Chapter Two

Functional EHR Systems

Learning Outcomes

After completing this chapter, you should be able to:

◆ Compare different formats of EHR data
◆ Describe the importance of codified EHR
◆ Have an understanding of prominent EHR code sets such as SNOMED-CT, MEDCIN, LOINC, and CCC
◆ Explain different methods of capturing and recording EHR data
◆ Catalog and retrieve documents and images from a digital image system
◆ Discuss the exchange of data between EHR and other systems
◆ Discuss the benefits of patient-entered data
◆ Describe the functional benefits from a codified EHR
◆ Compare different formats of lab result data
◆ Discuss alert systems and drug utilization review
◆ Describe two important components of health maintenance
◆ Provide examples of EHR decision support

Format of Data Determines Potential Benefits

The ability to easily find, share, and search patient records makes an EHR superior to a paper record system. However, remember that Chapter 1 defined the EHR as the portions of the patient’s medical record stored in the computer system as well as the functional benefits derived from them.

The IOM defined eight core functions that an EHR should be capable of performing.
Four of the *functional benefits* identified by the IOM are health maintenance, trend analysis, alerts, and decision support. The form in which the data is stored determines to what extent the computer can use the content of the EHR to provide additional functions that improve the quality of care.

This chapter will examine the forms in which EHR data is stored, explore how functional benefits are derived from it, and how data may be entered.

**EHR Data Formats**

The various ways in which medical records data are stored in the database may be broadly categorized into three forms:

**Digital images**

This form of EHR data can be retrieved and displayed by the computer, but a human is required to interpret the meaning of the content. This category may be subcategorized into:

- **Diagnostic images** such as digital x-rays, CAT scans, digital pathology, and even annotated drawings
- **Scanned documents** such as paper forms, old medical records, letters, or even sound files of dictated notes

**Text files**

The second type of data includes word processing files of transcribed exam notes and also text reports. It is principally obtained in the EHR by importing text files from outside sources.

**Discrete data**

This third form of stored information in an EHR is the easiest for the computer to use. It can be instantly searched, retrieved, and combined or reported in different ways. Discrete data in an EHR may be subcategorized into:

- **Fielded data** in which each piece of information is assigned its own position in a computer record called a “field.” The meaning of the information is inferred from its position in the record. For example, a record of the patient’s medical problem might look like this:

  "knee injury","20120331","improved","20120428"

  The fields in this example are surrounded by quotation marks. The computer would be programmed to look for the name of the problem in the first field, the date of onset in the second field, the status of the problem in the third field, and the date of the last exam in the fourth field.

- **Coded data** is fielded data that also contains codes in addition to or in place of descriptive text. Codes eliminate ambiguities about the clinician’s meaning. A codified EHR record of the same knee problem might look like this:

  "8442", "knee injury", "20120331", "improved", "20120428"

**Limitations of Certain Types of Data**

An EHR offers improved accessibility to patient records over a paper chart. That is certainly a functional benefit of any EHR regardless of the format of its data. However, to achieve its full functional benefits, the computer must be able to quickly and accurately identify the information contained within the records.
Digital image data can be retrieved and displayed by the computer, but a human is required to interpret the meaning of the content. Although this is beneficial for sharing diagnostic images, if the bulk of the EHR is simply scanned paper documents, only one or two of the IOM criteria defined in Chapter 1 are satisfied.

Text data are useful for doctors and nurses to read and can be searched by the computer for research purposes. However, text data is seldom used for generating alerts, trend analysis, decision support, or other real-time EHR functions, because the search capability is slow and the results often ambiguous.

Fielded data is the most common way to store information in computers and EHR systems. It is fast and efficient and uses very little storage space. However, unless the fielded data is also codified, the meaning of the data can be ambiguous.

Within medicine, many different terms are used to describe the same symptom, condition, or observation. Additionally, clinicians often use short abbreviations to document their observations in a patient chart. This makes it difficult for a computer to compare notes from one physician to another. For example, providers at two different clinics might record a knee injury problem differently:

- Dr. 1: “twisted his knee”
- Dr. 2: “knee sprain”

A search of medical records by the description “knee injury” might not find the records created by either clinician.

Coded data is when a code is stored in the medical record in addition to the text description—the record is then considered codified. The EHR system can instantly find and match the desired information by code regardless of the clinician’s choice of words. A codified EHR is more useful than a text-based record because it precisely identifies the clinician’s finding or treatment.

EHR data stored in a fielded, codified form adds significant value, but if the codes are not standard it will be difficult to exchange medical record data between different EHR systems or facilities. Remember, the exchange of data is one of the eight core functions defined by the IOM. Using a national standard code set instead of proprietary codes to codify the data will better enable the exchange of medical records among systems, improve the accuracy of the content, and open the door to the other functional benefits derived from having an electronic health record.

**Standard EHR Coding Systems**

EHR coding systems are called nomenclatures. EHR nomenclatures differ from other code sets and classification systems in that they are designed to codify the details and nuance of the patient–clinician encounter. EHR nomenclatures are different from billing code sets in this respect. For example, a procedure code used for billing an office visit does not describe what the clinician observed during the visit, just the type of visit and complexity of the exam. EHR nomenclatures need to have a lot more codes to describe the details of the exam; for this reason, they are said to be more granular. Two prominent nomenclatures for EHR records are SNOMED-CT® and MEDCIN®. Another prominent coding system, LOINC®, is used for lab results.
Unfortunately, many hospital systems use none of these standard systems, having instead developed internal coding schemes applicable only to their facilities. These work within the organization but create problems when trying to integrate other software or exchange data with other facilities. To create an EHR that is able to receive, create, and compare medical information from numerous sources, it is necessary to adopt a coding system that is used by other providers—in other words, a national standard.

Prominent EHR Code Sets

EHR nomenclatures have hundreds of thousands of codes to represent not only procedures and diseases but also the symptoms, observations, history, medications, and a myriad of other details. The level of granularity determines how fine a level of detail is represented by a code in the nomenclature.

However, too much granularity can make a code set difficult to use at the point of care. The point of care is when both the clinician and patient are present. Extremely granular code sets, called reference terminologies, are impractical for a clinician to use in an exam. Designed for data analysis, these code sets often are applied to the medical records after the fact for a specific research project.

To balance the need for granularity with the practical requirements of point of care documentation, EHR nomenclatures use the concept of findings, or codified observations, which are medically meaningful to the clinician. Although some systems of clinical vocabulary are just “data dictionaries” that are used to standardize medical terms, EHR nomenclatures precorrelate those terms into clinically relevant findings.

For example, a clinical vocabulary will have the terms eye, arm, leg, chest, nostril, left, right, red, yellow, radiating, discharge, and pain. These terms could be combined in many ways, some of them meaningless. Findings are less granular than individual terms but combine those terms in ways that are clinically relevant. For example, “chest pain radiating to the left arm” uses one coded finding to record five clinical terms as a meaningful symptom.

Findings are often linked to other findings, whereas codes in classification code sets are usually only related to the root code of the group that the code is in.

For example, the finding abdominal pain is related to more than 550 diagnosis codes, whereas a specific diagnosis code for peptic ulcer is not related to any other diagnosis code.

Conversely, in an EHR nomenclature the diagnostic finding of peptic ulcer is related to 168 other findings (one of which is abdominal pain).

Linked or indexed findings in an EHR nomenclature enable clinicians to quickly locate related symptoms, elements of the physical exam, assessments, and treatments when documenting the visit.

EHR users tend to locate findings by the description, not by the code. EHR nomenclature code numbers are typically invisible to the user.

A feature unique to EHR nomenclatures is that they often include internal cross-references to other standard code sets. These tables help the EHR to communicate
with other systems. Code sets not designed for an EHR do not typically contain a map to other code sets with their structure.

The following sections will provide a brief history and purpose of several of the most prominent coding standards you are likely to encounter or use in an EHR.

**SNOMED-CT**  SNOMED stands for Systematized Nomenclature of Medicine; CT stands for Clinical Terms. SNOMED-CT is a merger of SNOMED, a medical nomenclature developed by the College of American Pathologists, and the “Read Codes,” developed by Dr. James Read for the National Health Service in the United Kingdom.

SNOMED-CT includes cross-references to map SNOMED-CT to other standard code sets, including those discussed below.

**SNOMED-CT Structure**  The SNOMED-CT Core terminology contains over 364,400 healthcare concepts, organized into 18 hierarchical categories. The data structure of SNOMED-CT is complex. Concept names, descriptions, and synonyms number more than 984,000.

SNOMED Concepts have descriptions and Concept IDs (numeric codes). The concepts are arranged in the following hierarchies:

- Finding
- Disease
- Procedure and intervention
- Observable entity
- Body structure
- Organism
- Substance
- Pharmaceutical/biological product
- Specimen
- Physical object
- Physical force
- Events
- Environments and geographical locations
- Social context
- Context-dependent categories
- Staging and scales
- Attribute
- Qualifier value

SNOMED-CT has approximately 1,450,000 semantic relationships in the nomenclature. There are two types of relationships between SNOMED-CT concepts: Is-A relationships and Attribute relationships.
**Is-A** relationships connect concepts within a single hierarchy. For example, the disease concept Bronchial Pneumonia is-A Pneumonia (also a disease concept).

**Attribute** relationships, however, connect concepts from two different hierarchies. For example, the disease concept Bronchial Pneumonia has the associated Attribute Inflammation (which is from a different hierarchy, morphology.)

**MEDCIN** MEDCIN is a medical nomenclature and knowledge base developed by Medicomp Systems, Inc., in collaboration with physicians on staff at Cornell, Harvard, Johns Hopkins, and other major medical centers. The purpose of the MEDCIN nomenclature and the intent of the design differentiate it from other coding standards. SNOMED-CT and other coding systems were designed to classify or index medical information for research or other purposes. MEDCIN was designed for point-of-care use by the clinician. MEDCIN is not just a list of medical terms, but rather a list of findings (clinical observations) that are medically meaningful to the clinician.

MEDCIN includes cross-references to map MEDCIN to SNOMED-CT as well as other standard code sets that will be discussed later in this book. These include: ICD-9-CM, CPT-4, LOINC, CCC, and RxNorm drug codes.

**MEDCIN Structure** The MEDCIN nomenclature consists of 277,000 clinical concepts or “findings” divided into six broad categories:

- Symptoms
- History
- Physical Examination
- Tests
- Diagnoses
- Therapy

MEDCIN differs from other EHR coding systems in that the nomenclature is not just a codified list of findings. The MEDCIN nomenclature is available in a “knowledge base” with a diagnostic index of more than 68 million links between clinically related findings. This “knowledge” enables an EHR system based on MEDCIN to quickly find other clinical “findings” that are likely to be needed; this in turn reduces the time it takes to create exam notes.

This difference means a physician selects less individual codes to complete the patient exam note. For example, SNOMED-CT has a code for “arm” and a code for “pain,” MEDCIN has a “finding” for “arm pain.” MEDCIN often has additional findings that infer important nuances, for example, the “finding” for “arm tenderness” might more accurately describe the patient’s symptom than arm pain.

SNOMED-CT is often referred to as a “reference terminology.” It provides very granular coding that normalizes data for research and reporting. Its structure provides millions of semantic links based on a term, word, or concept.

Figure 2-1 shows the SNOMED-CT finding Asthma with its various Is-A relationships.
Figure 2-1 and Figure 2-2 compare the structure of SNOMED-CT and MEDCIN using the finding for asthma. As you can see from the comparison, the MEDCIN knowledge base relates asthma to 279 total direct links (only 70 are shown in Figure 2-2). Each of these has relevancy to point-of-care use for an asthma patient. SNOMED-CT links include obvious links to asthma but not directly to lung cancer, plus many other diseases. MEDCIN links include lung disease, bronchial disease, respiratory obstruction, lung structure, acute asthma, cardiac asthma, extrinsic asthma, etc.

Figure 2-1 SNOMED-CT links for the term “Asthma.”

Figure 2-2 MEDCIN links for the term “Asthma.”
the symptoms, tests, or therapy. Links in Figure 2-1 also connect to lungs and other lung diseases not related to asthma. Such associations are sometimes useful when coding records for research but can make it difficult for the clinician to use such a system while seeing the patient.

The MEDCIN knowledge base also includes 600,000 synonyms for findings allowing a finding to be looked up by several different terms. The MEDCIN knowledge base includes each finding selected by the clinician into a readable narrative text. EHR applications using the MEDCIN nomenclature can store medical information as coded data elements and still generate readable exam notes from the same data.

An EHR system based on MEDCIN enables the clinician to select fewer individual codes and to quickly locate other clinical “findings” that are likely to be needed. This difference reduces the time it takes to create exam notes and allows a physician to complete the patient exam note at the time of the encounter.

Many experts feel that for point-of-care documentation medical nomenclatures such as MEDCIN are the key to successful adoption of an EHR by clinicians. MEDCIN is used in many commercial EHR systems as well as the Department of Defense CHCS II system. Because of this, MEDCIN has been selected as the EHR nomenclature for the student exercises in this textbook. You will learn more about MEDCIN in subsequent chapters of this book.

**LOINC**  
LOINC stands for Logical Observation Identifiers Names and Codes. LOINC was created and is maintained by the Regenstrief Institute, which is closely affiliated with the Indiana University School of Medicine. LOINC standardizes codes for laboratory test orders and results, such as blood hemoglobin and serum potassium, and also clinical observations, such as vital signs or EKG.

LOINC is important because currently most laboratories and other diagnostic services report test results using their own internal proprietary codes. When an EHR receives results from multiple lab facilities, comparing the results electronically is like comparing apples and oranges. LOINC provides a universal coding system for mapping laboratory tests and results to a common terminology in the EHR. This then makes it possible for a computer program to find and report comparable test values regardless of where the test was processed.

The LOINC terminology is divided into three portions: laboratory, clinical (non-laboratory), and HIPAA. The largest number of codes is in the laboratory section, which contains codes in 14 categories.

The second largest section of LOINC is the clinical section, which includes codes for vital signs, EKG, ultrasound, cardiac echo, and many other clinical observations.

A third section of LOINC has been created to categorize codes for a HIPAA claims attachment transaction. Claims attachments are used to provide additional information to support an insurance claim.

The wide acceptance of LOINC is attributable in part to its adoption by HL7 (discussed later in this chapter). HL7 uses LOINC codes in its clinical messages.
UMLS  UMLS stands for Unified Medical Language System®. It is maintained by the National Library of Medicine (NLM). Because students may find mention of UMLS elsewhere, it is included here. However, UMLS is not itself a medical terminology, but rather a resource of software tools and data created from many medical nomenclatures, including those described in this chapter. UMLS is described as a “meta-thesaurus.” It can be used to retrieve and integrate biomedical information and provide cross-references among selected vocabularies.

Nursing Code Sets

Twelve standards for coded nursing languages are recognized by the American Nurses Association today for use in the assessment, diagnosis, intervention, and outcome of nursing care. Using a commonly understood codified structure enables nurses to create and communicate a patient plan of care that is evidence based, facilitates documentation of the practice of nursing in the EHR, and permits data sharing to improve patient care outcomes. This is not a comprehensive explanation of all 12 coding structures, but does represent some of those that may be found in EHR systems today.

Clinical Care Classification System (CCC)  The Clinical Care Classification system (CCC) was developed by Virginia Saba at Georgetown University. It can be used to document patient care in hospitals, home health agencies, ambulatory care clinics, and other healthcare settings. Developed from government-funded research, it was originally known as the Home Health Care Classification system, but CCC is now considered applicable to clinical care as well as other healthcare services.

The CCC system provides standardized coding concepts for nursing diagnoses, outcomes, nursing interventions, and actions in two interrelated taxonomies. CCC defines 21 Care Components that provide a framework to interrelate the 182 CCC Nursing Diagnoses and 198 CCC Nursing Interventions.

The CCC system offers a unique approach to documenting the nursing process in an EHR by correlating the six steps of the CCC system with the six steps of the nursing process. The CCC codes have been integrated into the Medcin nomenclature used for this course, as well as UMLS, SNOMED-CT, and LOINC.

NANDA-I  NANDA-I stands for the North American Nursing Diagnosis Association International. The NANDA-I Taxonomy is a system of classification of 206 Nursing Diagnosis that have been grouped into 13 domains of nursing practice. They offer a clearly understood language to enable the professional nurse to identify and prioritize nursing diagnosis to plan interventions that are based on best practice but individualized to the patient’s responses to health problems or life processes. It is available in 11 international languages, is ISO and HL7 compatible, included in UMLS, and available in SNOMED-CT. This association’s body of work facilitates all forms of nursing communications and guides the process of professional nursing practice for assessing and treating the nursing diagnosis. The NANDA-I taxonomy supports the development of EHR and enables the collection, retrieval, and analysis of nursing data to promote education, research, and evidence based standards of care.

NIC and NOC  NIC stands for Nursing Interventions Classification. It is a code set designed for documenting nursing interventions in any clinical setting. NIC
was first published in 1992 and is updated every four years. The system consists of numeric codes for 514 interventions, which are grouped into 30 classes and seven domains that span all nursing specialties. The seven domains are: Basic Physiological, Complex Physiological, Behavioral, Safety, Family, Health System, and Community. Their design is for use at the point of care to document care planning and nursing practices.

NOC stands for Nursing Outcomes Classification and includes a comprehensive list of nursing outcomes. It is used to document the effect of nursing interventions on patient progress. It can be used to measure the quality of care, cost efficiency, and progress of treatment. It is a structure of 330 numerically coded outcomes (311 individual, 10 family, and 9 community level outcomes). The NOC codes are grouped into 31 classes and seven domains corresponding to those identified in NIC.

NIC and NOC codes were developed in the University of Iowa, College of Nursing, and are owned by Elsevier Science.

ICNP® ICNP stands for International Classification for Nursing Practice. It is the result of a project by the International Council of Nurses, to create an organizing structure into which other nursing terminologies can be mapped. It was intended to facilitate the comparison of nursing data gathered from multiple systems. However, ICNP has evolved into a separate coding system attempting to unify other systems. It uses numeric codes to represent concepts in three areas—Nursing Phenomenon, Nursing Actions, and Outcomes, which are similar to the concepts of nursing diagnosis, interventions, and outcomes.

One factor that differentiates ICNP from other systems is that it has merged the two different taxonomies used for nursing diagnosis and nursing interventions into one classification, which can be used to represent diagnoses, interventions, and outcomes.

Omaha System The Omaha System is a standardized terminology recognized by the American Nurses Association as a standard language system to support nursing practice. It has been in development since the 1970s and is one of the oldest systems for nursing documentation. It often is used in community-based nursing such as visiting nursing associations. It is no longer under copyrights, but when used the terms and structure must be used as published. It is included in the U.S. Department of Health and Human Services interoperability standards for electronic health records, is integrated into LOINC and SNOMED-CT. It is recognized by HL7, congruent with ISO, and being mapped to the ICNP.

NMDS NMDS stands for Nursing Minimum Data Set. It was originally developed as the result of conferences held at the University of Illinois College of Nursing in Chicago in 1977 and at the University of Wisconsin—Milwaukee School of Nursing in 1985 in an attempt to define the minimum set of basic data elements for nursing use in the EHR. It has label and conceptual definitions of the essential, specific elements that are used on a regular basis by the majority of nurses in a variety of settings. The elements are arranged into three categories: nursing care, patient or client demographics, and service elements. NMDS is intended to standardize the collection of essential nursing data and can be used to capture nursing data for comparison of patient outcomes.
PNDS  PNDS stands for Perioperative Nursing Data Set and was developed by the Association of Perioperative Registered Nurses in the early 1990s. Like other nursing systems, it codifies nursing diagnoses, interventions, and outcomes, but this system is focused on the special needs and level of detail required to document perioperative nursing.

PNDS is used by nurses in hospital perioperative settings to document the patient experience from preadmission to discharge. PNDS consists of 74 nursing diagnoses, 133 nursing interventions, and 28 nurse-sensitive patient outcomes. PNDS is incorporated into SNOMED-CT.

PCDS  PCDS stands for Patient Care Data Set. PCDS was developed by Judy Ozbolt at the University of Virginia as a comprehensive catalog of terms used in patient care records at nine hospitals. PCDS was officially adopted as one of the standards by the American Nurses Association in 1998.

PCDS is different from the other classifications that have been previously described. Where CCC was based on home care nursing, the Omaha System on community-based nursing, and PNDS on perioperative needs, PCDS has a much stronger acute care origin. PCDS also includes terms for 363 problems, 311 goals, and 1357 patient care orders. PCDS is organized into 22 care components (the CCC components plus one as Immunology and Metabolism were divided into separate components). However, “the Patient Care Data Set has been developed primarily not as a classification system for clinical terms but as a data dictionary defining elements to be included in and abstracted from clinical information systems.”

Capturing and Recording EHR Data

The value of having an EHR is evident, but how does the data get into the EHR? Thus far we have discussed three forms of EHR data. In subsequent chapters of this book we will explore how healthcare providers (clinicians, nurses, and medical assistants) create codified EHR. But before we move on, let us briefly examine how digital image data and text file data are added to the EHR and used. We will also discuss additional sources of EHR data that can be imported directly into the system.

Digital Image Systems

As discussed previously, digital image data may be subcategorized into diagnostic images and scanned document images. Even with the implementation of a codified EHR, there will always be some paper documents. Obviously there are all the old paper charts of established patients, but there is also a continuing influx of referral letters and other medical documents from outside sources.

Many healthcare organizations choose to bring paper documents into the EHR as scanned images. Although document images do not offer all the benefits of a codified medical record, they do provide widespread accessibility and a means to include source documents for a complete electronic chart.

1Multiple Attributes for Patient Care Data: Toward a Multiaxial, Combinatorial Vocabulary, Judy G. Ozbolt, Ph.D., R.N., 1997.
Most document image systems have a computer program to associate various ID fields and keywords with scanned images. This is called cataloging the image. Catalog data adds the capability to search for the electronic document images in multiple ways.

**Guided Exercise 5: Exploring a Document Imaging System**

In this exercise you will experience how an imaging system works. You will need access to the Internet for this exercise. If you have not already done so, complete the student registration for the MyHealthProfessionsKit provided on the inside cover of this textbook.

**Step 1**

Start your web browser program and follow the steps listed inside the cover of this textbook to select a discipline, click on the book cover that matches this *Electronic Health Records* textbook, and log in.

When the welcome page is displayed, click on the link “Activities and Exercises” or select “Activities” from the drop-down list and click on the button labeled “Go.”

**Step 2**

A menu on the right of the screen will list various activities and exercises. Locate and click on the link **Exercise 5**.

Information about the exercise will be displayed.

Locate and click the link “Click here to start the Document/Image System program.”

A screen similar to Figure 2-3 will be displayed.
The Document/Image System Window
As you proceed through the following steps, you will be introduced to names, functions, and components of the Document/Image System window. This program simulates many of the features typically found in an EHR document/image management system.

The Menu Bar  At the top of the screen, the words “File,” “Select,” “View,” “Setup,” and “Help” are the menus of functions typically found in document image software. We call this the Menu bar. When you position the mouse over one of these words and click the mouse once, a list of functions will drop down below the word.

Once a menu list appears, clicking one of the items will invoke that function. Clicking the mouse anywhere except on the list will close the list. Certain items on the menu are displayed in gray text. These items are not available until a patient or document has been selected. The Setup and Help options are not available in this simulation.

Step 3
Position the mouse pointer over the word “Select” in the Menu bar at the top of the screen and click the mouse button once. A list of the Select menu functions will appear (see Figure 2-4).

![Figure 2-4 Document/Image System after clicking the Select menu.](image)

Step 4
Move the mouse pointer vertically down the list over the word “Patient” and click the mouse to invoke the Patient Selection window shown in Figure 2-5.
Step 5

Find the patient named Raj Patel in the Patient Selection window. Position the mouse pointer over the patient name and double-click the mouse. (Double-click means to click the mouse button twice, very rapidly.)

Once a patient is selected, the patient’s name, age, and sex are displayed in the title at the top of the window.

Compare your screen to Figure 2-6 as you read the following information:

The Toolbar  Also located at the top of your screen are a row of icon buttons called a Toolbar. The purpose of the Toolbar is to allow quick access to commonly used functions. Most Windows programs feature a Toolbar, so you may already be familiar with the concept.

All instructions in these exercises refer to the simulation window. Because you are running this simulation inside a browser, be careful to use the Menu bar and Toolbar inside the simulation window, not the Menu bar or Toolbar of your Internet browser program.

The Catalog Pane  The middle portion of the screen is divided into two window panes. The left pane (just below the Toolbar) is where a list of cataloged documents display once a patient is selected. At the top of the catalog pane there are
eight tabs. These look like tabs on file folders. The tabs are used to limit the list to images by category, making it easier to find a specific type of image quickly. The initial tab is “All Images,” listed in date order.

**Step 6**

Locate the Toolbar in the Document/Image System window. The first icon is labeled “Exit” and it will close the simulation program and return you to the MyHealthprofessionskit page. Do not click it yet.

The next two buttons are used to change display of items in the Catalog pane from a list to thumbnails. Thumbnails are small versions of the document or image.

Position your mouse pointer over the “Thumbs” icon on the Toolbar (circled in Figure 2-7) and click your mouse.

Compare your screen to Figure 2-7.

Now position your mouse pointer over the “Catalog” icon on the Toolbar and click your mouse. Your screen should again resemble Figure 2-6.

**Step 7**

Locate the tab labeled “Med/Srg Hist” above the Catalog pane. Position your mouse pointer over it and click your mouse. The list should now be shorter as it is limited to items cataloged in the category of Medical/Surgical History.
Step 8

Locate the catalog item “Anesthesia Report” and click on it. Compare your screen to Figure 2-8 as you read the following information.
The Image Viewer Pane  The right pane of the window will dynamically display the corresponding image for a catalog entry that is clicked.

Item Details  Just below the Catalog pane is a gray panel that displays information about a selected catalog item such as the user who scanned the document, relevant dates, and a longer description of the item.

Image Tools  Just below the Image Viewer pane are a row of icon buttons used to change the displayed image. These include the ability to page through multipage documents, enlarge or reduce the displayed image.

Step 9
Locate the image tools buttons just below the viewer pane. The first three icons become active whenever a multipage document is selected. The Anesthesia Report has two pages. Locate and click on the Next page button (circled in red in Figure 2-8). The button displays the next page of a multipage document. The numeral between the two buttons is the page number currently displayed. Your screen should now display the second page of the report and the Image Tool should display the numeral two.

The Previous page button is the first icon in the image tools. Locate it and click on it. The image tool area should now display numeral one, and the image viewer should again display the first page of the report.

The next two icons resemble magnifying glasses. One includes a plus sign—this is the Zoom In tool; it enlarges the text in the viewer. The other magnifying glass has a minus sign—this is the Zoom Out tool; it reduces the enlarged view to show more of the page in the viewer.

Locate and click on the Zoom In icon to see how this works.

Cataloging Images
The process of scanning documents or importing scanned images into an image system includes not only capturing the image but tying it to the correct patient and entering data in the computer about the document such as the date, provider, type of image, and so on. This is called cataloging the image. Figure 2-10, shown later, is an example of an image catalog system.

Document images are scanned and cataloged into the EHR by many different people, including nurses, medical assistants, and personnel in the patient registration and Health Information Management departments. During scanning and cataloging, quality control is most important. Once a document has been scanned and cataloged, the original may be shipped to a remote storage facility or shredded. In either case, the original document may no longer be available for comparison. Although the scanned document image is stored safely on the computer, if it has been incorrectly cataloged it may not be easy to locate.

For the most part, the catalog data is entered by hand, but in some instances the image cataloging can be automated. Here are some examples of automated image cataloging:

Paper forms can include a barcode to identify catalog data; the scanning software interprets the barcode and automatically creates the catalog record. For example,
CONSENT TO USE AND DISCLOSE HEALTH INFORMATION for Treatment, Payment, or Healthcare operations

I understand that as part of my healthcare, Memorial Hospital originates and maintains health records describing my health history, symptoms, examination and test results, diagnoses, treatment, and any plans for future care or treatment. I understand that this information serves as:

- a basis for planning my care and treatment
- a means of communication among the many health professionals who contribute to my care
- a source of information for applying my diagnosis and surgical information to my bill
- a means by which a third-party payer can verify that services billed were actually provided
- and a tool for routine healthcare operations such as assessing quality and reviewing the competence of healthcare professionals

I understand and have been provided with a Notice of Privacy Practices that provides a more complete description of information uses and disclosures. I understand that I have the right to review the notice prior to signing this consent. I understand that Memorial Hospital reserves the right to change their notice and practices and prior to implementation will mail a copy of any revised notice to the address I’ve provided. I understand that I have the right to object to the use of my health information for directory purposes. I understand that I have the right to request restrictions as to how my health information may be used or disclosed to carry out treatment, payment, or healthcare operations and that Memorial Hospital is not required to agree to the restrictions requested. I understand that I may revoke this consent in writing, except to the extent that the hospital and its employees have already take action in reliance thereon.

I request the following restrictions to the use or disclosure of my health information:

Signature of Patient or Legal Representative Witness

Date Notice Effective Date or Version

Accepted ______ Denied

Signature: Raj Patel Date: 3-24-2011

Patient: Patel, Raj
Med Rec #: 837155

Figure 2-9 HIPAA Consent Form with barcode.
Figure 2-9 shows a HIPAA authorization form that was printed for patient signature. The form includes a barcode identifying the patient, date, and document type, allowing automatic cataloging of the signed copy when it is scanned by the Document/Image System.

Another type of technology uses Optical Character Recognition (OCR) software to recognize text characters in images. Some document imaging systems can be programmed to find and use the text contained in the scanned document to populate the fields in the catalog records. Typically, only a few types of documents are processed this way, as each document type requires custom programming. However, when an organization images thousands of the same type of document, it can be worth it. For example, your bank keeps an image of the front and back of each check it processes. Because the account number and check number are in a consistent place at the bottom of the check, the bank computers can automatically catalog each image to the correct account as it is scanned.

Guided Exercise 6: Importing and Cataloging Images

In this exercise you will catalog a scanned report and 2 diagnostic images for a patient. You will need access to the Internet for this exercise.

Step 1
If you are still logged in from the previous exercise, proceed to Step 2; otherwise, start your web browser program and follow the steps listed inside the cover of this textbook to select a discipline, click on the book cover that matches this Electronic Health Records textbook, and log in.

When the welcome page is displayed, click on the link “Activities and Exercises” or select “Activities” from the drop-down list and click on the button labeled “Go.”

Step 2
Locate and click on the link Exercise 6. Information about the exercise will be displayed.

Locate and click the link “Click here to start the Document/Image System program.”

The document image system screen will be displayed. (Refer to Figure 2-3 for an example.)

Position your mouse pointer over the word “Select” in the Menu bar at the top of the screen and click the mouse button once.

Move the mouse pointer vertically down the list over the word “Patient” and click the mouse to invoke the Patient Selection window shown in Figure 2-10.

Step 3
Find the patient named Sally Sutherland in the Patient Selection window. Position the mouse pointer over the patient name and double-click the mouse.

Once a patient is selected, the patient’s name, age, and sex are displayed in the title at the top of the window. The Catalog pane displays the message “No Documents or Images” because Sally has no documents or images in the catalog.
Step 4
Because you may not have a scanner connected to your computer, you are going to import a file that has already been scanned but not yet cataloged.

Locate and click on the Toolbar button labeled “Import”.

The “Open Media File” window, displaying available files, will open. Compare your screen to Figure 2-11.

Step 5
Locate and click on the thumbnail image of the radiologist report document (suth70943rpt.tif).

Locate and click on the button labeled “Open.”

Compare your screen to Figure 2-12.

Step 6
The imported file displays in the Image Viewer pane and data entry fields replace the catalog list. The fields shown in Figure 2-12 are the minimum for most Document/Image systems. The actual fields in a catalog record will differ by software vendor or medical facility.

The image you have imported should be the radiologist’s report. The Catalog pane reminds you that it has not been saved into the patient’s EHR.
Figure 2-11 Open Media window displays after the clicking Import icon.

Figure 2-12 Data entry fields in Catalog pane; Image Viewer displays imported Radiology report.
The first two fields in the catalog pane are determined automatically because the Document/Image System recognizes that you have imported the file and that you are performing a manual entry of the catalog data. Other options for these fields are “Scanned” image and “Automatic” cataloging (e.g., from a barcode).

The Category field uses short mnemonic codes to represent longer category names, for example, HIST for “Medical/Surgical History,” or RAD for “Radiology.”

The Category field is already set to “RAD.”

**Step 7**
The first field you will enter is the date of the original document; this is for reference purposes, to locate a document by the date of the report, letter, surgery, and so on. Note that the system will automatically record other dates, such as the date of the scan, the date it was cataloged, and so forth. These other dates are used for audit purposes.


**Step 8**
The final field you must complete is the description. Although the field can hold a lengthy description, only the first portion of it is displayed in the catalog list, which is used by others at the healthcare facility to find the document/image. Therefore, when cataloging documents and images, be sure to put the most important information at the beginning of the description. In this case, you will type: Mammogram Rpt - Dr. Gold.

Compare your fields to those shown in the left pane of Figure 2-12. If everything is correct, click on the button labeled “Save.”

**Step 9**
The Catalog pane will now display your cataloged listing (as shown in Figure 2-13). Now catalog the corresponding diagnostic images.

Locate and click on the Toolbar button labeled “Import.” The Open Media window (shown in Figure 2-11) will be displayed.

Click on the center Thumbnail (the mammogram image “suth70943mam2.tif”). Locate and click on the button labeled “Open.”

**Step 10**
Enter the catalog data in the Catalog entry fields as follows:

Date: 5/23/2012

Description: Mammogram right breast w/abnormality

Compare your screen to Figure 2-14. Click the button labeled “Save.”

The Catalog pane will now display two listings.
Figure 2-13 Cataloged mammogram report.

Figure 2-14 Cataloged mammogram image.
Step 11
Catalog the other mammogram image by clicking the Toolbar button labeled “Import.” When the Open Media window appears, click on the left Thumbnail (the mammogram image “suth70943mam1.tif).

Locate and click on the button labeled “Open.”

Enter the catalog data in the Catalog entry fields as follows:
Date: 5/23/2012
Description: Mammogram left breast

Click the button labeled “Save.” The Catalog pane will now display three listings.

The exercise is concluded. You may exit and close your browser.

**Picture Archival and Communication System (PAC)**

In the previous exercise you imported diagnostic images (mammograms) into the EHR. At many facilities, digital images such as x-rays and CAT scans reside on a separate Picture Archival and Communication System (PAC). These images can be associated with the radiology report in the EHR and appear to be part of the EHR record, even though they are on a separate system. In those facilities, the diagnostic image is not actually imported into the EHR, but rather linked to the patient EHR record.

**Importing Text to the EHR**

The second form of data we discussed is text data—that is, data that consists of words, sentences, and paragraphs, but is not fielded data. Frequently this type of data comes from word processing files that result from transcribed dictation. A good example of this is the radiologist’s report. A radiologist is a specialist who interprets diagnostic images. Radiologists often dictate their impressions of a study (as shown in Figure 2-15.) Their dictation is later typed by a medical transcriptionist. The word processing file containing the radiology report can be imported directly into the EHR, eliminating the steps of printing and scanning.

Similarly, a healthcare facility implementing an EHR will eventually need to bring old paper charts into the Document/Image system. If the facility has retained word processing files of transcribed dictation, importing them as EHR text records instead of scanning the printed pages from the paper chart increases the amount of the EHR that is text data and reduces the number of pages to be scanned.

Although imported text data are not codified like those created when clinicians enter actual data, they may be preferable to a scanned image for two reasons. First, the text records are searchable by computer. Second, text data can be dynamically reformatted for display on smaller devices such as mobile phones, images of scanned documents cannot.

For example, a text document viewed on a small device such as a mobile phone might display in a font suitable for that device. If the same document were a scanned image, it might be too small to read, thus requiring the clinician to zoom the image and making it cumbersome to read.
Importing Coded EHR Data

As we have already learned, the very best form of EHR data is fielded, codified data. In addition to the coded data that will be created by the clinician using an EHR, many other sources of codified data can be imported. Importing coded data produces a better EHR and eliminates the need to re-key data or scan reports into the chart.

For example, electronic lab order and results systems can be interfaced to send the orders and merge test results directly into the patient’s chart. The numerical data that makes up many lab results lends itself to trend analysis, graphs, and comparison with other tests. The ability to review and present results in this manner allows providers to see the immediate, tangible benefits of using an EHR and improves patient care.

Other sources of EHR data available for import into the EHR include vital signs when they are measured with modern electronic devices (as shown in Figure 2-16). Similarly, glucose monitors and Holter monitors are devices that gather and store data about the patient. Most of these medical devices have the ability to transfer the data they have collected to a computer.

When clinicians use the EHR to write prescriptions, the orders are also automatically recorded in the EHR as part of the workflow. This keeps a record of the patient’s past prescriptions and makes renewing prescriptions much faster for the provider.

HL7 Health Level 7 (HL7) is a nonprofit organization and the leading messaging standard used by healthcare computer systems to exchange information. The organization is comprised of healthcare providers, institutions, government...
representatives, and software developers. HL7 uses a consensus process to arrive at specifications acceptable to everyone involved. The HL7 specifications are updated regularly and released as new versions.

Hospitals and other large healthcare organizations often have many different computer systems created by unrelated vendors. These systems generate various portions of the patient's medical data. HL7 is used to translate and interface that data into a main EHR system.

The simplest act of transferring patient information from the admissions office to the radiology department or hospital pharmacy would not be easy without HL7. If you work in a hospital, your hospital probably uses HL7. As a part of this course, it is not necessary to delve into the specific structure or flow of HL7 messages, but it is helpful to understand its advantages and limitations.

HL7 specifications are independent of any application or vendor; therefore, applications that can send and receive HL7 messages can potentially exchange information. That is its advantage and importance to an EHR system.

HL7 has been successful because it is very flexible both in its structure as well as its support for multiple coding standards. However, when a message is received the codes and terms used by the other system may not match those used by the EHR. That is its disadvantage.
To overcome this problem, segments of the HL7 message that contain coded data also contain an identifier indicating which coding standard is being used. A special computer program called an HL7 translator is used to match the codes in the message with the codes in the EHR. The translator also can reconcile differences between HL7 versions from multiple systems.

**DICOM**  
DICOM stands for Digital Imaging and Communications in Medicine. It is the standard used for medical images, such as digital x-rays, CT scans, MRIs, and ultrasound. Other uses include the images from angiography, endoscopy, laparoscopy, medical photography, and microscopy. It was created by the National Electrical Manufacturers Association and is the most widely used format for storing and sending diagnostic images.

DICOM is the standard for communication between diagnostic imaging equipment and the image processing software. The standard also defines the specification for a file that contains the actual digital image. A DICOM file includes a “header” that contains information about the image, dimensions, type of scan, image compression, and so on, as well as patient information such as ID number or name. DICOM compatible software is required to view the image.

**CDISC**  
A subgroup of HL7 is CDISC, which stands for Clinical Data Interchange Standards Consortium. CDISC originated as a special interest group of the Drug Information Association but became its own entity and formed an alliance with HL7. Although the focus of HL7 is to facilitate message standards for a broad range of healthcare, CDISC has a specific focus on clinical drug trials.

CDISC standards enable sponsors, vendors, and clinicians to acquire and exchange data used in clinical trials. Because the FDA is the agency to whom the final results are submitted, the standard is very focused on following the FDA requirements. However, the commitment of CDISC to HL7 will eventually make it easier to use EHR data in clinical trial studies. It is mentioned here because you may encounter CDISC if you work at a healthcare facility that participates in clinical trials.

**Biomedical Devices**  
Biomedical devices can output important and useful medical information that can be received and stored as data in the patient’s EHR. However, the type of data and method of communicating between the device and EHR often are proprietary to the particular device. Therefore HL7 is often used to exchange demographic information between the device and the EHR system.

Still, the advantage of having the data in the EHR is so strong as to warrant the additional interfaces. Many of the patient monitoring, point-of-care testing, and biomedical devices in hospitals have the capability of exporting data to the EHR. Examples include instruments for measuring vital signs and cardiac and arterial blood gas monitors. Today, many of these devices have wired or wireless telemetry to transmit their information to nurses and into the EHR.

A similar capability is available in systems used in medical offices and for patient home monitoring such as the spirometer data shown in Chapter 1, Figure 1-1. Other examples include electrocardiograms, ultrasound, and the vital signs device shown earlier.
Telemonitors  Many patients with chronic conditions are monitored at home using devices such as blood pressure monitors, glucose meters, and Holter monitors. Some of these devices store the readings and transfer the data to the doctor’s system either by using a modem and phone line or by downloading from the device during a patient encounter. For blood pressure monitoring, if the device does not store the readings, the patient may keep a log, which is then entered into the patient’s medical record at the doctor’s office.

One example of a telemonitor is the Holter monitor, a device the patient wears for 24 to 72 hours to measure and record information about the patient’s heart. The data is then transferred either remotely or in person to the doctor’s computer, where it is reviewed. Figure 2-17 shows a patient wearing a Holter monitor.

When a patient is seen in a doctor’s office, measurements of vital signs, a glucose test, or even an ECG reflect only the patient’s condition at that particular time. The advantage of telemonitoring is that it allows the provider to study these values measured many times over the course of the patient’s normal daily activity.

RHIO  One of the issues discussed in Chapter 1 was that patients often no longer see a single doctor, so their records reside at many separate facilities. Regional Health Information Organizations (RHIO) and the Office of National Coordinator for Health Information Technology’s development of a national health information network (NHIN) are both examples of projects to enable the electronic transfer of health records between providers.

Although it may take considerable time to create a true NHIN, many areas of the nation are attempting to create state or local versions. RHIO stands for regional health information organization. The Health Information Management Systems Society (HIMSS) defines a RHIO as a “neutral organization that adheres to a defined governance structure which is composed of and facilitates collaboration among the stakeholders in a given medical trading area, community or region through secure electronic health information exchange to advance the effective and efficient delivery of healthcare for individuals and communities.”

RHIOs encourage the exchange of a patient’s health information across medical practices and facilities that are owned by different entities for the better well-
being of the patient. The formation and operation of a RHIO must overcome numerous obstacles. These include technical, economic, and political issues:

**Technical** Interfacing systems from different vendors in a hospital is not an easy task, but at least it is managed by one Information Technology (IT) department and shares a common network. The level of difficulty becomes multiplied when unrelated hospitals and physician practices—each with numerous systems—attempt to translate data and share a common network.

**Economic** The translation of data from one system to another requires an interface engine and possibly a regional MPI (master person index). Who bears the cost of the networking, interface programming, and maintenance of the translation and MPI systems? Also, many RHIOs operate on a volunteer basis, but require a paid IT director, employed by the RHIO, not one of its members.

**Political** Some participants in the RHIO are business competitors who may be leery about what data is shared and whether it can be analyzed to reveal their patient or case mix, volume of business, and so on. Additionally, state laws may affect who can participate in the RHIO and whether members can be in bordering states.

**Patient-Entered Data**

Numerous studies have shown that patient data also can become a significant contributor to the EHR, for some of the following reasons:

- Only the patient has the information about what symptoms were present at the outset of the illness.
- Only the patient knows the outcome of medical treatment of those symptoms.
- The patient is also the source of past medical, family, and social history.
- Patient-entered data is a more accurate reflection of a patient’s complaints.
- Patients who can review their histories are better prepared for the visit.

A computer program such as Instant Medical History™ developed by Dr. Allen Wenner, allows patients to enter their history and symptom information on a computer in the waiting room or via the Internet prior to the visit. This is the same symptom and history information that the nurse or clinician would have entered. Once the process is completed, the data is organized by the computer for the provider in a succinct and easy-to-read format that becomes the starting point for the encounter.

According to Dr. Allen Wenner, up to 67 percent of the nurse or clinician’s time with the patient is spent entering the patient’s symptoms into the visit documentation. Patient-entered data saves time and allows the triage nurse to focus on the review of the information with the patient rather than on the keying of data. Having a complete history in advance of the visit allows the clinician to ask fewer questions about the diagnosis and concentrate more on the effects of the illness on the patient. It also allows the clinician more time to discuss the treatment plan with the patient.
By Julie DeSantis

Hinsdale Hematology Oncology Associates, Ltd. (HHOA), of Hinsdale, Illinois, switched from traditional paper records to the advanced technology of wireless, mobile electronic medical records (EMR) from IMPAC Medical Systems. At HHOA, the result of implementing an EMR is improved patient and clinician satisfaction, an increased patient load, and an elevated level of process efficiency that has paid for itself within 2 years of implementation.

Michele White, practice administrator at HHOA, said that patient confidence improved with the use of advanced technology, such as PDAs and wireless laptop systems. “Our patients have noticed that our medical documentation is complete, up-to-date, and right at hand,” she said. The patients have more confidence in our doctors, and have received more face-to-face interaction time during their visits, she said. “We have a high standard of care that we did not want to compromise, and with tablet PCs, wireless laptops, and the Siemens PDAs—we have everything we need to access lab reports, scheduling, and more.”

HHOA provides services to 80–100 patients a day—an increase in patient load since installing IMPAC. With 12 busy exam rooms and only 6 physicians, they use IMPAC’s online transcription and report management system to quickly and accurately document patient encounters and manage them online. In addition, HHOA uses a structured noting system for patient documentation within the EMR. All incoming lab results also are downloaded into the system via interface, and available from any laptop at the practice, ensuring the patient record is complete, up-to-date, and easily accessible to physicians and staff. “From an administrative and economic perspective, our mobile access to EMRs has meant that we did not need to purchase additional antivirus software and miscellaneous upgrades. We’ve saved a lot of money, while increasing efficiency, security, and reliability,” White said.

For six years, HHOA used pcAnywhere™ in the physicians’ homes to access the office. However, they have found remote access to the EMR from IMPAC to be faster, more reliable, and readily accessible from anywhere. There are six physicians on staff at HHOA, all with different technical knowledge, but “they are all comfortable with IMPAC’s EMR,” White explained. “They can get any reports they need and print right through the system when they are off-site.”

Patients do not have access to the EHR, but use a separate program that is linked to the EHR. The patient-entered data is reviewed by the doctor or nurse during the exam and before being merged into the EHR. You will have an opportunity to explore this concept yourself in Chapter 11.

Provider-Entered Data

Finally, the surest source of reliable coded EHR data is that entered by the providers (doctor, nurse, and medical assistant) during the patient encounter using a standardized nomenclature. That process will be the subject of Chapters 3–12 of this book.
Functional Benefits from Codified Records

Because coded EHR data is nonambiguous, the computer can use it for trend analysis, alerts, health maintenance, decision support, orders and results, administrative processes, and population health reporting. We will now explore four of the functional benefits that can be derived from using a codified EHR.

Trend Analysis

In healthcare, laboratory tests are used to measure the level of certain components present in specimens taken from the patient. When the same test is performed over a period of time, changes in the results can indicate a trend in the patient’s health.

With a paper chart, the clinician must page through the reports and mentally remember the values to compare them. When a health record is electronic, it is easier to compare data from different dates, tests, or events. When the data is fielded and coded, it is possible to generate graphs and reports that support trend analysis.

To experience the differences in forms of data, we will compare a patient’s lab results that have been stored in each of the three data formats we discussed earlier in this chapter.

Critical Thinking Exercise 7: Retrieving a Scanned Lab Report

In this exercise you will use what you have learned in Guided Exercise 5 to locate information from a recent lab report for a patient.

Step 1
Log into the Document/Imaging simulation on the Myhealthprofessionskit web site as you did in Guided Exercise 5.

Step 2
Select patient Raj Patel.

Step 3
On February 8, 2012, the facility received the results of a lab test performed by Quest laboratories. The lab report was scanned and cataloged in Raj Patel’s chart.

Locate the catalog entry for this lab report and click on it to display the report.

Step 4
When the report is displayed in the Image Viewer, locate the results for the test component “Triglycerides” and write down the value on a sheet of paper with your name and today’s date.

You may need to use the Zoom In button to read the value accurately.
Step 5
Close your browser window and give your paper to your instructor.

This is an example of data in the format of a digital image. As you can see, the lab data are present in the EHR, but requires a human to locate and read the data values.

**Lab Report as Text Data** If a lab results report was received as a text file, it might resemble Figure 2-18. The file could be imported into the EHR, but because the data is not fielded or codified, a computer might have difficulty accurately parsing the data in the report, but it could easily search text records and locate those that contained the word cholesterol. This could be useful to quickly locate records of previous tests containing the same word.

**Coded Lab Data** If the test result data is fielded and coded, the computer can find matching results in the data and generate a cumulative summary report or a graph, making it easier to compare test results from different times and dates.

The cumulative summary report shown in Figure 2-19 has three sections of results: blood gases, whole blood chemistries, and general chemistry. Within each section are the results from tests performed five different times; the date and time is printed above each column of data.

The report is read from left to right; each row contains the name of the test component followed by result values for each of the five times. The right two columns are informational; they contain the range of values considered normal for each particular test and the unit of measure.

A simple graphing tool can turn numeric data in the EHR into a powerful visual aid that would be impractical to create from a paper chart. Figure 2-20 provides an example of how data from multiple lab tests can be quickly extracted and graphed for the clinician. The value of the total cholesterol results over a three-month period of time is trended with the green line. The reference ranges of normal high (200) and low (140) values are shown in the graph as red and blue lines, respectively.

![Figure 2-18 Text-based lab results.](image-url)
The computer is able to generate this graph because the data is fielded and the different tests and components have unique codes. From all the possible tests a patient might have had, the computer can quickly find those coded as "total cholesterol." Using a graph, the clinician can easily see the trend of this patient's total cholesterol levels.

Trend analysis is not limited to lab test results. Graphs of patient weight loss or gain are used as patient education tools. Effects of medication can be measured by comparing changes in dosage to changes in blood pressure measurements. Flow sheets (shown later in Chapter 8) are another type of trend analysis tool.
Alerts

One of the important reasons for the widespread adoption of EHR is the potential to reduce medical errors. Paper charts and even electronic charts that are principally scanned images depend on the clinician noticing a risk factor about the patient. However, when an EHR consists primarily of fielded and codified data using standard nomenclature, rules can be set up that allow the computer to do the monitoring.

Alert is the term used in an EHR for a message or reminder that is automatically generated by the system. Alerts are based on programmed rules that cause the EHR to alert the provider when two or more conditions are met. For example, an electronic prescription system generates an alert when two drugs known to have adverse interactions are prescribed for the same patient.

Alerts can be programmed for just about anything in the EHR. However, the most prevalent alert systems are those implemented with electronic prescription systems. Interactions between multiple prescription drugs, allergic reactions to certain classes of drugs, and patient health conditions that contraindicate certain drugs can all contribute to suffering, additional illness, and in extreme cases even death.

To prevent this, most physicians consult the patient medication list, allergy list, and the Physicians’ Desk Reference (for interactions) before writing a prescription. As a further precaution, the pharmacy checks for drug conflicts and provides the patient with warning materials about the drug. When prescriptions are written electronically, however, the computer can quickly and efficiently check for drug safety and present the clinician with warnings, alerts, and explanatory...
information about the risks of particular drugs. Figure 2-21 shows a clinical warning alert generated by the Allscripts EHR system. Let’s take a closer look at how this process works.

**Drug Utilization Review** When the clinician writing an electronic prescription selects a drug and enters the Sig[^4] information, the EHR system scans the patient chart for allergy information, past and current diagnoses, and a list of current medications. This information is then passed to a drug utilization review (DUR) program that compares the prescription to a database of most known drugs. The database includes prescription drugs as well as over-the-counter drugs, and even nutritional herb and vitamin supplements. The DUR program performs the following functions:

- The drug about to be prescribed is checked against the patient medication list to determine if there is a conflict with any drug the patient is already taking. Certain drugs remain in the body for a period of time after the patient has stopped taking it. This latency period is factored in as well.
- Ingredients that make up the drug are checked against the ingredients of current medications to see if they conflict or would hinder the effectiveness of the drug.
- Drugs are checked for duplicate therapy, which occurs when a patient is taking a different drug of the same class that would have the effect of an overdose.
- Allergy records are checked for food and drug allergies that would be aggravated by the new drug.
- Some drugs cannot be given to patients with certain medical conditions; the patient’s diagnosis history is checked to see if such a situation would occur.
- A patient education alert is created when the drug might be affected by certain foods or alcohol interactions.
- If the Sig has been entered at the time of the DUR, then it is also checked to see if it matches recommended guidelines for the drug. Too much, too little,

[^4]: The term Sig, from the Latin signa, refers to the instructions for labeling a prescription.
too many days, or too many refills could cause overdosing, underdosing (causing it to be ineffective), or abuse.

If the DUR software finds any of these conditions, the clinician is given an alert message explaining the conflict. The clinician can then alter the prescription or select a new drug, having never issued the incorrect one.

**Formulary Alerts** Another type of alert found in many EHR prescription systems warns the clinician if the drug about to be prescribed is not covered by a patient’s pharmacy benefit insurance. This is important because if a patient’s insurance will not pay for it, the patient may choose not to fill the prescription or to take less than the amount prescribed.

Insurance plans provide formularies indicating preferred, nonpreferred, and noncovered drugs. If the clinician prescribes a drug that is not on the list, then when the patient tries to have the prescription filled, the pharmacy will call and ask the physician to change it. This causes an inconvenience to the patient and wastes the doctor’s time. Instead, a clinician using an EHR can select from a list of therapeutically equivalent drugs that are on the formulary of the patient’s insurance plan and avoid writing an incorrect prescription. Figure 2-22 shows an Allscripts Therapeutic Alternatives alert.

**Other Types of Alerts** Electronic lab order systems can provide alerts as well. For example, certain tests are not covered by Medicare. CMS requires that patients sign a waiver indicating that they were notified that a test would not be covered. The waiver is called an Advance Beneficiary Notice (ABN). When certain tests are ordered, the clinician is alerted if an ABN is required.

Another example is an alert that monitors changes in values of certain blood tests and pages a doctor whenever the value is outside of a certain range.
Figure 2-23 Sample advance beneficiary notice form.

**ADVANCE BENEFICIARY NOTICE OF NONCOVERAGE (ABN)**

**NOTE:** If Medicare doesn’t pay for (D)________________ below, you may have to pay.

Medicare does not pay for everything, even some care that you or your health care provider have good reason to think you need. We expect Medicare may not pay for the (D)________________ below.

<table>
<thead>
<tr>
<th>(D)________________</th>
<th>(E) Reason Medicare May Not Pay:</th>
<th>(F) Estimated Cost:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**WHAT YOU NEED TO DO NOW:**
- Read this notice, so you can make an informed decision about your care.
- Ask us any questions that you may have after you finish reading.
- Choose an option below about whether to receive the (D)________________ listed above.

**Note:** If you choose Option 1 or 2, we may help you to use any other insurance that you might have, but Medicare cannot require us to do this.

**OPTIONS:** Check only one box. We cannot choose a box for you.

- **OPTION 1.** I want the (D)________________ listed above. You may ask to be paid now, but I also want Medicare billed for an official decision on payment, which is sent to me on a Medicare Summary Notice (MSN). I understand that if Medicare doesn’t pay, I am responsible for payment, but I **can appeal to Medicare** by following the directions on the MSN. If Medicare does pay, you will refund any payments I made to you, less co-pays or deductibles.

- **OPTION 2.** I want the (D)________________ listed above, but do not bill Medicare. You may ask to be paid now as I am responsible for payment. I **cannot appeal if Medicare is not billed.**

- **OPTION 3.** I don’t want the (D)________________ listed above. I understand with this choice I am not responsible for payment, and I **cannot appeal to see if Medicare would pay.**

**Additional Information:**

This notice gives our opinion, not an official Medicare decision. If you have other questions on this notice or Medicare billing, call 1-800-MEDICARE (1-800-633-4227/TTY: 1-877-486-2048). Signing below means that you have received and understand this notice. You also receive a copy.

<table>
<thead>
<tr>
<th>(I) Signature:</th>
<th>(J) Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>

According to the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0938-0566. The time required to complete this information collection is estimated to average 7 minutes per response, including the time to review instructions, search existing data resources, gather the data needed, and complete and review the information collection. If you have comments concerning the accuracy of the time estimate or suggestions for improving this form, please write to: CMS, 7500 Security Boulevard, Attn: PRA Reports Clearance Officer, Baltimore, Maryland 21244-1850.

Form CMS-R-131 (03/08)                          Form Approved OMB No. 0938-0566
Alerts can be generated by nonactions as well. Task list systems can notify an administrator when medical items are not handled in a timely fashion. CPOE systems can generate alerts when results for a pending test order have not been received within the time frame normally required for that type of test.

Once an EHR system contains codified data, an alert system is just a matter of programming a rule to watch for a certain event or detect a finding with a value above or below the desired limit.

**Health Maintenance**

One of the best ways to maintain good health is to prevent disease, or if it occurs, to detect it early enough to be easily treated. Two important components of health maintenance are preventive care screening and immunizations.

**Preventive Care** The simplest example of health maintenance is a card or letter reminding the patient that it is time for a checkup. In a paper-based office, creating this reminder is a manual process. However, when a medical practice has electronic records, preventive screening can become more dynamic and sophisticated.

Health maintenance systems, also known as preventive care systems, can go beyond simple reminders for an annual checkup. When an EHR has codified data, it can be electronically compared to the recommendations of the U.S. Preventive Services Task Force (described further in Chapter 9).

Using a sophisticated set of rules, the EHR software compares the list of tests recommended for patients of a certain age and sex to previous test results stored in the EHR. It also calculates the time since the test was last performed and compares that to the recommended interval for repeat testing. A guideline unique to the patient is generated and displayed on the clinician’s computer. Using
this information, the clinician can order tests, discuss important healthcare options, and recommend lifestyle changes to the patient at the point of care. Figure 2-24 shows the Health Maintenance screen from EHR vendor NextGen.

It would be difficult to create standardized rules for the preventive care system if the tests were not coded using a standardized coding system. Preventive care screening guidelines are not limited to lab tests; other examples include mammograms, hearing and vision screening, and certain elements of the physical examination.

**Immunizations**  The other important component of preventive care is immunizations. Immunization slows down or stops disease outbreaks. Vaccines prevent disease in the people who receive them and protect those who come into contact with unvaccinated individuals.

Immunizations must be acquired over time. Vaccines cannot be given all at once. Several require repeated applications over a period of time, and some, such as the measles vaccine, cannot be given to children under the age of one year. Therefore, the CDC and state health departments have designed a schedule to immunize children and adolescents from birth through 18 years of age. The CDC also publishes a recommended immunization schedule for adults. Adult immunizations are different from those given to a child.

Using the codified data in an EHR, computers can compare a patient’s immunization history with the CDC-recommended vaccines and intervals and identify which immunizations the patient needs. EHR systems can also scan the data and generate letters to send to patients who have not been in recently but may need to renew their immunizations.

**Decision Support**

Physicians are trained to analyze information from a patient’s history, physical exams, and test results for a medical decision. They are also accustomed to researching the medical literature when faced with an unusual case. However, the quantity of information available to clinicians regarding conditions, disease management, protocols, case studies, and treatments far exceeds their available time to read it.

*Decision support* refers to the ability of EHR systems to store or quickly locate materials relevant to the findings of the current case. These might include defined protocols, results of case studies, or standard care guidelines prepared by specialists, medical societies, or government organizations.

Decision support is not about “artificial intelligence” replacing a physician with a computer; it is instead about providing help just when the clinician needs it. There are many examples of decision support systems, but let us look at four:

- **Prescriptions**  Decision support can include the drug formularies mentioned earlier. Formularies can be used to look up drugs by name or therapeutic class. Electronic prescription systems provide decision support to the clinician by comparing alternative brands that are therapeutically equivalent. They can also provide information on costs, indications for use, treatment recommendations, dosage, guidelines, and prescribing information.
Medical references  Decision support systems can provide quick access to medical references directly from the EHR. This can make access to evidence-based guidelines or medical literature as easy as clicking on a link in the chart.

Protocols  Protocols are one form of decision support that can ultimately speed up documentation of the patient exam and improve patient care. Protocols are standard plans of therapy established for different conditions. With a decision support system, when a doctor has diagnosed a patient with a particular condition, the appropriate protocol appears on the EHR screen and all therapies are ordered with a click of the mouse.

Medication dosing  Many medications have serious side effects, some of which must be monitored by regular blood tests. When both the medications and lab results are stored in the EHR as codified data, it is possible for decision support software to compare changes in medication dosing with changes in the patient’s test results. This assists the clinician in adjusting the patient’s medication levels to obtain the maximum benefit to the patient.

Meeting the IOM Definition of an EHR

Each of the functional benefits we have discussed—trend analysis, alerts, health maintenance, and decision support—are products of EHR systems that store medical records as codified, fielded data. It is only when these functional benefits are added to the clinical practice that the EHR approaches the vision of the IOM and meets the CMS “meaningful use” criteria discussed in Chapter 1.

Chapter Two Summary

The IOM definition of an EHR went beyond a computer that just stores the patient’s medical record to include the functional benefits derived from having an electronic health record. In this chapter we explored how the format that the data are stored in determines to what extent the data can be used to achieve that extended functionality.

The forms of EHR data are broadly categorized into three types:

1. Digital image data (provides increased accessibility)
2. Text-based data (provides accessibility and text search capability; can be displayed on different devices)
3. Discrete data, fielded and ideally codified (provides all of the above plus the capability to be used for trending, alerts, health maintenance, and data exchange)

Increased benefits of an EHR can be realized when the information is stored as codified data. In addition, codified EHR data that adheres to a national standard enables the exchange and comparison of medical information from other facilities.

A code set designed specifically to record medical observations is referred to as a clinical “nomenclature.” Using an EHR nomenclature provides consistency in patient records and improves communication between different medical specialties.
EHR nomenclatures differ from other coding standards in several ways:

- EHR nomenclatures precorrelate individual terms into clinically relevant “findings” or codified observations that are medically meaningful to the clinician.
- Findings are often linked to other findings, which helps the clinician quickly locate associated information and shortens the time required to document the exam.
- EHR nomenclatures differ from billing codes in that EHR nomenclatures have many more codes used to describe the detail of the exam such as the symptoms, history, observations, and plan. Billing codes tend to represent simply that the service was rendered.
- Reference terminologies designed for research may codify each medical term, but these terms can combine in ways that are not clinically relevant; therefore, these nomenclatures are not easy to use at the point of care.
- EHR nomenclatures often include cross-references to other standard code sets. Coding systems not intended for EHR do not typically contain a map to other coding systems.

Several of the most prominent coding standards you are likely to encounter or use in an EHR were discussed in this chapter.

- SNOMED-CT is a medical nomenclature developed by the College of American Pathologists and United Kingdom’s National Health Service.
- MEDCIN is a medical nomenclature and knowledge base used in many commercial EHR systems as well as the Department of Defense CHCS II system. MEDCIN differs from other EHR coding systems in that MEDCIN was designed for point-of-care use by the clinician, so that each “finding” represents a meaningful clinical observation or term. The MEDCIN findings are linked in a “knowledge base.” This enables a clinician to quickly find other clinical “findings” that are likely to be needed. This difference means a physician selects fewer individual codes to complete the patient exam note.
- LOINC stands for Logical Observation Identifier Names and Codes. LOINC is an important clinical terminology for laboratory test orders and results. LOINC has become one of the standard code sets designated by the U.S. government for the electronic exchange of clinical health information.
- CCC stands for Clinical Classification Codes, a system of codes for nursing that is incorporated into other EHR nomenclatures, such as SNOMED-CT, MEDCIN, and LOINC.

EHR data may be captured in many ways:

- Scanning paper records
- Importing diagnostic images in digital format
- Importing text or word processing files
- Receiving data electronically from other systems using
  - HL7
  - DICOM
  - CDISK
RHIO

Biomedical devices

Telemonitoring devices

Patients may enter their own history and symptoms

Providers record the EHR at the point-of-care

When EHR data is coded, it can be used for:

- Trend analysis, the comparison of multiple values or findings over a period of time
- Alerts, computer-prompted warnings such as a potential drug interaction or a lab result seriously above or below the expected range
- Health maintenance, which creates reminders of health screening, immunizations, and other preventive measures
- Decision support, systems to quickly locate materials relevant to the findings of the current case such as defined protocols, standard care guidelines, or medical research

**Testing Your Knowledge of Chapter 2**

1. Name three forms of EHR data.
2. Name at least two medical code sets considered national standards.
3. What is a nomenclature?
4. In an EHR, what is meant by the term “finding”?
5. Describe the difference between an EHR nomenclature and a billing code set.
6. What is one advantage of codified data over document imaged data?

Give examples for the following terms:

7. Trend analysis
8. Decision support
9. Alerts
10. Health maintenance
11. List at least two ways codified data in the EHR can be used to manage and prevent disease.
12. Name at least two benefits of having patients entering their own symptoms and history into the computer.
13. Name a type of decision support.
14. Name some advantages of electronic prescriptions.
15. What is HL7?