH Act of 2009, which created the EHR Incentives Programs in the US, may help us catch up. Since the advent of that program EHR adoption in the US appears to be increasing more rapidly. As of July 2011, 76% of large practices (26+ physicians), 72% of mid-large practices (11-25 physicians), 63% of mid-size practices (six to 10 physicians), 51% of smaller practices (three to five physicians), 42% of two-physician practices and 31% of solo physician practices have adopted EHRs with an overall adoption rate of 40%.[93]

Barriers to Electronic Health Record Adoption

Many of the same barriers to HIT adoption discussed in chapter 1 also pertain to EHR adoption. According to Shortliffe[94] there are four historic constraints to EHR adoption: (1) the need for standardized clinical terminology; (2) privacy, confidentiality and security concerns; (3) challenges to data entry by physicians and (4) difficulties with integrating with other systems. These and other barriers are discussed below.

Financial Barriers

Although there are models that suggest significant savings after the implementation of ambulatory EHRs, the reality is that it is expensive. Multiple surveys report lack of funding as the number one barrier to EHR adoption.[95] In a 2005 study published in *Health Affairs*, initial EHR costs averaged $44,000 (range $14-$63,000) per FTE (full time equivalent) and ongoing annual costs of $8,500 per FTE. These costs included the purchase of new hardware, etc. Financial benefits averaged about $33,000 per FTE provider per year. Importantly, more than half of the benefit derived was from improved coding.[96] This is not a surprise given the fact that studies have shown that physicians often *under-code* for fear of punishment or lack of understanding what it takes to code to a certain level.[97] A 2008 survey reported about one-third of physicians paid between $500-$3,000 per clinician, one-third paid between $3,001-$6,000 and about one-third paid more than $6,000.[98]

It is important to consider that integration with other disparate systems such as practice management systems can be very expensive and hard to factor into a cost-benefit analysis. The web-based application service provider (ASP) option is less expensive in the short term and perhaps in the long term, when you factor in the expenses to maintain and upgrade an office client-server network. According to many studies EHR adoption was far higher in large physician practices that could afford the initial high cost.[99]

Physician Resistance

Prior to EHR reimbursement lack of support by medical staff was consistently the second most commonly perceived obstacle to adoption.[100] Physicians have to be shown a new technology makes money, saves time or

is good for their patients. None of these can be proven for certain for every practice. Although you should not expect to go paperless from the beginning, at some point it can no longer be optional. It seems clear that CPOE does take longer than written orders but offers multiple advantages over paper as pointed out previously.[101] Implementation will not fix old work flow issues and will not work if several physicians in a group are opposed to going electronic. We now know that some practices have opted to change or discontinue their use of an EHR. A 2007 survey demonstrated fewer than 20% of respondents had uninstalled their EHR in an effort to step down to a less expensive alternative and 8% had returned to paper.[102] EHRs are not the only important issue for most physicians. They face increases in overhead while reimbursement wanes, along with ICD-10, HIPAA 5010, new healthcare reform and Red Flag rules, just to mention several looming challenges.

Loss of Productivity

It is likely physicians will have to work at reduced capacity for several months with gradual improvement depending on training, aptitude, etc. This is a period when physician champions can help maintain morale and momentum with a positive attitude.

Work Flow Changes

Everyone in the office will have to change the way they route information compared to the old paper system. If planning was well done in advance you should know how your work flow will change. As an example, many offices place the patients chart in the exam room door to indicate that the patient is ready to be seen. How will you do that with an electronic system? Initially, you will have to maintain a dual system of paper and electronic records. Work flow analysis will also determine where you will place computer terminals. Importantly, clinicians will have to maintain eye contact as often as possible and learn to incorporate the EHR into the average patient visit. Use of a movable monitor or tablet PC may help diminish the time the clinician spends not looking at the patient.

Usability Issues

Usability has been defined as the "effectiveness, efficiency and satisfaction with which specific users can achieve a specific set of tasks in a particular environment."[103] Is the software well organized and intuitive such that the user can find what they are looking for with a minimal number of mouse clicks? This is more complicated than what one would expect because there are multiple sub-specialties with unique needs, as well as multiple clinicians who are used to working in a set sequence. Based on several surveys included in this chapter, usability does not necessarily correlate with the amount of money paid for the software. HIMSS now has an EHR usability task force and it is predicted that eventually all certified EHRs will need to pass usability testing.[104]

Integration with Other Systems

Hopefully, integration with other systems like practice management software was already solved prior to implementation. Be prepared to pay significantly for programmers to integrate a new EHR with an old legacy system. An average cost is about $3-$15,000 per interface.[105] Most office and hospitals have multiple old legacy systems that do not talk to each other. Systems are often purchased from different vendors and written in different programming languages. If either the EHR or practice management system's software is upgraded, then interfaces need to be checked and possibly changed. It is now popular to purchase an EHR already integrated with practice management, billing and scheduling software programs.

Lack of Standards

Data standards and medical vocabularies are necessary for interoperability. The initial standards have been proposed by ONC and will be covered in more detail in another chapter. Reimbursement for Meaningful Use will mandate that EHRs demonstrate the ability to exchange information. Although we have numerous standards already accepted (separate chapter) they will likely need to be updated and new standards added based on use cases. Furthermore, computers are based on data and not information, as discussed in the chapter on healthcare data, information and knowledge.

Privacy Concerns

The HITECH Act of 2009 introduced a new certification process for EHRs sponsored by ONC, in addition to CCHIT certification. This new certification ensures that EHRs will be able to support Meaningful Use and that they also will be HIPAA compliant. ONC certification includes requirements on database encryption, encryption of transmitted data, authentication, data integrity, audit logs, automatic log off, emergency access, access control and accounting of HIPAA releases of information. The HITECH Act also strengthened the prior HIPAA requirements as they relate to EHRs, particularly in the areas of enforcement of HIPAA and notification of breaches. Both civil and criminal penalties for Business Associates (as well as covered entities) were introduced. Civil penalties in their harshest form can range up to 1.5 million dollars. If a data breach of PHI (Protected Health Information) occurs, all affected individuals must be notified. If more than 500 individuals are affected, HHS must be notified as well. Sale of PHI is prohibited.[106] Users of EHRs must:

- Use HIPAA compliant technology
- Provide for physical and software security of data systems
- Provide for physical and software security of their network(s) including mobile and remote computing
- Provide access control with defined user roles, passwords and user authentication and auditing
- Monitor and manage user behavior
- Have written security policies and procedures
- Have an effective disaster recovery plan[107]

EHRs pose new potential privacy and security threats for patient data, but with proper technology as well as proper health entity and user behavior, these risks can be mitigated. On the bright side, EHRs offer new safeguards unavailable in the paper record world, like audit trails, user authentication, and back-up copies of records. Further details are available in the chapters on privacy and security.

Legal Aspects

A 2010 Health Affairs article estimated that malpractice costs in the US are around 55 billion dollars annually (in 2008 dollars) or 2.4% of what we spend on health care.[108] Will EHRs increase or decrease that number? Unfortunately the answer isn't in yet. Arguments can be made for either outcome. On one hand, by increasing the quality of care, theoretically EHRs should reduce malpractice risk. Yet that assumes that quality and malpractice are related in a linear fashion, which may well not be the case. On the other hand, EHRs that are poorly designed, or that contain bugs, could promote inadvertent errors. This risk points to a need for monitoring and corrective action related to EHR- generated errors. The Office of the National Coordinator (ONC) for Health IT understands that a system of monitoring and corrective action for EHR-related errors needs to be implemented. ONC outlined its plans for this in a December 2010 statement.[109] As a first step, one can currently report EHR-generated errors to AHRQ-recognized Patient Safety Organizations like PDR Secure.[110]

Two important areas of potential risks and benefits include documentation of clinical findings and clinical decision support. One might expect that the more comprehensive documentation produced by EHRs will improve a physician's defense against malpractice. It certainly may. However the automated way that EHRs carry information forward from one note to the next can also promote errors and potential liability, if a piece of data is recorded incorrectly from the start yet never corrected. E-discovery laws now allow electronically stored data related to patient records to be considered discoverable for the purpose of malpractice, so the metadata and audit trails that supplement EHR documentation can be used both to defend and to impeach a physician in a malpractice case.[111] Will that be a net benefit or liability for physicians? Decision support alerts and guidelines embedded into EHRs could potentially provide a defense against malpractice claims if their advice is followed. But what if alerts or guidelines are overridden? There may be very appropriate reasons to do so, but will physicians be expected to document the reason for each and every alert they override? Will they run the risk of being penalized if they don't?

Improved access to information provided by health information exchanges (HIEs) should improve the coordination of care, the quality of medical information that is available, and thus the quality of medical decision making. But, will clinicians have a tendency to overlook key nuggets of clinical information simply because they are overwhelmed by the volume of information they receive? Will ready access to outside information on a patient make a physician more liable if he or she doesn't always actively search for every piece of potentially relevant information? In addition, user errors can arise as users climb a steep learning curve to become proficient with EHRs. Care especially needs to be taken particularly during the implementation of an EHR to guard against user error.

A study in Massachusetts in 2005 suggested that users of EHRs had fewer paid malpractice claims than non-users (6.1% versus 10.8%).[112] But when the study's results were risk-adjusted by physician demographics including age, specialty and practice size, the statistical difference in paid malpractice claims between the EHR and non-EHR users disappeared. Finally, as EHRs become the standard of care, will practicing without an EHR become a medicolegal liability? At this point in time it is still undetermined whether EHRs will significantly impact the incidence and expense of malpractice in a positive or a negative way.[113]

Inadequate Proof of Benefit

Successful implementation of HIT at a medical center with a long standing history of systemic IT support does not necessarily translate to another healthcare organization with less IT support and infrastructure. A systematic review by Chaudry is often cited as proof of the benefits of HIT, but in his conclusion he states "four benchmark institutions have demonstrated the efficacy of health information technologies in improving quality and efficiency. Whether and how other institutions can achieve similar benefits and at what costs, are unclear."[114]

There have been five recent articles in the medical literature that failed to demonstrate a significant impact of EHRs on medical quality in the US and in Europe.[115-119] A more positive study was published in 2011 of more than 25,000 diabetics in 46 practices that showed achievement of diabetic care was significantly better for practices with EHRs, compared to paper-based practices. They measured intermediate outcomes and not actual patient outcomes, so we don't know the impact on morbidity or mortality.[120]

Several studies have shown increased errors as a result of implementing CPOE[68,121-125] Weiner coined the term *e-iatrogenesis* to mean "patient harm caused at least in part by the application of health information technology."[126] In late 2011 AHRQ released the monograph "Guide to Reducing Unintended Consequences of Electronic Health Records."[127] Eventually, with better training or re-design some of the technology-related errors are likely to be overcome. More research is needed to obtain a balanced opinion of the impact of EHRs on quality of care, patient safety and productivity. Furthermore, we will need to study the impact on all healthcare workers and not just physicians.

The HITECH Act and EHR Reimbursement

Arguably, the most significant EHR-related initiative occurred in 2009 as part of the American Recovery and Reinvestment Act (ARRA). Two major parts of ARRA, Title IV and Title XIII are known as the Health Information Technology for Economic and Clinical Health or HITECH Act. Approximately $20-30 billion was dedicated for Medicare and Medicaid reimbursement for EHRs to clinicians and hospitals. In this chapter we will primarily focus on reimbursement to eligible professionals (EPs) and not hospitals or Medicare Advantage organizations, even though they are also potentially reimbursable. The Centers for Medicare and Medicaid Services (CMS) established a web site www.cms.gov/EHRIncentivePrograms to explain the EHR Incentive Program we will summarize in the following sections.

In order for clinicians to participate in this program they must be: (1) eligible, (2) register for reimbursement, (3) use a certified EHR, (4) demonstrate and prove Meaningful Use, and (5) receive reimbursement.

Eligible Professionals (EPs)

Medicare: Medicare defines EPs as doctors of medicine or osteopathy, doctors of dental surgery or dental medicine, doctors of podiatric medicine, doctors of optometry and chiropractors. Hospital-based physicians such as pathologists and emergency room physicians are not eligible for reimbursement. Hospital-based is defined as providing 90% or more of care in a hospital setting. The exception is if more than 50% of a physician's total patient encounters in a six-month period occur in a federally qualified health center or rural health clinic. Physicians may select reimbursement by Medicare or Medicaid, but not both. They cannot receive Medicare EHR reimbursement and federal reimbursement for e-prescribing. They can receive Medicare reimbursement as well as participate in the Physicians Quality Reporting Initiative (PQRI). If they participate in the Medicaid EHR incentive program they can participate in all three programs.

Medicaid: Medicaid EPs are defined as physicians, nurse practitioners, certified nurse midwives, dentists and physician assistants (physician assistants must provide services in a federally qualified health center or rural health clinic that is led by a physician assistant). Medicaid physicians must have at least 30% Medicaid volume (20% for pediatricians). If a clinician practices in a federally qualified health center (FQHC) or rural health clinic (RHC), 30% of patients must be *needy individuals*. The Medicaid program will be administered by the states and physicians can receive a one-time incentive payment for 85% of the allowable purchase and implementation cost of a certified EHR in the first year, even before Meaningful use is demonstrated.[128]

Registration: Registration began in January 2011. Medicare physicians must have a National Provider Identifier (NPI) and be enrolled in the CMS Provider Enrollment, Chain and Ownership System (PECOS) and National Plan and Provider Enumeration System (NPPES) to participate. Through the end of 2011, approximately 150,000 physicians and 2,800 hospitals have registered for reimbursement and 20,000 physicians and 1,200 hospitals have received reimbursement. Registration details for Medicare and Medicaid are available on the CMS web site.[128]

Certified EHRs: An EHR has to be certified by a recognized certifying organization in order for a physician or hospital to receive reimbursement. As of mid-2011 there are six organizations that can provide certification. The original certification organization CCHIT was discussed in chapter 1 and to date is the only certification organization to test and report usability. Standards and certification criteria are listed on the HHS site as are the currently certified EHRs. Users can view ambulatory and inpatient EHR categories and search by product name. The search should review who certified the EHR, whether it was for a complete or modular EHR and the EHR certification ID number they would need for reimbursement.[129] To date, 1,500 EHRs or EHR modules have received certification.

Meaningful Use (MU): The goals of MU are the same as the national goals for HIT: (a) improve quality, safety, efficiency and reduce health disparities; (b) engage patients and families; (c) improve care coordination; (d) ensure adequate privacy and security of personal health information; (e) improve population and public health. Three processes stressed by ARRA to accomplish this are: e-prescribing, health

information exchange and the production of quality reports. As planned, Meaningful Use will occur in three stages:

- Stage 1 (2011): Meaningful Use mandates a *core set* and a *menu set* of objectives. To be a Meaningful Use Stage 1 user, participants must meet all 15 of the core objectives (Appendix A, end of chapter) and select five out of 10 menu objectives (Appendix B, end of chapter). They must choose at least one population and public health measure. The appendices delineate criteria and measures for EPs, not hospitals. For each objective there are reporting measures that must be met to prove Meaningful use

  In 2011 the results of all objectives and measures, to include clinical quality measures will be reported by clinicians and hospitals to CMS and Medicaid clinicians will report to states by attestation. Quality measures are derived from the Physician Quality Reporting Initiative (PQRI) and the National Quality Forum (NQF). Each EP will submit information on three core quality measures in 2011 and 2012 (tobacco use, blood pressure measurement and adult weight screening). They must also choose three other measures that are ready for incorporation into EHRs. Medicare was ready for attestation in early 2011 but as of mid-2011 many states were not ready. Physicians will fill in numerators and denominators for Meaningful use objectives and indicate if the qualify for exclusions and attest that they have met Meaningful use. Details about Meaningful Use and attestation for Medicare and Medicaid are available on the CMS web site. As of October 2011, more than 100,000 clinicians and hospitals signed up for reimbursement. Those who attest in 2011 will not have to meet Stage 2 requirements until 2014.[128]

- Stage 2 and 3: The HIT Policy Committee has proposed MU objectives and measures, viewed at http://healthit.hhs.gov/media/faca/MU_RFC%20_2011-01-12_final.pdf. The proposed changes include increasing the percent compliance with Stage 1 objectives, moving several menu objectives to core and adding new objectives (e.g secure messaging). It is likely that the actual content and time line will change prior to implementation.

Reimbursement

Tables 3.4 and 3.5 list the Medicare and Medicaid reimbursement levels for EHRs. Payment is likely to occur 4-8 weeks after successful attestation. Payments will be held until the Medicare physician meets the $24,000 threshold for allowed charges. Medicare physicians may earn an additional 10% if they practice in a healthcare professional shortage area (HPSA). Payments are based on the calendar year. It is important to note that no monies are paid upfront and contrary to what is published by EHR vendors and others, the amount listed yearly in Table 3.2 is a maximum. Physicians will be reimbursed 75% of allowable Part B charges or up to, for example, $18,000 in the first year. Clinicians are paid in a single annual payment and have to demonstrate Meaningful Use for 90 days of continuous EHR use in the first year and the entire calendar year thereafter.

Medicare physicians who do not use a certified EHR nor demonstrate Meaningful Use will receive penalties of 1% in 2015, 2% in 2016 and 3% in 2017 when they bill Medicare. Penalties could reach 5% in 2018 and beyond if fewer than 75% of physicians are using EHRs at that point. In addition, late adoption might mean that more complex Meaningful Use (Stage 2 or 3) will be required, likely to make purchase and implementation more difficult.

Medicaid is administered by states and will use the same Meaningful Use criteria. In addition to the states being given the reimbursement money by the federal government to give to clinicians and hospitals, they will also receive 90% reimbursement for the cost of administering the program. Medicaid EPs and hospital-based physicians are not subject to possible payment reductions. Unlike Medicare, Medicaid physicians can be paid the first year just to adopt, implement or upgrade an EHR and not yet meaningfully use the EHR. Medicaid EPs must demonstrate Meaningful Use in years two through six. Medicaid physicians are not eligible for the

10% HPSA bonus but can receive the e-prescribing and PQRI bonuses. The last year to begin participation in the Medicaid program is 2016.

Hospitals can also be reimbursed for the purchase of EHRs and can share this technology with the known limits of the *Safe Harbor Act* discussed later in this chapter. Hospitals will start at a base of $2 million annually with decreasing amounts over five years, plus an additional amount dependent on patient volume. Hospitals may receive reimbursement from both Medicare and Medicaid.[128]

Table 3.4: Maximum *Medicare* reimbursement for EHR adoption

Year	2011 (year 1)	2012 (year 1)	2013 (year 1)	2014 (year 1)	2015 (year 1)
2011	$18,000				
2012	$12,000	$18,000			
2013	$8,000	$12,000	$15,000		
2014	$4,000	$8,000	$12,000	$12,000	
2015	$2,000	$4,000	$8,000	$8,000	$0
2016	$0	$2,000	$4,000	$4,000	$0
Total	$44,000	$44,000	$39,000	$24,000	$0

While a substantial number of physicians have stayed on the sidelines, many have taken advantage of the new programs. As of September 2011 about 80,000 physicians were registered for EHR reimbursement according to HHS Secretary Kathleen Sebelius.[130]

Table 3.5: Maximum *Medicaid* reimbursement for EHR adoption

Eligible Clinician	Base Year: Max 85% of EHR cost	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total
Physician	$21,250	$8,500	$8,500	$8,500	$8,500	$8,500	$8,500	$63,750
Dentist	$21,250	$8,500	$8,500	$8,500	$8,500	$8,500	$8,500	$63,750
Nurse mid-wife	$21,250	$8,500	$8,500	$8,500	$8,500	$8,500	$8,500	$63,750
Physician assistant	$21,250	$8,500	$8,500	$8,500	$8,500	$8,500	$8,500	$63,750
Nurse practitioner	$21,250	$8,500	$8,500	$8,500	$8,500	$8,500	$8,500	$63,750
Pediatrician	$14,167	$5,667	$5,667	$5,667	$5,667	$5,667	$5,667	$42,500

Electronic Health Record Examples

There are more than 300 EHRs available in the United States that vary in price from free to about $40,000 with features that range from basic to comprehensive. Importantly, not all have been certified for Meaningful Use. Also, very few EHR vendors have price transparency so only a minority actually post their charges on

their web sites. The EHR market has changed rapidly due to Meaningful Use requirements, in addition to advances in technology and user demands.

We will present examples of EHRs in three categories based on size and target audience. Small practice is defined by having one to four physicians and typically do best with subscription service (cloud computing, ASP model, SaaS) where they only need an internet connection. A medium medical practice is defined as having five to 20 physicians that might use a subscription service or have the client-server model with onsite servers which would normally mandate either onsite IT support or contract support services to manage the network. A large practice is defined as having 20 to 99 physicians and most likely will have onsite servers and their own IT staff. A very large practice is defined as having 100+ physicians and will typically utilize the client-server model with their own data center and IT staff as well as programmers and database administrators.

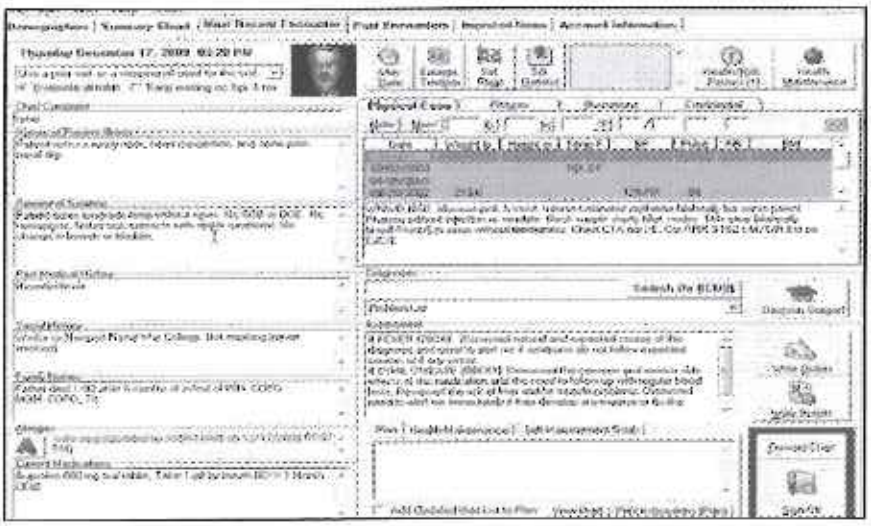
Small Medical Practice

Amazing Charts: This simple and intuitive EHR is ONC ATCB certified and has scored high in usability by multiple reviewers which we will discuss later in the chapter. They offer a three month free trial which is unique among vendors. Currently they claim more than 4000 users.

- Standard package: scheduling, internal secure messaging, charting (template driven), e-prescribing, billing (superbills) and ad hoc reporting are included
- Practice management: a practice management system or web-based model at this time
- Remote access: physicians can access their computers remotely with services such as LogMeIn and they can view but not modify records remotely using an iPhone app
- Pricing: the standard charge is $1,995 per physician (includes training and support for physician and staff) for first year, followed by $995 per physician per year after that for software updates and tech support. For a separate fee they offer offsite backup and a low cost ($500) interface to practice management systems.

Figure 3.5 shows a typical screen shot of a patient encounter from Amazing Charts.[31]

Figure 3.5: Amazing Charts patient encounter screen shot (Courtesy AmazingCharts)

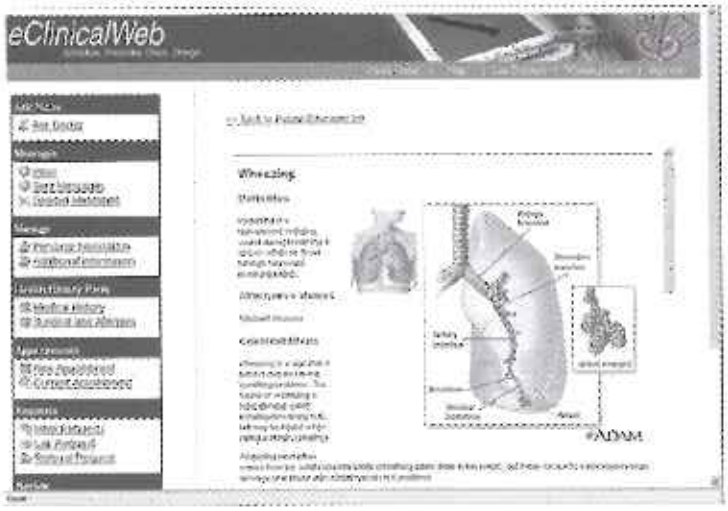


Medium Size Medical Practice

eClinicalWorks: This EHR was selected by the Massachusetts Medical Society because it is multi-featured and well designed with excellent physician acceptance. In 2011 they claimed 55,000 users and they have CCHIT 2011 certification. Their modules are fully integrated and not standalone. The system will operate on Windows or Linux-based servers and is compatible with SQL or MySQL databases. They offer both a web-based and client-server model. It is also one of the few that lists its pricing schedule on their web site. Current modules include:

- EMR module: multiple means of inputting data such as templates, handwriting recognition, voice recognition and free text; tab to access the resource UpToDate; Continuity of Care Record (electronic patient summary) available; patient/disease registries with customizable alerts; referral letters can be automatically generated; e-visit capability
- Practice management: scheduling, billing management, claims scrubbing, business analytics and reporting
- Patient portal: online registration, secure messaging, web consults, prescription refills, online appointing, view of billing statements, lab results, patient education, receive alerts and complete consent forms. (Figure 3.6)
- Clinical messenger: communication with patient via email, text messaging or Voice over IP (VoIP). Patients can confirm appointment with one phone key, receive (normal) lab results and receive individual or group alerts. This is a hosted eClinicalWorks function
- Interoperability: cEHX community health exchange can connect disparate offices, labs and hospitals. Provides master patient index, integration engine, push/pull capability and quality measure reporting and public health alerts
- Mobile: iPhones or BlackBerry smartphones applications to access EHR works are available

Figure 3.6: Patient portal module eClinicalWorks (Courtesy eClinicalWorks)



- Pricing:
  - Option 1 (client-server): EHR/PMS combined system is $10,000 for the first physician and $5,000 for the next physician. Maintenance and support (M&S) is additional. EHR only system is $7,500 for the first physician and $4,500 for the next physician. M&S is additional

- Option 2 (web-based): EHR/PMS combined system is $400 per physician per month that includes M&S. EHR only system is $250 per physician per month that includes M&S. Hosting by eClinicalWorks is another $100 per physician per month [32]

Large to Very Large Medical Practice

Epic: Epic is the most popular and highest rated EHR for large to very large healthcare organizations like Kaiser Permanente, Geisinger Clinic, Group Health Cooperative and the Cleveland Clinic. They offer an ambulatory EHR for medical practices and an inpatient EHR for hospitals or a system that will work for both. It is interesting that this very intuitive comprehensive EHR is based on early MUMPs programming that is also found in VistA the EHR used by the Veterans Health Administration. The following are their main services:

- EpicCare EHR: approximately 50% of clinicians are specialists so they offer 40 specialty modules that have specialty specific workflow, templates and order sets. Inpatient EHR modules include flow sheets, electronic medication administration record (eMAR), interdisciplinary care plans, hospital outpatient support, clinical pathways, ICU support, ED department, operating room integration, anesthesia and pathology integration, radiology and laboratory information system integration, health information management, nurse triage, home health integration, barcode administration, pharmacy integration and enterprise reporting
- Practice management: registration, scheduling, billing and call management
- Personal Health Record:
  - My Chart is an integrated personal health record (PHR) with the following services: view test results, view upcoming & past appointments, schedule appointments, pay bills securely, get automated health maintenance reminders, view problem-based education materials, request refills, send & receive secure messages with physicians, view a child's records and print growth charts and manage the care of elderly parents
  - Lucy is a standalone PHR not integrated with the EHR
- Information Exchange: EpicCare Link provides a secure web-based portal for read-only access to limited sections of the EHR to community physicians, in addition to secure messaging
- Physician Portal: Epic Web is a physician portal for remote access to the EHR
- Interoperability: Care Everywhere is an interoperability capability for disparate EHRs and can pull in data from Lucy
- Mobile: Epic Haiku is an iPhone app that provides authorized users of Epic's EHR with secure access to clinic schedules, hospital patient lists, health summaries, test results and notes. Haiku also supports dictation and access to inbox. [33]

Future Trends

One doesn't need a crystal ball to determine the direction that EHRs in the US will take over the next several years. The potent force shaping that direction will be the Meaningful Use (MU) criteria of the EHR Incentive Programs. The developer of these criteria is the Health Information Technology Policy Committee (HITPC), a Federal Advisory Committee that advises the Office of the National Coordinator (ONC) and the Department of Health and Human Services (HHS). So far those agencies have closely followed HITPC's recommendations, and it is likely that they will continue to do so in the future. ONC in turn is responsible for creating the EHR certification criteria that ensure that EHRs can perform to specifications that allow for Meaningful Use.

The Meaningful Use program is currently in its first stage (2011-2013), will start its second stage in 2014, and then move to its third stage in 2016. On June 16, 2011, HITPC formally made its recommendations for Stage 2 MU criteria to HHS via ONC. HHS is expected to follow these criteria, announcing its Proposed Notice of Rule Making on Stage 2 requirements in the fall of 2011, and to finalize those requirements in the summer of 2012.

So what direction is HITPC headed? HITPC has designed the MU criteria around five policy areas:

- Improving quality, safety, efficiency and reducing health disparities – goals set out by the Institute of Medicine (IOM)
- Engaging patients and families in their care – another IOM goal
- Improving care coordination
- Improving population and public health
- Ensuring adequate privacy and security protections for personal health information

The proposed Stage 2 criteria, and early suggestions about Stage 3 from HITPC, point to increased care coordination, increased reliance on electronic ordering, more patient portal use, and a greater focus on clinical measurements and quality reporting. Thus we can expect to see EHRs that have more sophisticated analytics, increased standardization, enhanced interoperability, and tight linkages with more sophisticated patient portals than now exist. A desired outcome is that data and information will no longer remain locked in the plethora of EHR silos built by physicians and hospitals, but will electronically flow from one to the other.[134, 135]

Beyond 2016, when the CMS EHR Incentives for the Medicare program end, the direction that EHRs will take is less clear. Experts suggest a number of trends, including an increased reliance on cloud computing,[136] large shared databases used for comparative effectiveness research[137, 138] increasing use of natural language processing[139] more pervasive use of telehealth (virtual visits and consultation),[140] improved clinical decision support, more use of patient registries built into EHR workflow,[141] and greater use and integration of wireless remote outpatient monitoring of patients.[142, 143]

Of course, down the road, one or more unforeseen health IT technologies breakthroughs could alter EHRs in ways that we can currently only barely imagine.

Key Points

- Electronic health records are central to creating health information organizations and a nationwide health information network
- The current paper-based system is fraught with multiple shortcomings
- It is likely that reimbursement for e-prescribing and electronic health records by the federal government will promote adoption
- In spite of the potential benefits of electronic health records, obstacles and controversies persist
- Clinical decision support are still in their infancy and will likely improve in the future with artificial intelligence
- Advance planning and training is mandatory for successful implementation of EHRs

Conclusion

In spite of the slow acceptance of EHRs by clinicians and healthcare organizations, they continue to proliferate and improve over time. Electronic health records have been transformational for large organizations like the VA, Kaiser-Permanente and the Cleveland Clinic, but the reality is that medicine in this country is mostly practiced by small medical groups, with limited finances and IT support. As a new trend, we are seeing outpatient clinicians opt to re-engineer their business model based on an EHR. Their goal is to reduce overhead by having fewer support staff and to concentrate on seeing fewer patients per day but with more time spent per patient. When this is combined with secure messaging, e-visits and e-prescribing the goal of the *e-office* is achievable.[144]

Buyers have a wide choice of features and cost to choose from. At this time cost is a major obstacle as well as the lack of high quality economic studies demonstrating reasonable return on investment. As more studies show cost savings, medical groups that have been sitting on the fence will make the financial commitment.

Without doubt, Medicare and Medicaid reimbursement for EHRs and e-prescribing is the most significant impetus to jump start EHR adoption we have seen. Preliminary studies have shown a significant increase in EHR adoption as a result of reimbursement programs. It is too early to know how well received Stage 1 Meaningful Use objectives and measures will be received, implemented and reported. For those practices that can afford and need complexity, multiple high-end vendors exist. For smaller, rural, primary care practices, simpler alternatives exist. It is also worth noting that purchasing EHRs is only one of multiple difficult challenges facing clinicians and their staff. According to a mid-2009 Medical Group Management Association (MGMA) survey implementing an EHR was ranked third in difficulty preceded by rising operating costs and maintaining clinician salaries in the face of decreasing reimbursement.[145]

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