CHAPTER

6

Electronic Health Records and Applications for Managing Patient Care

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In the future the electronic health record (EHR) will play a pivotal role in personalized medicine as a medium for data, information, and knowledge exchange and for exploration.

OBJECTIVES

At the completion of this chapter the reader will be prepared to:

1. Discuss terms and definitions associated with the electronic health record (EHR)
2. Describe the essential components and attributes of an EHR
3. Define Meaningful Use in the context of EHR adoption and the impact on health practitioners
4. Examine EHR applications used in the clinical setting
5. Analyze the benefits of an EHR related to cost, access, quality, safety, and effectiveness
6. Evaluate stakeholder perspectives and key issues that affect EHR adoption
7. Explore future directions for EHR adoption and integration

KEY TERMS

Ancillary system, 95
Bar Code Medication Administration (BCMA), 93
Clinical documentation, 94
Computerized provider order entry (CPOE), 92
Data integrity, 99
Disruptive technology, 100
Electronic health record (EHR), 88
Electronic medical record (EMR), 88
Electronic Medication Administration Record (eMAR), 93
Health Information Technology for Economic and Clinical Health (HITECH) Act, 90
Niche applications, 95
Radio frequency identification (RFID), 94
Stakeholders, 97

ABSTRACT

Over the past decades the electronic health record (EHR) is one of the most significant innovations introduced in healthcare. Today almost all healthcare providers are using automation in the sharing of patient data and information across facilities locally, nationally, and perhaps internationally. Although there is concern about how to establish a nationwide interoperable system and many issues still need to be resolved related to EHR implementation and adoption, the long-term benefits to organizations, healthcare providers, and patients and consumers cannot be ignored. This chapter explores the evolving nature of the EHR along with essential components and functions, how these components are used in the clinical setting, and benefits related to cost, access, quality, safety, and efficiency of care. A discussion of key issues that influence the implementation and adoption of these systems and future directions concludes this chapter.

INTRODUCTION

The complex nature of the current U.S. healthcare system has created a challenging environment for managing patient data

and information. Traditional paper systems can be easier to use for documenting a single episode of care but access to these records is limited, reporting is extremely cumbersome, and trending of data across patient visits or types is nearly impossible. Provider specialty practices create treatment silos that often hinder continuity of care. Healthcare providers and hospitals endeavor to keep current with billing regulations to receive optimal reimbursement. This requires vigilant monitoring of private insurance contracts and changes in governmental mandates. Some clinicians find it difficult to maintain competencies and gain access to information about the latest medical techniques and research. Add to this the introduction of personal computers, mobile devices, and the Internet, which have boosted consumer demands and a variety of healthcare delivery concerns.

The robust nature of the EHR has the potential to address many of these issues and transform the way we collect, store, access, process, manage, and report patient data. Government initiatives and financial incentives are being offered to expedite the implementation and expansion of EHR systems. However, despite all of the attention on this technology, there are still different views on what an EHR is, what it does or should do, and how it should be used.

Early Terms and Definitions

Multiple labels and definitions have been used throughout the years to refer to electronic systems used in healthcare. Early terms focused on using the words *computer* and *record* to merge the idea of a paper chart with technology, but computers provided much more functionality than traditional methods. These early terms were not sufficient to describe this emerging phenomenon. Specific early terms and acronyms such as computer patient records (CPRs), computer-based patient records (CBPRs), and computer health records (CHRs) were used to identify systems that contained select automated components of the patient's medical record. The acronym CPR was not popular in the health community since it also represents the term *cardiopulmonary resuscitation*. Generic names like hospital information system (HIS) or medical information system (MIS) were adopted to represent the management of a larger body of data and information throughout a specific hospital or healthcare system.

Later definitions for electronic systems in healthcare often focused on the system's distinctive purpose, content, ownership, and functional differences. This is especially true for technology used in specialty areas such as nursing, pharmacy, laboratory, radiology, and other support departments. For example, a laboratory information system (LIS) would be used to collect, store, process, and manage laboratory data and would be controlled by the laboratory department personnel whereas a pharmacy system would provide medication inventory, control, and dispensing for pharmacy personnel. Specific clinical departmental systems will be discussed in more detail later in the chapter. Terms such as CBPR or CPR referred to a larger collection of information about the patient, such as orders, medications, treatments, laboratory and diagnostic test results, and other information related to overall patient care. Although the terms imply a patient-owned record, access and input to the record were typically controlled by the healthcare provider. As computer technology continued to progress and more functionality became available, a need surfaced for clarity and refinement in terms and definitions relating to EHR systems.

Electronic Medical Record (EMR) versus Electronic Health Record (EHR)

More recently, terms such as **electronic medical record (EMR)** and **electronic health record (EHR)** have emerged. These are often used interchangeably but it is important to understand the differences between them. Sewell and Thede defined the EMR as "an electronic version of the traditional record used by the healthcare provider."[1(p320)] Hebda and Czar described an EMR as an electronic information resource used in healthcare to capture patient data.[2] In essence, an EMR can be viewed as the electronic version of a patient's paper chart. The EMR is what most clinicians think of as the automated medical record system used in the clinical setting and it represents an episodic view of patient encounters. This type of system, seen in hospitals, hospital corporations, and clinician practices, is predominately controlled by the healthcare provider. The EMR is not just one system but may include interfaces with multiple other systems and applications used by the facility such as registration, patient scheduling, order entry, clinical documentation, radiology, laboratory, and other departmental systems. The patient usually does not interact with or provide input to the EMR, although some software vendors are working to incorporate portals that provide patient access to test results, scheduling features, email interaction with clinicians, and the ability to add and update health information.

How is this different from an EHR? In 2008 the National Alliance for Health Information Technology, as a division of the U.S. Department of Health & Human Services (HHS), convened to clarify and define key health information technology (health IT) terms. The EHR was defined as "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 health care organization."[3] This suggests the availability and use of communication standards, such as nomenclatures, vocabularies, and coding structures, in order to share patient data across multiple organizations.[4] It also implies data sharing across multiple facilities. In comparison, the EMR is limited to information exchange within a single organization or practice whereas the EHR has the ability to exchange information outside the healthcare delivery system.[5]

The Healthcare Information and Management Systems Society (HIMSS) provides a similar definition of the EHR as a longitudinal electronic record of patient health information produced by encounters in one or more care settings.[6] The implication is that every person will have a birth to death (and even prenatal and postmortem) record of health-related information in electronic form from multiple sources, such

as physician office visits, inpatient and outpatient hospital encounters, medications, allergies, and other medical services to support care. This means that components of the EMR would ultimately be part of the EHR. Other definitions stress the importance of the EHR as a way to automate and streamline workflow for healthcare providers, support patient care activities, and provide decision support, quality management, and outcomes reporting.[7–11] Despite the clarification provided by these definitions, many are still using the terms EMR and EHR interchangeably. Also, these definitions are often directed toward the needs of the healthcare provider and lack reference to patient and consumer interaction or integration of personal health records.

At this point it is important to mention the personal health record (PHR) as a component of the EHR. This type of record is primarily patient or consumer controlled and is discussed in more detail in Chapter 15. The ultimate goal is that PHR development conform to nationally recognized standards and be integrated into larger systems allowing the individual to view, manage, and share personal health information with providers. As part of the EHR, this could provide a more comprehensive record of a person's medical history and overall health.

In summary, EHR has become the preferred term for the lifetime patient record that would include data from a variety of healthcare specialties and provide interactive access and input by the patient. The term EHR is distinct in meaning from the term EMR. As with other expressions in the past, the term EMR may eventually fade away. Although some disagreement exists on exactly what the terms EHR and EMR mean or how an interoperable lifetime patient record will work, the EHR is clearly a complex tool that will continue to grow and evolve.[12]

EHR COMPONENTS, FUNCTIONS, AND ATTRIBUTES

Present-day electronic systems in most organizations typically include patient demographics, financial data, order information, laboratory and diagnostic test results, medications and allergies, problem lists, and clinical documentation. Beyond these basic features, an EHR should also incorporate clinical events monitors, preventive care recommendations, and decision support tools that enhance the efficiency and effectiveness of patient care.

In 2003 the HHS formed a group called the EHR Collaborative to support rapid adoption and to develop standards for EHR design in preparation for this initiative.[13] This group included sponsors from the following organizations:

- American Health Information Management Association (AHIMA)
- American Medical Association (AMA)
- American Nurses Association (ANA)
- American Medical Informatics Association (AMIA)
- College of Healthcare Information Management Executives (CHIME)
- eHealth Initiative (eHI)
- Healthcare Information and Management Systems Society (HIMSS)
- National Alliance for Health Information Technology (NAHIT)

The EHR Collaborative held forums and gathered input from stakeholder communities such as healthcare providers, insurance companies, IT vendors, researchers, pharmacists, public health organizations, and consumers. EHR Collaborative organizations, along with the IOM and Health Level Seven (HL7), were tasked to design a standard for EHRs. As a result the IOM released a report on July 31, 2003, called *Key Capabilities of an Electronic Health Record System.*[14] This report identified eight essential care delivery components for an EHR, with an emphasis on functions that promote patient safety, quality, and efficiency. More recently the U.S. Department of Defense added dentistry and optometry records as EHR components needed to provide a more comprehensive picture of overall health status.[15] See Table 6-1 for a list of essential EHR components and their descriptions. Each component of an EHR incorporates unique functions and attributes that contribute to the integration of a comprehensive patient record.

In addition to the various components and functions, there are 12 key attributes prescribed by the IOM[14] as the gold standard components of an EHR. These attributes serve as guidelines to organizations and vendors involved in the design and implementation of EHRs and include the information shown in Box 6-1.

SOCIOTECHNICAL PERSPECTIVES

Since the late 1990s, the design, implementation, and adoption of EHR systems has received a great deal of attention as a method to reduce medical errors, increase patient safety, and improve the quality of care.[16–18] The underlying assumption is that an EHR will save time, provide real-time access to patient information at the point of care, facilitate the work of the clinician, provide decision support capabilities, support clinical care and research, and improve quality and safety of care.[9,19–22] This section explores factors that influence EHR adoption, Meaningful Use, and the health practitioner's role in EHR adoption.

EHR Adoption

As discussed in Chapter 24, a presidential executive order in 2004 called for widespread adoption of interoperable EHRs. More recent regulation also guides EHRs in the United States. Numerous strategies and incentives are being used to expedite implementation, adoption, and meaningful use of EHR systems.

Meaningful Use

National mandates and guidelines from collaborative working groups were not enough to accelerate the development and adoption of health IT. In 2009 the American Recovery and Reinvestment Act (ARRA) was passed and included a critical

TABLE 6-1 SUMMARY OF THE EHR ESSENTIAL COMPONENTS AND FUNCTIONS FOR CARE DELIVERY

COMPONENT	ESSENTIAL FUNCTIONS	APPLICATION EXAMPLES
Administrative processes	Ability to conduct all financial and administrative functions associated with institutional operations and patient management.	Admissions/registration Scheduling Claims processing Administrative reporting
Communication and connectivity	Provides a medium for electronic communication between healthcare providers and patients.	Email Text/web messaging Integrated health records Telemedicine
Decision support	Provides reminders, alerts, and resource links to improve the diagnosis and care of the patient.	Medication dosing, allergies Risk screening/prevention Clinical guidelines Resource links
Dentistry and optometry	Ability to incorporate dental records and vision prescriptions.	Dental records Vision records
Health information and data	Ability to enter and access key information needed to make clinical decisions.	Patient demographics Problem lists Medical/nursing diagnoses Medications/allergies Results reporting
Order entry management	Ability to enter all types of orders via the computer system.	Laboratory Pharmacy Radiology Other orders
Patient support	Provides patient education and self-monitoring tools.	Discharge instructions Computer-based learning Telemonitoring
Results management	Provides the ability to manage current and historical information related to all types of diagnostic reports.	Laboratory tests Radiology reports Other procedures
Population health management	Provides data collection tools to support public and private reporting requirements.	Public health system Disease surveillance Bioterrorism

Adapted from Institute of Medicine, Committee on Data Standards for Patient Safety: Board of Health Care Services. *Key Capabilities of an Electronic Health Record System: Letter Report*. Washington, DC: The National Academies Press; 2003.
EHR, Electronic health record.

component addressing healthcare technology called the **Health Information Technology for Economic and Clinical Health (HITECH) Act**. The HITECH Act authorized programs designed to improve healthcare quality, safety, and efficiency using HIT.[23] More details about the HITECH Act and Meaningful Use criteria can be found in Chapters 24 and 25. Of importance to this chapter, the provision was targeted to stimulate the adoption of EHRs and the development of secure health information exchange (HIE) networks. It includes incentives for healthcare providers (primarily physicians) through Meaningful Use of certified EHRs. The purpose of Meaningful Use is more than just to implement an EHR but also to leverage the technology to improve quality, safety, and efficiency in patient care. Meaningful Use objectives are being implemented in several stages. The first stage focuses on electronic data capture and tracking, coordination of care, and sharing of health information.[24,25] Box 6-2 summarizes core and optional Meaningful Use objectives for Stage 1.

Requirements for Stage 2 Meaningful Use were released by the Federal Register in August 2012, with reporting to begin as early as fiscal year 2014. The focus of this stage is to encourage patient engagement and the robust use of health IT through continuous quality improvement efforts, HIE networks, and structured data capture. Similar to Stage 1, healthcare providers and hospitals will need to address a set of 17 core and 3 of 6 optional Meaningful Use objectives. In a broader sense, the expectation for Stage 2 involves expanded EHR functionality to support quality improvement, patient safety, structured information exchange, population health, and research.[26] Stage 3 criteria will expand on the objectives for the first two stages to further support quality initiatives;

BOX 6-1 THE INSTITUTE OF MEDICINE'S KEY ATTRIBUTES OF AN ELECTRONIC HEALTH RECORD (EHR)

1. Provides active and inactive problem lists for each encounter that link to orders and results; meets documentation and coding standards
2. Incorporates accepted measures to support health status and functional levels
3. Ability to document clinical decision information; automates, tracks and shares clinical decision process/rationale with other caregivers
4. Provides longitudinal and timely linkages with other pertinent records
5. Guarantees confidentiality, privacy and audit trails
6. Provides continuous authorized user access
7. Supports simultaneous user views
8. Access to local and remote information
9. Facilitates clinical problem solving
10. Supports direct entry by physicians
11. Cost measuring/quality assurance
12. Supports existing/evolving clinical specialty needs

Adapted from Institute of Medicine, Committee on Data Standards for Patient Safety: Board of Health Care Services. *Key Capabilities of an Electronic Health Record System: Letter Report*. Washington, DC: The National Academies Press; 2003.

improve safety, efficiency, and patient outcomes; address population health requirements; provide enhanced decision support; and promote patient-centered HIE.

EMR Adoption Model

In 2005 the HIMSS Analytics group developed an EMR Adoption Model to track the progress of HIT adoption rates in hospitals and, more recently, ambulatory facilities.[27] The systems and functions required for each stage for U.S. hospitals are shown in Table 6-2. Although originally developed for the United States, the EMR Adoption Model is also being used in Europe and Canada.[28,29] This model provides realistic and achievable measures in seven stages that coincide with Meaningful Use requirements. The model assists organizations by providing a sequenced implementation structure for IT adoption to align with business strategies, benchmarking data to compare progress with other facilities, and an approach that maps to Meaningful Use objectives. EMR Adoption Models for physician practice and ambulatory facilities are similar, with modifications specific to those settings.

Health Practitioner Role in EHR Adoption and Meaningful Use

Although early incentives are directed toward hospitals, clinics, and physician practice, all health practitioners will be

BOX 6-2 STAGE 1: MEANINGFUL USE OBJECTIVES

CORE SET OF MEANINGFUL USE OBJECTIVES

1. Use of Computerized Provider Order Entry (CPOE) for medication orders by licensed prescriber
2. Implement drug–drug, drug–allergy checks
3. Transmit prescriptions electronically
4. Record patient demographic information
5. Maintain current problem and diagnoses list
6. Maintain active medication and medication allergy list
7. Record and chart changes in vital signs
8. Record smoking status (13 years or older)
9. Implement one clinical decision support rule related to specialty
10. Report clinical quality measures to CMS or State (where appropriate)
11. Provide electronic summary of care when patient transitions to another setting or care provider
12. Provide patients with an electronic copy of health information upon request
13. Provide patients with electronic copy of discharge instructions or summaries of office visits
14. Protect electronic health information using appropriate technical capabilities.

OPTIONAL OBJECTIVES (5 OF 10 REQUIRED)

1. Incorporate clinical lab test results as structured data
2. Implement drug formulary checks
3. Support medication reconciliation
4. Record advance directives (65 years or older)
5. Provide patient-specific education resources
6. Generate summary of care records for transition of care or referral to another provider
7. Submit electronic data to immunization registries
8. Submit syndromic surveillance data to public health agencies
9. Provide patients electronic access to health information
10. Generate lists with patient conditions for quality improvement, reduction of disparities, research or outreach

From U.S. Department of Health and Human Services, Centers for Medicare & Medicaid Services Medicare and Medicaid Programs. Electronic Health Record Incentive Program final rule. *Federal Register.* 2010;75(144):44313-44588. http://edocket.acess.gpo.gov/2010/pdf/2010-17207.pdf.
CMS, Centers for Medicare & Medicaid Services.

TABLE 6-2 HIMSS ANALYTICS UNITED STATES EMR ADOPTION MODEL 2005-2012

STAGE	CUMULATIVE CAPABILITIES
Stage 7	Complete Electronic Medical Record (electronic); CCD transactions to share data; Data warehousing in use; Data continuity with Emergency Department, Ambulatory, Outpatient
Stage 6	Physician documentation (structured templates); Full CDSS (variance & compliance); Full Radiology-Picture Archiving and Communication System (PACS)
Stage 5	Closed-loop medication administration
Stage 4	Computerized Provider Order Entry (CPOE); CDS System (clinical protocols)
Stage 3	Clinical documentation (flow sheets); CDS system (error checking); Picture Archiving and Communication System (PACS) available outside Radiology
Stage 2	Clinical Data Repository (CDR); Controlled Medical Vocabulary Clinical Decision Support (CDS) System; May have Document Imaging; Health information exchange
Stage 1	Ancillaries—Lab, Radiology, Pharmacy – All installed
Stage 0	All Three Ancillaries Not Installed

Adapted from Healthcare Information and Management Systems Society (HIMSS). EHR: Electronic health record. HIMSS. http://www.himssanalytics.org/stagesGraph.asp.
CCD, Continuity of Care Document; *CDS*, clinical decision support; *EMR*, electronic medical record; *HIMSS*, Healthcare Information and Management Systems Society.

integral to the collection of Meaningful Use data through the use of EHR technology.[30] For example, nursing care is a primary reason for hospitalization so nurses' roles in addressing the Meaningful Use objectives should not be underestimated. Nurses are the single largest group of employees in the hospital setting, where labor costs are often bundled with room and supply fees.[31] With the threat of a nursing shortage, executives are pressured to find ways to increase productivity while they struggle to recruit and retain qualified healthcare personnel. The adoption of an EHR system can enhance access to patient information, provide more accurate and complete documentation, improve data availability, and provide decision support capabilities often leading to increased staff productivity and satisfaction.[2,21,32] Many health practitioners are involved in providing care coordination and patient education, key objectives of the Meaningful Use requirements. Health practitioners assist in designing clinical decision support (CDS) systems that can be used to enhance patient adherence to disease management. Other activities include developing data set standards to improve outcomes, increase patient safety, and evaluate quality of care. Many are engaged in local, regional, and national strategic initiatives to improve care coordination using EHRs and an HIE.[25,33,34] How the HITECH Act will affect the role of each group of health professionals in the future is yet to be determined. What is clear is that patient care should be a collaborative effort guided by interdisciplinary teams that work together with the patient to provide the best possible outcomes. A typical EHR is designed to allow access and input by a variety of healthcare providers as a way to manage this care. In the same way, fulfillment of the Meaningful Use objectives requires active involvement and contributions from multiple disciplines in order to produce high-quality patient outcomes.

EHR APPLICATIONS USED IN THE CLINICAL SETTING

An EHR is composed of multiple applications and in different settings may differ in terms of integration between the components, data presentation, usability, and clinical workflow. This section discusses the various applications currently used in the clinical setting, including computerized provider order entry (CPOE), Electronic Medication Administration Record (eMAR), Bar Code Medication Administration (BCMA), clinical documentation, specialty applications, and clinical decision support (CDS).

Computerized Provider Order Entry (CPOE)

Computerized provider order entry (CPOE) is a component of the larger EHR system. The "P" in CPOE originally stood for "physician" but since advanced practice registered nurses, physician assistants, and other healthcare providers also write orders, this "P" has changed to "prescriber," "practitioner," or "provider." CPOE is software designed to allow clinicians to enter a variety of orders, such as medications, dietary services, consults, admission and discharge orders, nursing orders, lab requisitions, and other diagnostic tests, via a computer.

For many years handwritten orders were interpreted and entered into the computer system by unit secretaries, nurses, and pharmacists. Transcription errors such as a misplaced decimal point and illegible handwriting were major causes of error. Incomplete orders were a problem that caused additional steps in the nursing workflow. The idea behind CPOE was for prescribers, such as physicians, dentists, osteopathic doctors, anesthesiologists, nurse practitioners, and physician assistants, to enter orders directly into the computer. During the ordering process, alerts, such as drug allergy warnings, and other decision support rules should be available to assist the healthcare provider. Once an order is entered, the CPOE system interfaces or integrates with other EHR components, such as a laboratory or pharmacy system, to process the order. In fact, the term *order entry* can be misleading, as CPOE is truly an orders management system that allows orders to be entered, processed, tracked, updated, and completed.

The 1999 IOM report *To Err Is Human: Building a Safer Health System*[18] and demands from special interest groups put pressure on physicians and other prescribers to enter their orders directly into EHRs. Financial incentives offered

through the HITECH Act and Stages 1 and 2 Meaningful Use objectives were designed to enforce the use of some aspects of CPOE and systematic adoption of EHR functionality. The mandate for EHR adoption, and specifically CPOE, as a means of reducing medical errors continues to receive a lot of attention.[17,18,35] Studies have consistently demonstrated the benefits of CPOE on reducing medication errors. Early landmark studies found that the implementation of CPOE decreased the length of hospital stay, lowered costs, improved quality of care, improved the appropriateness of drug dosing, and decreased the number of allergic reactions.[35–38] Mekhjian et al.[39] conducted a pre- and post-CPOE implementation comparison study at a large university medical center and found significant reductions in transcription errors, faster medication turnaround times, and timely reporting of results. Bates et al.[40] went further by evaluating the impact of CPOE with decision support tools on different types of medication errors and reported a significant reduction in overall errors. Other studies that focused on CPOE implementation suggest that medical and medication errors can be reduced along with improving data integrity, accuracy, workflow, and patient outcomes.[41–44] In essence, CPOE combined with clinical decision support capabilities such as checking for drug interactions, drug–allergy interactions, and dosing ranges can significantly reduce many serious medication errors.[45]

Physician resistance, financial constraints, and other issues make CPOE compliance challenging. In a landmark study, Ash, Berg, and Coiera[17] identified unintended consequences of CPOE that lead to medical errors related to (1) the process of entering and retrieving information and (2) methods of communication and coordination. Koppel et al.[46] also researched CPOE-related factors that may increase the risk of medication errors and found that new errors were reported because of fragmented data and processes, lack of integration among systems, and human–computer interaction issues.

Using CPOE can be time consuming during order entry, and design efficiencies are needed to entice clinicians to enter their own orders. For example, prior to CPOE many providers used standard handwritten order sheets for their patient population. Order sets were developed to include all or most of the information required to process multiple orders at one time. In a study comparing the use of traditional order entry methods and standardized order sets, researchers reported the potential to reduce errors, decrease order entry time, and eliminate variations in order presentation.[47]

The lack of decision support or overuse of alerts was another issue. Payne et al.[48] found that in 42,641 orders generated there was an 88% override rate for critical drug interaction alerts and a 69% override rate for drug–allergy interaction alerts among ordering practitioners. This prompted concern that too many alerts could cause the ordering healthcare provider to become immune to the warnings and ignore them. Recommendations to address unintended consequences, user resistance, and discussion support issues focused on providing education to healthcare providers and consumers, designing systems that support communication and clinical workflow, early user participation in the implementation process, continuous safety monitoring, and the use of qualitative multidisciplinary research methods to provide deeper insight into the benefits and issues surrounding CPOE and EHRs generally.[49,50]

Electronic Medication Administration Record (eMAR)

The **Electronic Medication Administration Record (eMAR)** provides a medium to view and document medication use for individual patients. This system takes the place of using medication cards or a Kardex. When medication orders are entered into the CPOE system, this information is sent to the pharmacy system for verification and dispensing by the pharmacist. New orders appear on the patient's medication list in the eMAR and include information about the drug name, administration time, dose, and route. Usually the eMAR contains all types of medication and intravenous fluid orders, with the ability to sort the list in a variety of ways. For example, users can display scheduled, as needed (prn), pending, past due, or completed medications and can query the list for specific entries. Some systems will color-code medication order types for quick sorting and identification. Efforts to decrease medication administration errors use an eMAR in combination with bar-coding devices. An example of an eMAR screen is shown in Figure 6-1.

Bar Code Medication Administration (BCMA)

Bar Code Medication Administration (BCMA) is a method used to address patient safety and reduce errors that occur during the actual administration of medicines. This system is most effective when combined with CPOE, a pharmacy dispensing system, and the eMAR. Although CPOE has been successful in reducing transcription-related medication errors, it was not designed to prevent errors that may occur during the actual dispensing of a drug to the patient. In 2004 the U.S. Food and Drug Administration (FDA) indicated that the use of BCMA had the potential to reduce medication errors and recommended that bar-coding become standard on patient identification bands and medication labels.[51] Bar codes can then be read by optical scanners or bar code readers. The research findings in the area of BCMA support its advantages. Poon et al.[52] conducted a before and after, quasi-experimental study to evaluate the effectiveness of BCMA and eMARs. They reported a significant reduction in medication error rates as well as avoidance of numerous potential adverse drug events. Other studies report similar results and found that BCMA was easy to use, saved time, and improved medication documentation.[53–56]

The medication administration process with BCMA in the clinical setting starts with the nurse scanning his or her badge, the patient's wristband bar code, and the medication bar code. The scanner verifies the five "rights" of medication administration—right patient, right drug, right dose, right time, and right route—and documents the actual administration in the eMAR. **Radio frequency identification (RFID)** is also being used for medication administration. This

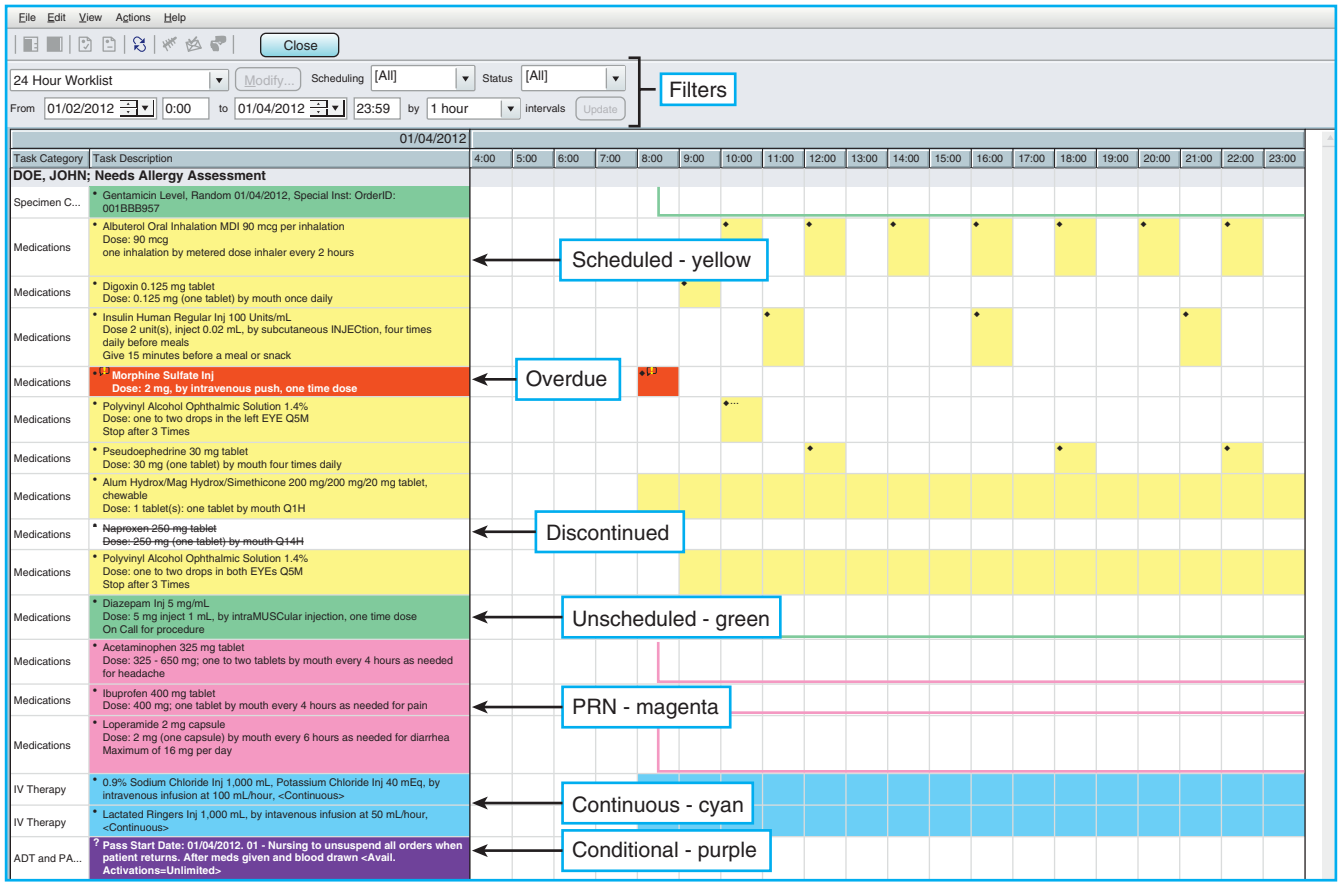

FIG 6-1 Example of an Electronic Medication Administration Record (eMAR). (Copyright 2012 Allscripts. Used with permission.)

technology uses electronic tags embedded in an identification badge or band to track and monitor activities. Passive RFID works in a similar way to regular bar-coding with the use of a scanner. Active RFID does not require a scanner; rather, it automatically transmits signals to a computer or wireless device without disturbing the patient. This technology is becoming more common in hospitals to track patient care activities, including medication dispensing and administration.[57]

Clinical Documentation

Clinical documentation software provides a medium for recording, managing, and reporting patient care activities by a variety of disciplines. The format for documenting may differ by application and organizational preference. Although many clinicians still embrace the richness of narrative notes, advantages exist to using standardized vocabularies and taxonomies for documenting patient care, as discussed in detail in Chapter 22. Structured notes using standardized language may come in the form of pull-down menus, decision trees, or key words embedded in a sentence. Some systems contain functionality to store and retrieve predefined notes of normal findings. Some organizations may use "charting by exception" wherein normal values and entries are predefined and selected according to established guidelines so clinicians need to document only abnormal findings.

Clinical documentation systems should have functionality to support workflow processes and the creation of plans of care. Often electronic flow sheets or grids are used to record vital signs and other procedures quickly. An effective documentation system includes decision support rules that alert the clinician about abnormal values, missing content, or additional assessments that are needed. Rules can also be written to remind healthcare providers to verify essential information (e.g., new orders or allergies). Many systems provide the ability to graph numeric data, such as vital signs and lab values. Problem lists, allergies, medications, and other critical information about a patient can be extracted and displayed on a single summary screen to assist the busy clinician. Depending on the type of data collected, various clinical, administrative, and research reports can be generated.

Overall, clinical documentation systems should support better communication between healthcare providers, promote professional accountability, and streamline workflow. Access to literature sources, policies and procedures, clinical guidelines, and standards of care can be functionally incorporated to support evidence-based practice (EBP) through the use of

applications such as Infobuttons or the EBP InfoBot (discussed under Clinical Decision Support below). Additional information about EBP is included in Chapter 3. Electronic documentation makes it easier to search, query, and extract data for reports. This information can be used for quality improvement initiatives, critical incident reviews, resource management, long-term planning, and research and to address the requirements of the accreditation process.

Specialty Applications

Many of the basic EHR components such as CPOE, eMAR, and clinical documentation are available to all healthcare providers, but sometimes there is a need for unique functionality beyond what is provided in these applications. Specialty or **niche applications** are software programs created to address the requirements of specific departments and groups of users. Although many niche applications can function as standalone systems, integration with or interface to the hospital-wide EHR is preferred in order to decrease redundancy, enhance communication, and provide a more comprehensive patient record. Some examples of specialty department systems include perioperative or surgical services, maternity care, neonatal intensive care, and the emergency department (ED).

A surgical information system (SIS) incorporates functionality to improve clinical, operational, and financial outcomes throughout the entire perioperative experience. Functionality may include operating room scheduling; management of equipment, supplies, and inventory; documentation for nurses and anesthesiologists; patient and specimen tracking; and administrative reporting capabilities.

A maternity care information system (MCIS) is another type of niche system used to address the needs of obstetrics staff. An MCIS is used to support clinical protocols for maternity care, track mother and baby progress, capture fetal-uterine monitoring data, and record results of Doppler blood flow and other diagnostic tests. Key features of this system include electronic forms for documenting and reporting all aspects of antenatal, intrapartum, and postnatal care as well as normal, healthy, or adverse pregnancy outcomes. Likewise, a neonatal information system (NIS) that interfaces with the EHR would contain much of the same information found in the primary system. Unique to an NIS would be growth charts, nutritional calculations, monitor parameters, and coding structures specific to the needs of critically ill newborns. Clinical staff in these specialty units can benefit from user-defined logbooks, resource utilization, quality improvement, and statistical reports designed for their specific needs.

The ED has unique computer needs related to clinical workflow, documentation of triage and patient encounters, tracking of patient location and treatment progress, charge capture and reimbursement management, clinical rules for risk mitigation, and patient education and referral. Once again, not unlike other niche systems, the emergency department information system (EDIS) is designed to improve clinical, operational, and financial outcomes throughout the entire ED experience. However, EDISs are often integrated into a facility's EHR since EDs are the portal into acute care; these integrated data are then readily available to acute care providers and areas.

Clinical Decision Support (CDS)

Clinical decision support (CDS) systems are tools and applications that assist the healthcare provider with some aspect of decision making. These applications are discussed in detail in Chapter 10. Of importance here, CDS systems are crucial components of EHRs, linked to at least CPOE in the form of warnings related to duplicate orders, allergies, and medication dosing errors. A CDS system could also provide alerts related to changes in a patient's condition and reminders about important tasks such as follow-up visits, preventive care, immunizations, and updates to critical patient information.[58]

Some EHRs may contain external web links to resources to assist with clinical decision making (see, for example, the discussion of Infobuttons in Chapter 10). Many healthcare systems also have internal intranets that provide links to policies and procedures, clinical guidelines, and evidence-based protocols. In 2006 the National Institutes of Health (NIH) in collaboration with the National Library of Medicine (NLM) developed a decision support application called the Evidence-Based Practice (EBP) InfoBot.[59] This system was designed to augment a patient's EHR automatically by searching various literature sources and providing information that could be used to develop plans of care and assist with decision making. Operating behind the scenes are rule sets programmed to extract key data from the patient's medical record, map free text data to standardized terminology, and create a series of EBP-type queries from extracted data. These questions are used to search multiple NLM databases, internal standards of care and guidelines, and other external clinical resources, and then provide a summary of the information based on clinical user group preference directly into the EHR. The application functions in real time and provides flexibility to adapt to the requirements of the decision maker. Overall, the EBP InfoBot decreased provider search time, reduced information overload, and provided current and timely resources to support decision making at the bedside. An example of the EBP InfoBot summary screen is shown in Figure 6-2. Ideally, at a minimum, the CDS in EHRs should be accurate, be available to the clinician at the point of care, provide timely and up-to-date information, and easily be incorporated into daily care processes and workflow.

Ancillary Systems

An **ancillary system** usually refers to software applications used by patient care support departments such as laboratory, radiology, and pharmacy. Other departments such as cardiology, respiratory, physical therapy, and material management may have their own software applications as well. Laboratory information systems (LISs) and radiology

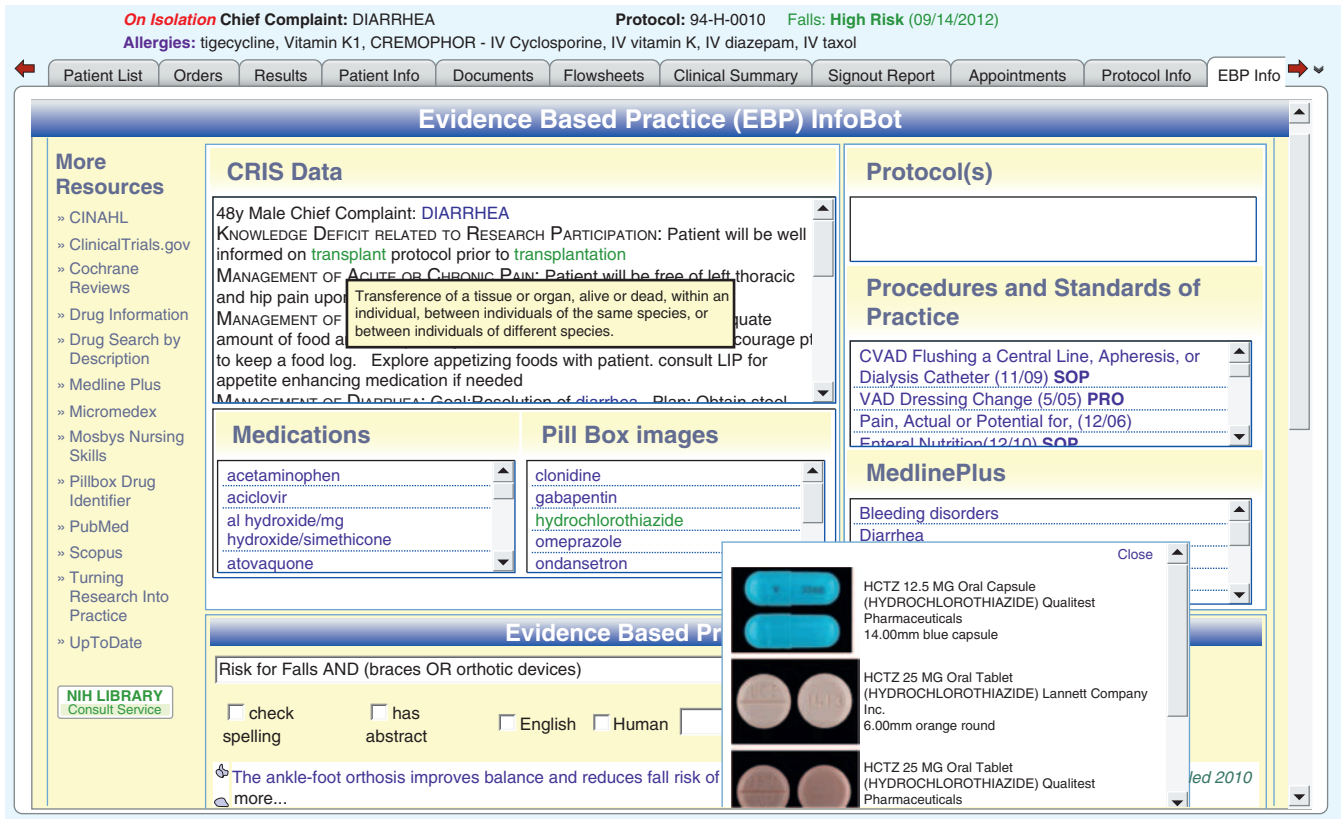

FIG 6-2 Evidence-Based Practice InfoBot. (From the National Library of Medicine.)

information systems (RISs) were available long before the concept of EHR systems was introduced. Both LISs and RISs are designed to address the specific needs of the department related to collecting, processing, and reporting test results along with managing resources and costs. The LIS consists of several components related to the laboratory subdepartments, including hematology, chemistry, microbiology, blood bank, and pathology.The LIS may also interface with other devices, such as blood analyzers, for direct input of blood test results.

Coding structures are used to track and identify resources and provide cost data for billing. Logical Observation Identifier Names and Codes (LOINC) is a universal coding system used to identify laboratory and other clinical observations, while the Systematized Nomenclature of Medicine (SNOMED) coding structure is commonly used in pathology. These standard languages are discussed in more detail in Chapter 22.

The RIS is similar to the LIS in that it incorporates data from multiple services that include x-rays, fluoroscopy, mammography, ultrasound, magnetic resonance imaging (MRI) scans, computed tomography (CT) scans, and other special procedures. It also uses coding structures such as Current Procedural Terminology (CPT) or International Classification of Diseases (ICD) to identify procedures, resources, and billing. However, the global standard for the transmission, storage, and display of medical imaging information is Digital Imaging and Communications in Medicine (DICOM). The RIS may integrate data from a picture archiving and communication system (PACS), which stores digital versions of diagnostic images for display in the EHR.

The pharmacy department typically has a system to assist with inventory, prescription management, billing, and dispensing of medications. The FDA requires that all drugs be registered and reported using a National Drug Code (NDC). The NDC and SNOMED C axis are examples of coding structures that would be used in a pharmacy system. RxNorm is another standard mandated by the Office of the National Coordinator for Health related to Meaningful Use reporting and data exchange. Clinical screening can be done by monitoring medication usage throughout the hospital and identifying potential adverse drug events. Prescriptions can be tracked along with printing of labels and medication instructions for patients or staff. The pharmacy system can provide patient drug profiles that include current and past medications, allergies, and contraindications. These features are designed to enhance patient safety. A closed-loop medication management system connects the pharmacy system to the CPOE, eMAR, and bar-coding systems.

EHR BENEFITS

Most health policy initiatives are designed to address a triad of concerns that focus on cost, access, and quality. For example, concerns regarding the increasing cost of

prescription drugs became the focus of Medicare reform legislation in 2003. Recent policy directed toward the adoption of EHR systems also highlights these concerns. The HITECH Act (2009) and the Patient Protection and Affordable Care Act (2010) addressed the need for EHR adoption to improve the quality, safety, and efficiency of care. With this in mind, the benefits of an EHR will be presented in terms of cost; access; and quality, safety, and efficiency of care delivery.

Cost

Cost savings is always a big motivator, especially if a healthcare provider or institution wants to stay in business. Numerous studies focusing on direct cost savings related to EHR use reported a positive financial return on investment for the healthcare organization.[60–64] Other cost benefits include increased productivity, efficiency in billing, improved reimbursement rates, improved verification of coverage, faster turnaround for accounts, lower medical record costs, support for pay-for-performance bonuses, and enhanced regulatory requirement compliance.[61,65,66] Benefits to patient care were also seen related to lower costs associated with disease management and decreased length of stay.[65,67]

Access

There is no doubt that an EHR provides better and faster access to patient care information. Looking for paper charts that mysteriously disappear from the nurses' station or waiting for medical records to retrieve an old record are events of the past. An EHR allows simultaneous access to patient records and restricts users' access to only the information that they are permitted to view. Many systems contain functionality such as graphs and charts that trend on demand and tools that facilitate comparison of current and past data. Another benefit is that clinicians have access to drug information, decision support tools, and literature searches to supplement patient care. Alerts and triggers that warn users of drug interactions and allergies can prevent medication errors. Clinical research often involves reviewing chart data and can be a cumbersome process if done manually. The EHR provides a more effective and efficient method to access and aggregate data for research. As EHR adoption continues to expand this will improve data access across multiple facilities and provide better continuity of care.

Quality, Safety, and Efficiency of Care Delivery

One of the main reasons to adopt an EHR is the potential to improve the quality, safety, and efficiency of care delivery. Quality is an ambiguous term that has a variety of meanings. Quality as it relates to EHR technology is fostered through better management of health information and improved data integrity. This may take the form of providing data that are readable, organized, accurate, and complete. Quality could also refer to increased staff and patient satisfaction, improved care coordination, and support for benchmarking. Safety and efficiency are much easier to quantify. Reducing medication errors has been a major focus of CPOE implementation. Systems that support clinical decision making and provide early warnings of changes in patient status can be used to avert medical errors. Diagnosis and treatment options can be explored through the use of decision support technology. Clinical and operational efficiencies in communication, workflow, documentation, and administrative functions are reported benefits of EHR adoption.

STAKEHOLDER PERSPECTIVES

In most organizations the implementation of an EHR will affect multiple groups or **stakeholders** that share a vested interest in the outcome of this endeavor. Stakeholders may have similar concerns about the technology but different needs and approaches for resolution. It is important to consider many perspectives; essential stakeholders may include consumers, nurses and other healthcare providers, healthcare administration and organizations, insurance payers, and state and national governments.

Consumers

The general attitude of consumers toward health IT is positive but consumers are embracing this innovation with some skepticism. According to a large survey conducted by the Louisville Health Information Exchange (LouHIE), consumers were most interested in "time-savings, streamlined registration, tracking their own records, safer emergency care, improved care quality, and reduced duplicate services."[68(p46)] Although the EHR has the potential to address these items, security and privacy of personal information is a major concern. In a national survey conducted by the California HealthCare Foundation in 2008, consumers indicated a desire to be more engaged in healthcare decisions and have access to online medical information.[69] Consumers also reported that health IT has the potential to improve quality and efficiency of care throughout the healthcare system and that concerns about privacy should not hinder organizations from moving ahead with EHR adoption. From a consumer perspective an EHR system should provide the ability to customize care through appointment reminders, health risk assessments, and timely access to personal health information. The availability of online educational resources can also improve consumers' understanding of their health status and treatment choices.

Nurses

Nurses constitute one of the largest groups of users of the EHR and their perspective is critical to the successful integration of current and future technology. There are mixed reviews on user satisfaction related to individual systems but nurses are encouraged to embrace the EHR as a way to enhance consistency and quality of care.[70–72] Seckman and Mills[73] reported that nurses' perception of an EHR was positive over a 5-year period and that overall the system increased productivity, improved performance, enhanced effectiveness, was easy to use, and supported clinical care and research.

Other reported benefits involve improvements related to centralized access to patient information, clinical documentation, monitoring patient status, and resources for patient education.

Nurses are responsible for distributing medications to patients under their care. Because the EMR and EHR usually interfaces with a pharmacy system, eMAR, and bar-coding technology, the potential exists to decrease administration-related medication errors. Knowledge-based systems may include functionality that integrates clinical guidelines or protocols to assist nurses in the development of critical pathways and plans of care.

Nurse leaders struggle to measure quality outcomes required by The Joint Commission (TJC), the Centers for Medicare & Medicaid Services (CMS), and other regulatory agencies. The EHR provides the ability to access data and compare across institutions for benchmarking. Stefan[74] suggested several quality metrics that nurse leaders should evaluate when implementing an EHR, including timely access and documentation of patient information, EBP alerts, impact on length of stay, discharge follow-up with patients, and accuracy of documentation for reimbursement and regulatory agencies.

Healthcare Providers

In a recent study of EHR use in primary care practices, physicians and staff reported increased efficiencies related to billing and care coordination, access to current and past medical records, storing of patient information, and overall office operations.[75] Doyle et al.[76] concurred with these findings and concluded that EHRs used in the healthcare provider's examination room facilitate a partnership between physician and patient through collaboration of treatment plan options and increase patient teaching by sharing of online medical information. In other studies physicians also reported improvements in prescribing and medication safety when eprescribing and decision support tools were available.[77,78] EHRs that provide tools for comprehensive documentation, warnings for changes in patient status, medication alerts, and follow-up and preventive care reminders improve decision making, which can reduce liability for the physician.[79] In addition, automated reporting capabilities enhance compliance to quality and regulatory requirements.[80]

Overall, healthcare providers reported favorable opinions about the EHR, citing many potential benefits related to clinical, organizational, and consumer outcomes.[65] Clinical benefits are often seen through the reduction of medical and medication errors, better health and disease management, and enhanced quality of care. Financial needs of the physician practice are streamlined and more efficient with electronic access to payer information and reporting to facilitate compliance with regulatory requirements. Workflow, communication, and coordination of care activities improve when there is easier access to records and other resources. Consumers also benefit from EHR technology when there is collaborative interaction between patients and physicians, more timely access to personal health information, and online access to educational materials.

Healthcare Organizations

A current question for healthcare organizations is how to stay financially viable in a healthcare environment determined to control escalating healthcare costs. Added to this burden is the mandate to implement comprehensive EHR systems to meet Meaningful Use criteria and reap the benefits of available incentives. Depending on the size and complexity of each organization, costs for implementing EHR technology are a significant investment. Beyond the initial expense for the hardware and software are fees associated with consultants and programmers to assist with implementation, licensing, maintenance, and providing staff time away from regular duties to participate in the process. For the healthcare executive, implementing EHR systems has the potential to improve operational efficiency, strengthen communication throughout the organization, increase patient safety, support compliance with regulatory requirements, improve medical record security and storage, improve care coordination, enhance the quality of care, and provide faster turnaround for procedure authorization, billing, and claims submission.

Healthcare executives and leaders must look at leveraging this technology not only to control costs, but also to improve the quality of care. The successful implementation of information systems requires an understanding of the technical, cultural, and organization factors that influence change. Additional information related to successful implementation of health-related information systems can be found in Chapter 17. Healthcare executives must also reflect beyond single-facility implementation to the possible benefits of system integration that will foster collaboration at local, national, and international levels.

Insurance Payers

The EHR provides several benefits for insurance companies through better disease management and reporting of services. Pay for performance requirements are supported and can be submitted in a timely manner. Claims that are incorrectly coded or that lack coding standards can confuse payers when they attempt to reimburse organizations for services. Systems that integrate patient data with coding and billing with coding and billing structures can provide data to control costs and manage expensive procedures.

State and National Governments

Over the past 20 years the cost of healthcare in the U.S. has risen to nearly $2.6 trillion and is expected to grow faster than the national income.[81] One proposed measure for cost containment focuses on improving coordination and quality of care. The implementation of a nationwide interoperable EHR is recommended as a solution that would significantly reduce medical errors, improve care quality, and save the U.S. healthcare system major expense.[18,82] The U.S. is behind other developed nations in deploying technology of this magnitude. A major challenge is how to support the sharing of patient data

across multiple organizations, requiring a nationwide technology infrastructure and communication standards, such as standardized nomenclatures, vocabularies, and coding structures.[4] Although the initial expenditures for such a system would be high, the anticipated benefits to our nation would be the ability to identify and address safety issues in a timely fashion, notify patients and populations at risk for disease or environmental exposure, detect epidemics, and prepare for bioterrorism attacks.[83] A clinical dataset of essential information would be available, allowing researchers to explore preventive and curative solutions that address the nation's health and healthcare issues. Ultimately, the adoption of a nationwide EHR system would assist government agencies to improve overall healthcare for all U.S. citizens.

KEY ISSUES

The actual and potential benefits of an EHR are promising but challenges also exist. This section focuses on several issues associated with EHR adoption related to cost, ownership, data integrity, privacy and confidentiality, standards, organizational culture, and human factors.

Cost

The cost to implement and maintain an EHR is a major barrier. Physicians in private practice can expect to spend between $54,000 and $100,000 or more to purchase and implement a certified EHR.[24] This does not include the per-year maintenance costs or hiring of technical staff to keep the system running on a daily basis. If a practice is using paper records, additional staff may be needed to enter previous patient data into the new system. Providers with a noncertified EHR will need to replace or update the system to meet standards and data conversion may be necessary to move from the old system to the new system.

Hospitals and other healthcare organizations have the same issues. EHR technology expenses can range from $1 million to $100 million or more depending on the size of the facility, software vendor selection, and functionality purchased. Annual maintenance is an added expense that can be approximately 20% of the purchase price and easily cost more than $1 million annually. In both scenarios, financial planning for initial and ongoing training, technical support, and software upgrades must be considered. The bottom line is that implementing and maintaining an IT system is very expensive. Currently each healthcare organization purchases its own EHR; connections to other facilities are less common, although this trend is changing with the use of HIE. It is unclear who will be responsible for the electronic links that will form the infrastructure for local, regional, or national EHRs of the future.

Ownership

Ownership of the patient record is another issue. Traditional health records have always been the property of the service institution. Patient access to this record could be permitted but sometimes at a cost. A comprehensive, interoperable EHR would cross institutional boundaries and include patient interaction, making ownership more complex. Since healthcare providers use a lot of the same data, many questions are currently unanswered, such as: What data would be shared? How would users access these data? Who would be responsible for updating and ensuring data accuracy? Who would store the shared data? Would patients and consumers have access to the data or a subset of the data? What role would the government play in monitoring the access, quality, security, privacy, and confidentiality of patient records? Consumer consent and access are critical elements of the EHR adoption initiative, which has implications for healthcare organizations and the issue of ownership. Healthcare providers may be uncomfortable with the prospect of patients reading their notes and alter what and how they document to accommodate consumer access. Consumer consent is required for health professionals to retrieve or share patient records to ensure that personal information is not accessed inappropriately. This rule could affect quality of care if the consumer is concerned about confidentiality and denies permission. Ultimately, ownership may be driven by who has control and access to the data.

Data Integrity

Data integrity refers to the accuracy and consistency of stored and transmitted data that can be compromised when information is entered incorrectly or deliberately altered or when the system protections are not working correctly or suddenly fail. As EHR adoption expands to include data from multiple healthcare entities, more opportunities for human error exist. Poor screen designs that are confusing and cumbersome and lack of system training often lead to data entry errors. How this will be monitored and who is responsible for correcting inaccurate information will be an issue. Critical patient information, such as allergies and medications, should always be validated and updated at each episode of care. Education on how to use the EHR should be provided to all staff prior to implementing a new system, when changes are made to an existing system, and during orientation for new employees. Stringent security measures that include audit trails, penalties for fraudulent activities, and detailed policies and procedures are other measures that protect data integrity.

Data integrity can also be affected if a system is not working correctly or suddenly fails. Unfortunately, users do not always recognize when a feature is not functioning, such as a broken alert or incorrect calculations, and this leads to inaccuracies in data. When an interface from one application to another is not working, this also may not be readily noticeable. For example, a physician is able to enter orders using CPOE but the interface to the pharmacy department system fails and medication orders are not received or dispensed, which ultimately affects patient care. A nurse may discover this problem only when it is time to administer medications and he or she learns that they are missing from the unit. When the interface resumes functioning the orders will cross

over, but depending on the time the order was placed, some data may be lost or corrupted. Appropriate downtime procedures (discussed in Chapter 18) and support mechanisms, such as a customer help desk to track and resolve issues, along with rigorous system testing is extremely important to ensuring data integrity.

Privacy and Confidentiality

Despite advances in technology and robust software that limits access to computerized health information, privacy and confidentiality continue to be major concerns for both the healthcare professional and consumer. With the expansion of the EHR and HIE as a driving force to automate and share health information, clinicians may find government and regulatory requirements for controlled access to patient information too restrictive or an invasion of privacy. In this respect, providers may be less inclined to use the EHR or more cautious when documenting patient care in order to avoid litigation. Like facilities, consumers can also be bombarded with PHR computer attacks, such as viruses, spyware, and hackers. Some consumers do not trust that health IT will be any different than traditional healthcare and fear a large-scale EHR system could allow access to personal data without adequate protection against unauthorized use of information. Some consumers prefer that sensitive health information (such as psychiatric care) never be shared, which creates problems because this can represent critical information missing from a medical record. Before a nationwide interoperable EHR can be implemented, issues related to privacy and confidentiality need to be resolved. This topic is discussed in more detail in Chapter 19.

Standards

In a famous commentary on hospitals in 1863, Florence Nightingale wrote: "In attempting to arrive at the truth, I have applied everywhere for information, but in scarcely an instance have I been able to obtain hospital records fit for any purposes of comparison. If they could be obtained they would enable us to decide many other questions besides the ones alluded to. They would show subscribers how their money was being spent, what amount of good was really being done with it, or whether the money was not doing mischief rather than good."[84(p176)] Almost 150 years later these same issues with extracting data for comparisons still exist. Healthcare professionals have been discussing the need for standardized vocabularies and terminologies for many decades. Implementation has been hindered by numerous factors related to disagreement on which terminologies to use, lack of standards to harmonize multiple coding structures, cultural and language barriers, interpretation of meaning, threats to autonomy, and user resistance. The benefits of standardization allow for a mutual understanding of terms and improved communication among healthcare professionals along with a common way to collect and aggregate data. A universal language would allow us to consistently capture, represent, access, and communicate clinical data, information, and knowledge across all settings. While progress is underway, standards continue to be an issue for EHR adoption.

Organizational Culture

The healthcare environment is filled with many cultures, subcultures, and traditions and the implementation of an EHR can be disruptive to the socio-cultural system. A **disruptive technology** is an innovation that replaces long-held traditional ideas and ways of doing things. This type of technology can improve or replace a product in ways that are unexpected and often opens up new market demand, which leads to lower-priced products or products designed for a different set of consumers. Cellphones, email, Twitter, and Facebook have significantly changed our interpersonal, professional, and business communications. In this respect, a disruptive technology such as the EHR may challenge and alter social and cultural norms. How these cultures respond to change will vary based on belief systems, values, roles within the healthcare team, and computer knowledge.

Healthcare organizations are challenged with issues surrounding the evolving nature of EHR technology, one of the most important of which is user acceptance. Whether in a hospital setting or private practice, nurses, physicians, and other caregivers are required to use an EHR as part of their daily routine but some find it difficult to comply. Reasons for this vary from lack of computer skills, complexity of application, lack of available hardware, or difficulty adjusting to change. Caregivers often indicate that documenting in the computer interferes with routine workflow or takes away from valuable time with patients. When CPOE was enforced by some institutions, physicians complained that entering orders in the computer was a task beneath them since this was traditionally secretarial work. This also had an impact on the role of nurses since they no longer had to interpret and validate handwritten orders. Physicians entered these orders in isolation and the computer forced them to be more specific during the entry process. Nurses' workflow changed since they no longer had a paper form to alert them when new orders became available. Checking the computer more often was disruptive to care and procedures were needed to avoid mistakes and delays. These types of reasons for resistance must be addressed for an EHR adoption to be successful. Acceptance of this technology is dependent on effective leadership, user involvement, the ability of the system to integrate with workflow, and timely education and technical support.

Human Factors

A significant amount of time is spent by all healthcare providers in processing and documenting patient-related data but using an EHR system for these activities can be perceived as a frustrating experience.[85] Research on human–computer interaction has identified several issues related to the usability of EHRs. Despont-Gros, Mueller, and Lovis,[86] in their review of human–computer interaction models, reported user acceptance to be a reliable concept to reflect evaluation of clinical information systems. Problems with usability related to complex human–computer interfaces, poorly designed

decision support tools, and lack of training are recognized as obstacles that lead to significant medical errors and resistance to accept the technology.[17,85,87,88]

The complexities of EHR technology add concerns that new types of errors are beginning to emerge. Many clinicians complain that information systems increase their workload, which decreases productivity and efficiency. Ash, Berg, and Coiera[17] reported that EMR systems can have a negative impact on communication and teamwork due to the linear processing of computer systems, which conflicts with the more fluid iterative and interruptive nature of providing care. They also concluded that cognitive workload increased with unnecessary clerical tasks, overly structured data entry requirements, and fragmented patient data retrieval formats. In a study of physician groups who used an EMR, the investigators reported that adequate technical support and training were critical for the successful integration and acceptance of new technology.[88] Addressing issues related to human factors is complex and requires early user involvement and attention to system design and testing. Human factors concepts are discussed in detail in Chapter 21.

CONCLUSION AND FUTURE DIRECTIONS

EHR has become the preferred term for the lifetime patient record that would include healthcare data from the consumer and a variety of provider sources. The IOM identified eight essential care delivery components for all EHRs: (1) administrative processes, (2) communication and connectivity, (3) decision support, (4) health information and data, (5) order entry management, (6) patient support, (7) results management, and (8) population health management.[14] Dentistry and optometry records were added to this list by the Department of Defense.[15]

Common EHR applications used in the clinical setting include CPOE, eMAR, BCMA, clinical documentation, specialty applications, and CDS. The HITECH Act (2009) established programs to accelerate EHR adoption, one of which offers financial incentives for hospitals and healthcare providers who adopt certified EHR technology and comply with Meaningful Use objectives. How the HITECH Act will address the needs of health practitioners is unclear but many are actively involved in local, regional, and national initiatives to improve the quality, safety, and efficiency of care using technology. Current research findings indicate that EHR benefits related to cost, access, quality, safety, and efficiency of care delivery support healthcare policy initiatives driving adoption. Despite the many advances in technology, there are still numerous issues to resolve associated with implementation costs, ownership, data integrity, privacy and confidentiality, organizational culture, human factors, and development of an infrastructure to support a nationwide EHR. Future directions are promising for the EHR for personalizing care, supporting research efforts, and mobilizing care coordination across national and international boundaries.

In the future the EHR will play a pivotal role in personalized medicine as a medium for data, information, and knowledge exchange and for exploration. Advanced computing and systems integration will provide powerful evaluation tools to facilitate healthcare providers and consumers in the decision making process. The Human Genome Project, in which findings were accelerated through the use of computer technology, will contribute knowledge that could lead to genetic profiling and the creation of individualized care. Genetic testing, along with access to an interoperable EHR, can be used to diagnose, prevent, and treat preexisting and potential health issues based on our unique biological responses. In the future an individual's genome sequence may be part of a comprehensive medical record, not unlike recording medications and allergies.[89]

Customized medications will likely eliminate prescribing drugs or doses that do not work, minimize side effects, and decrease costs. Other treatments, such as diet and exercise, can be personalized to avoid a lot of guesswork and trial and error. For example, if a patient's genetic code reveals a risk for colon cancer, preventive measures can start earlier. More frequent exams, colonoscopies, and diets that promote colon health can be the focus of care. In addition to personalizing care, the EHR will contain a wealth of information related to disease, interventions, and treatment responses that can be used for research. Data mining of these huge databases can reveal patterns and predictions on how to reverse or prevent disease.

The EHR continues to be an evolving concept with global and national implications. As of early 2012 EHR adoption in U.S. hospitals was progressing, with approximately 43.9% at Stage 3 and another 30% at Stage 4 or above.[27] The rate of adoption by physician practices and clinics was much lower, with only 10.9% at Stage 3. Although hospitals may be in a better position to fulfill Meaningful Use objectives, additional support and guidance may be needed to achieve nationwide implementation goals projected for 2015. Many other countries, such as Canada, Australia, England, and Finland, have focused their efforts toward building an infrastructure and developing systems that support health information at a national level.[90] The European Commission has launched several initiatives to improve the safety and quality of care through information sharing at an international level, such as the eHealth Action Plan that supports standardization of EHR content and structure and the Smart Open Services (SOS) project that recommends allowing healthcare provider access to critical medical information for consumers traveling abroad.[91,92] EHR adoption has the potential to reach beyond the borders of this nation to meet the needs of a mobile society.

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DISCUSSION QUESTIONS

1. In September 2012 the American Health Information Management Association (AHIMA) released a new guide to help consumers understand medical records. A press release can be viewed at www.ahima.org/downloads/pdfs/pr/press-releases/consumer%20onc%20presentation.pdf and the guide can be viewed at http://myphr.com/HealthLiteracy/understanding.aspx. Discuss the significance of using the term *medical record* as opposed to *health record*.
2. Historically, patient records maintained by healthcare institutions did not contain financial data such as charges or incident reports. Should this segregation of patient data be maintained with the implementation of EHRs?
3. Increasingly patients expect full access to their EMRs and EHRs. What limitations, if any, would be in the best interest of patients? For example, should healthcare providers have access to new test results for 3 full business days before these are posted for patient viewing?
4. How does the introduction of a computerized provider order entry (CPOE) system affect communication between healthcare providers (e.g., between pharmacists and physicians or nurses, between nurses and physicians)? What modifications, if any, should be made in the workflow of the different healthcare providers to adjust for this change in communication patterns?
5. Discuss the advantages and disadvantages associated with implementing and using a regional and national EHR.

CASE STUDY

A large healthcare enterprise in the Mid-Atlantic region that was created by a merger owns two acute care hospitals, a rehabilitation center, an outpatient surgical center, and three long-term care facilities. Each of these institutions uses a different EMR system. Admitting privileges extend to 550 physicians who have office systems that interface with at least one of the acute care EMR systems. The vision is to create an environment to support communication, care coordination, and data sharing across the organization in preparation for a regional EHR system. The organization also wants to move quickly in order to take advantage of the incentives offered by the government and meet mandatory requirements. Executives have decided to focus on the acute care facilities first and use lessons learned there to integrate the other centers at a later time. Hospital A uses certified EHR applications and has implemented ancillary systems, CPOE, and clinical documentation whereas Hospital B has a highly customized, beloved old mainframe computer that is outdated and no longer supported by the vendor. Instead of selecting a new system for both hospitals, the software programs used in Hospital A will be implemented in Hospital B.

Discussion Questions

1. You are the Vice-President of Patient Services for both acute care hospitals. Who would you identify as stakeholders in the implementation and why? What steps would you take to minimize user resistance?
2. According to the U.S. EMR Adoption Model, at what stage of implementation would you classify Hospital A? After both hospitals are using the same system, what would you recommend implementing next?
3. The healthcare enterprise needs to do more than implement certified systems in order to receive government incentives and address regulatory requirements. Identify at least five core objectives related to Meaningful Use that the hospitals need to execute.