CHAPTER

Medical Informatics: The Health Information Technology Decade

CHAPTER OUTLINE

• Learning Objectives
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• The Health Insurance Portability and Accountability Act of 1996: A Brief Introduction
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LEARNING OBJECTIVES

After reading this chapter, the student will be able to

• Define medical informatics.
• Define the decade of health information technology (HIT).
• Define the electronic medical record (EMR) and electronic health record (EHR) and discuss the differences between the two.
• Define interoperability.
• Define regional health information organizations (RHIOs) and discuss their role in interoperability.
• Discuss the EMR developed by the U.S. Indian Health Service.
• Describe computer information systems used in health care settings.
  ■ Hospital information systems (HIS)
  ■ Financial information systems (FIS)
  ■ Clinical information systems (CIS)
  ■ Pharmacy information systems (PIS)
  ■ Nursing information systems (NIS)
  ■ Laboratory information systems (LIS)
  ■ Radiology information systems (RIS)
  ■ Picture archiving and communication systems (PACS)
• Discuss the issues raised by several studies of the computerization of health records.
• Discuss the introduction of and resistance to computer systems in health care environments.

MEDICAL INFORMATICS

Medical informatics is a rapidly expanding discipline. It has a thirty-five year history in which it has sought to improve the way medical information is managed and organized. Medical informatics is located at the “intersection of information technology and medicine and health care.”

Medical informatics has many definitions. The common emphasis in all definitions is on the use of technology to organize information in health care. That information includes patient records, diagnostics, expert or decision support systems, and therapies. The stress is not on the actual application of computers in health care, but the theoretical basis. Medical informatics is an interdisciplinary science “underlying the acquisition, maintenance, retrieval, and application of biomedical knowledge and information to improve patient care, medical information, and health science research.” The tool used to perform these tasks is the computer. Medical informatics focuses on improving all aspects of health care. Some of the aspects it focuses on include improving the clarity of diagnostic images, improving image-guided and minimally invasive surgery, developing simulations that allow health care workers to improve treatments without practicing on human subjects, developing low-cost diagnostic tests, treating physical handicaps, providing consumers with information, coordinating international medical reporting, developing and improving information systems used in health care settings, and developing decision-support systems.

There are several subspecialties of medical informatics. A few are bioinformatics that uses computers to solve biological problems; dental informatics that combines computer technology with dentistry to create a basis for research, education, and the solution of real-world problems in dentistry; and nursing informatics that uses computers to support nurses. Public health informatics uses computer technology to support public health practice, research, and learning.

Currently one important focus of medical informatics is the integration of hospital information systems (HIS), so that radiological images, for example, are
available in real time in the operating room. Once the system in one institution is integrated, another important focus of medical informatics is creating regional, then national (and even international) interoperability (the connection of people and diverse computer systems). The application of computer technology continues to contribute to the achievement of these goals.

This entire book is about medical informatics; in this chapter, we will focus on the health information technology (HIT) decade, electronic medical record (EMR), the electronic health record (EHR), and various computer information systems used in hospitals. In the next chapter, we will focus on accounting in a health care environment. In the rest of the book, specific clinical applications will be emphasized. All of these applications are the focus of medical informatics.

THE HEALTH INFORMATION TECHNOLOGY DECADE

The U.S. government is attempting to make the EHR and electronic prescribing (e-prescribing) universal by 2014. It is calling 2004–2014 the Health Information Technology decade. It has established an Office of the National Coordinator of Health Information Technology (ONCHIT) whose mission is to “provide leadership for the development and nationwide implementation of an interoperable health information technology infrastructure to improve the quality and efficiency of health care and the ability of consumers to manage their care and safety.”

The ONCHIT asserts that “every doctor, outpatient office, hospital and nursing home” needs to computerize. It predicts that HIT will save money, reduce errors, allow the easy tracking of public health data, and protect privacy.

The Bush administration (2001–2009) requested $169 million for HIT for 2007, including $116 million for ONCHIT. The specific tasks proposed for 2007 include the following: promote interoperability; find ways to improve collecting public health surveillance data; find ways for patients to keep their own medical records; “define key elements of basic EHRs”; increase e-prescribing; attempt to solve privacy and security issues. With computerized physician order entry (CPOE), a doctor enters a prescription electronically and it is checked against a hospital database of patients’ allergies and drug interactions. Using bar code medication administration, each patient is given a bar code, which is scanned to identify the patient. Each medication is also bar coded. E-prescribing is seen as a way to reduce medication errors. It is discussed in Chapter 8 on pharmacy. A short definition of e-prescribing is the use of computers and software to enter prescriptions and send them to pharmacies electronically. At the present time (2006), fewer than 20 percent of doctors make use of e-prescribing.

Today, information is gathered manually in most health care facilities. Health records and the privacy of health information have been under the jurisdiction of state governments for many years. However, the federal government was interested in some aspects of health; note such agencies as the Centers for Disease Control (CDC). With health information crossing state lines routinely since the 1990s, HIPAA, which regulates some aspects of health care, was passed by the U.S. Congress.
THE HEALTH INSURANCE PORTABILITY AND ACCOUNTABILITY ACT OF 1996: A BRIEF INTRODUCTION

The Health Insurance Portability and Accountability Act of 1996 (HIPAA) was passed by the U.S. Congress and signed into law in 1996. Its goal was to make health insurance portable from one job to another and to secure the privacy of medical records. Its privacy provisions went into effect gradually in 2003 and the Enforcement rule went into effect in 2006. Its primary purpose is to protect the privacy of individually identifiable health information. Basically, patients must be aware of the privacy policy of the health care provider and be notified when their information is shared (with major exceptions detailed in the Patriot and Homeland Security acts). Patients are guaranteed the right to see and request changes and corrections in their medical records. The information may be used for research, but software exists to remove all personal identifiers. Staff must be trained to respect the privacy of patients; they should not discuss patients in a public area. Measures must be taken to ensure that only authorized people in the office see the record. These measures may include biometrics (using body parts to identify the user), encryption, and password protection. When data is sent over the Internet it is encrypted using software; that is, it is scrambled; it can only be seen by someone with a decryption key.11,12 (For a more detailed discussion of HIPAA, see Chapter 12.)

THE PATIENT INFORMATION FORM

At or before a patient’s first visit, he or she fills out a patient information or registration form. It includes personal data like name, address, home, cell and work phones, date of birth, Social Security number, and student status. The patient is also asked to fill in information about his or her spouse or partner. Medical information is required: allergies, medical history, and current medications. The patient is also asked for the reason for the visit, such as accident or illness, and the name of a referring physician.

In addition, the patient is asked to provide insurance information for him or herself and a spouse or partner. This information includes the name of the primary, secondary, and tertiary insurance carriers, name and birth date of the policyholder, the co-payment, and policy and group numbers.

THE PAPER MEDICAL RECORD

The information on the patient information forms will then be entered onto the patient’s record. The traditional patient record was on paper, stored in one doctor’s office. One of the problems with paper records is that they may be illegible, which can lead to serious errors in diagnosis, treatment, and billing. There is only one copy of a paper record leading to difficulty in sharing patient information and
the possibility of misplacing the record. There can be a time delay between the examination and the completion of the doctor’s notes on the record. A transcribed record or a record typed using a word processor may include human errors also. A paper record is hard to search for specific information. The use of electronic records may help solve some of these problems.

THE ELECTRONIC MEDICAL RECORD

In a computerized office, the information that was gathered and entered onto a patient information form will then be entered into a computer into EMRs. This will form the patient’s medical record. Encouraged by HIPAA and the federal government, the EMR is very gradually replacing the paper record. The federal government has set a goal of 2014 for universal adoption of electronic records and e-prescribing. However, only 14 percent of group practices are currently using e-prescribing. The EMR may be stored in a hospital’s private network. But it may be kept on the Internet. Patients may establish their own records through the iHealth Record. The iHealth Record is a personal medical record that the patient can create and maintain at no cost. It is available at some doctors’ offices.¹³

New software has been developed that makes it possible to store medical information on cell phones. The records include prescribed medications, insurance, and names of doctors among other relevant data. It also contains digital photo identification.¹⁴

THE ELECTRONIC HEALTH RECORD

The information on a patient’s EMR will form the basis of the electronic health record (EHR) (Figure 2.1). Although the terms EMR and EHR are used interchangeably, their meanings are not the same. According to the Healthcare Information Management Systems Society, an organization that promotes the expansion of the use of information technology in health care, “[t]he Electronic Health Record (EHR) is a longitudinal electronic record of patient health information generated by one or more encounters in any care delivery setting. Included in this information are patient demographics, progress notes, problems, medications, vital signs, past medical history, immunizations, laboratory data, and radiology reports. The EHR automates and streamlines the clinician’s workflow. The EHR has the ability to generate a complete record of a clinical patient encounter, as well as supporting other care-related activities directly or indirectly . . .”¹⁵

There are specific differences between the EMR and EHR. The EMR belongs to one health care institution—a doctor’s office or hospital; it must be interoperable (be able to communicate and share information with the other computers and information systems) within that institution only. Ideally the EHR is not the property of any one institution or practitioner. Eventually, it must be interoperable nationally and internationally.¹⁶ It is the property of the patient who can access the
record and add information. It must include information from all the health care providers and institutions that give care to the patient. It thus eases communication among many practitioners and institutions. It is a source for research in clinical areas, health services, patient outcomes, and public health. It is also an educational source. A fully developed EHR automatically sends an alert to a doctor, for example, to warn of any adverse drug interactions. It will also send reminders to a patient who needs a particular test. EHRs also provide decision support in the form of medical references.
There are many benefits predicted from the EHR: As records become interoperable your record will be available anywhere there is a computer on the network; this helps guarantee continuity of care; each of your health care providers will know your full medical history and can therefore provide better care. If you are in an accident in New Jersey, for example, but live in California, your record is a mouse click away. The EHR is legible and complete. Despite its benefits, the EHR raises serious privacy issues. Any network can be broken into, and your medical information can be stolen and misused; a great deal of medical information is private. No one wants their psychiatric diagnosis, HIV status, or children’s head lice infestation broadcast to the neighborhood. HIPAA provides the first federal protection for medical records. (See Chapter 12 for a full discussion of HIPAA and the privacy of medical information.)

According to the U.S. Department of Health and Human Services (HHS), the EHR has been shown to improve health care—(although it cites no actual studies to support this assertion)—and should be universally adopted. However, by 2005 fewer than 20 percent of group practices used the EHR. In hospitals, computerization of all aspects of patient care is also progressing slowly.

Some of the obstacles in the way of introducing the EHR are the initial cost, resistance from medical personnel, and the absence of convincing proof that the EHR improves health care (patient outcomes). HHS recommends that personnel be well-trained and convinced of the necessity of introducing the EHR, that the cost of introducing it be shared among health care providers and others, that EHRs be certified to guarantee their quality, and that the use of EHRs in rural areas be increased. HHS emphasizes that eventually EHRs must be completely interoperable (be able to communicate with each other nationally). “Unless EHR systems can communicate, they are simply islands of data where patient information does not flow seamlessly from one clinical setting to the next.”

**REGIONAL HEALTH INFORMATION ORGANIZATIONS**

A first step toward national interoperability would be regional interoperability. Regional cooperation is being fostered through the establishment of regional health information organizations (RHIOs) in which data could be shared within a region. The national health information network (NHIN) is the infrastructure that would allow communication between RHIOs. Finally a nationally interoperable system would be established, where any patient record would be available anywhere on the national network.

In order to move toward its goal of fully interoperable EHRs, HHS puts out Requests for Proposals (RFPs) that lead to contracts between private, nonprofit groups and HHS. For example, in 2005 three of the contracts that were awarded dealt with some of the problems blocking the adoption of EHRs. Some of the issues
these partnerships will address include standardizing health information, evaluating products, and dealing with privacy and security issues.\textsuperscript{23}

\section*{THE INDIAN HEALTH SERVICE ELECTRONIC HEALTH RECORD}

The Indian Health Service of the Department of HHS of the federal government is responsible for health services for Native Americans and Alaskans. It has developed an EHR with a graphical user interface, which interacts with the resource and patient management system (RPMS) database of health care applications. Each patient’s record is made up of several screens or pages of information including: a notifications page that displays information for the provider, such as new lab reports; a problem list page, which lists a patient’s problems with \textit{International Classification of Disease (ICD) codes}, and is easy to add to, delete from, and modify. The health care provider can use the problem list to generate a purpose of visit (POV), by picking a problem from a variety of POV lists and the patient’s problem list. An adverse reactions page lists all the adverse reactions a patient has had to medications. A page of medications interacts with the pharmacy information system. The system also includes a page to list reminders, and a page for crisis alerts. The lab orders page lists all of a patient’s lab orders and the status of each order. The lab results page lists lab results and also allows the user to graph results. The appointments and visits page lists all of a patient’s appointments and visits to the health care provider. Each patient has a page of vital measurements listing such things as the patient’s temperature and blood pressure. The system provides a reports section in which the provider can create any needed report. The notes page allows the provider to both review old notes and create new ones. Medications, lab tests, and images can be ordered from one screen (the enter orders screen). Superbills of any kind can also be generated. This EHR is customizable; it can be set to open to any screen of choice.\textsuperscript{24} This EHR shows how if all the information systems in a hospital are interoperable, they are united in the individual’s EHR. For those using this system, the Office of Information Technology of New Mexico publishes a clear online manual at http://www.rpms.ihs.gov/TechSupp.asp (Figure 2.1).
systems, to the resistance of staff to systems for which they are not adequately trained, to the imposition of systems designed without worker participation and knowledge of the work process have to be dealt with.\textsuperscript{25}

The first information systems introduced into hospitals (in the 1960s) were used for administrative purposes (managing finances and inventory). Today, the HIS attempts to integrate the administrative and clinical functions in a hospital. Ideally, the HIS includes clinical information systems, financial information systems, laboratory information systems, nursing and pharmacy information systems, picture archiving and communication systems, and radiology information systems. Systems may be technically perfect. However, if the people in the hospital do not use them, they are a failure.\textsuperscript{26}

A financial information system (FIS) is concerned with the financial details of running a hospital. These include payroll, patient accounting (all charges that a person generates as an inpatient or outpatient); accounts payable, accounts receivable, general ledger and asset, claims, and contract management.\textsuperscript{27} FIS are among the oldest and most widely used computerized information systems in health care. Although FIS are not the most important use of computers in health care, because they are so widely used Chapter 3 examines accounting systems in detail.

A clinical information system (CIS) uses computers to manage clinical information. This information includes medical history, and other relevant information, which helps health care personnel make decisions.

The information in a computerized information system is legible and accessible. The U.S. government states that these systems will lead to improved patient outcomes by improving decision making using computerized decision support systems and reducing adverse drug events by eliminating handwritten prescriptions. Actual studies are divided on these questions. However, these systems are expensive to adopt, raise privacy questions, and may be resisted by doctors who believe that their workload will increase.\textsuperscript{28}

Pharmacy information systems (PIS) monitor drug allergies and interactions, and fill and track prescriptions. They also track inventory and create patient drug profiles. Because the PIS receive prescriptions, they need to be able to interact with the CIS. For billing purposes, they needs to be able to interact with the FIS.\textsuperscript{29}

Nursing information systems (NIS) are supposed to improve nursing care by using computers to manage charting, staff scheduling, and the integration of clinical information. NIS are not common and may meet with resistance from nurses. The resistance may stem from a lack of adequate training, the imposition of a system by the management, or the perception (which may be accurate) that the new system will add to their workload.\textsuperscript{30}

Laboratory information systems (LIS) use computers to manage both lab tests and their results.\textsuperscript{31} Ideally, the LIS can interact with the EHR. However, this is often not the case; lab results are usually mailed or faxed to the doctor’s office to be entered into the EHR manually. The California HealthCare Foundation EHR-Lab Interoperability and Connectivity (ELINCS) project is attempting to create “a national standard for the delivery of real-time laboratory results from a lab’s information system to an electronic health record.”\textsuperscript{32}
Radiology information systems (RIS) manage patients in the radiology department including scheduling appointments, tracking film, and reporting results. To add images to a patient’s electronic record, the RIS must be able to interact with the EMR.\textsuperscript{33}

Picture archiving and communication systems (PACS) manage digital images. Digital images are immediately available on the monitor and can be shared over a network. PACS can enhance images and eliminate film.\textsuperscript{34} The standard communication protocol of imaging devices is called digital imaging and communications in medicine (DICOM).

Under the resource and patient management system (RPMS) EHR, the U.S. Department of Health and Human Services Indian Health Service is developing and testing the patient information management system (PIMS) to integrate clinical and administrative functions. PIMS incorporates software that can be used in a hospital setting for admissions, discharge, transfer, outpatient appointments, chart requests, and overseeing the use of patient records deemed “sensitive.” Although the system continues to change in response to users’ comments, it is currently in use in many hospitals.\textsuperscript{35,36}

**DOES COMPUTERIZATION IMPROVE PATIENT OUTCOMES?**

While HHS mandates the EHR and e-prescribing by 2014 and states that this will improve patient care, it does not cite particular studies. Some studies support HHS’ position, others question it. A recent study published in *Health Affairs* did find the EHR and e-prescribing improved health care by decreasing errors caused by illegible handwriting and improving preventive medicine by generating reminders.\textsuperscript{37} Another study, completed in 2006 found that alerts led to a “22% relative decrease in prescribing of non-preferred medications.”\textsuperscript{38} However, the authors point to the fact that not enough providers are using the EHR to see the full benefit of computerization, and an editorial in *Health Affairs* asserted that more testing is needed before “embarking on a widespread program.”\textsuperscript{39}

With all the positive reports on the effects of IT in health care, there are many dissenting voices. In 2005, research published in *JAMA* and reported in the *New York Times* warns of some unintended and negative consequences; although decreasing some medication errors, computerized order entry systems can introduce other kinds of errors. Among the causes cited are “information on patients’ medications was scattered in different places in the computer system. To find a single patient’s medications, the researchers found, a doctor might have to browse through up to 20 screens of information.” Computer crashes can also cause errors. Another study published in *JAMA* examined one hundred decision support systems. It found “most of the glowing assessments of those clinical decision support systems came from technologists who often had a hand in designing the systems.”\textsuperscript{40}
THE INTRODUCTION OF COMPUTER SYSTEMS

Computer systems may have the potential of improving the management of health care information, but only if they are accepted by the people who need to use them. There is no one comprehensive study of the introduction of computer information systems into health care environments. However, the studies that do exist suggest that the most successful systems are created with the participation of those who will use them. Systems imposed from above are not as readily accepted. Any system that is perceived to add work or change workflow is resisted. One Canadian study of three hospitals (published in *CMAJ*) found that the response to physician resistance to the introduction of computer systems was a crucial variable. If the response addressed the real issues that physicians were concerned with, resistance dropped. However, a lack of response or antagonistic response increased resistance to the point of having to discontinue the use of the new information systems (in two of the three hospitals studied). A commentary on this article points out that in all three cases the introduction of the new computerized system “meant that clinicians would need to take more time to care for a patient during a particular encounter.” The commentary further points out that those systems that reduce or are perceived to reduce workload (for example, PACS) are readily accepted.41–47

IN THE NEWS
Excerpt from, “Doctors Join to Promote Electronic Record Keeping”
by Milt Freudenheim

NOT AVAILABLE FOR ELECTRONIC VIEWING
Excerpt from, “Doctors Join to Promote Electronic Record Keeping” (continued)

NOT AVAILABLE FOR ELECTRONIC VIEWING
CHAPTER SUMMARY

- The Bush administration (2001–2009) has declared 2004–2014 the decade of health information technology (HIT) and established an Office of the National Coordinator of Health Information Technology (ONCHIT) to promote the universal use of the EHR, and e-prescribing.
- The EMR is a computerized record of a patient’s health information within one health care facility.
- The EHR is a patient’s record of all his or her health care and will eventually be interoperable nationally.
- The first step for national interoperability is to enable regional interoperability through the establishment of RHIOs.
- The Indian Health Service of the Department of HHS of the federal government has developed an EHR with a graphical user interface that interacts with the RPMS database of health care applications.
- Computerized information systems (hospital information systems that should include FIS, CIS, PIS, LIS, and RIS) are used in some hospitals and other health care facilities to help manage and organize relevant information.
- There is not yet a consensus based on studies on the effects of computerization on patient outcomes.
- The introduction of computer systems may be resisted by those who are supposed to use them.
- In order to afford the EHR, some small practices are banding together.

KEY TERMS

- biometrics
- clinical information systems (CIS)
- computer information systems
- encryption
- e-prescribing
- financial information systems (FIS)
- hospital information systems (HIS)
- iHealth Record
- International Classification of Disease (ICD) codes
- interoperability
- laboratory information systems (LIS)
- medical informatics
- national health information network (NHIN)
- nursing information systems (NIS)
- picture archiving and communication systems (PACS)
- pharmacy information systems (PIS)
- radiology information systems (RIS)
- regional health information organizations (RHIOs)
Multiple Choice

1. _____ Information Systems use computers to manage both lab tests and their results.
   A. Custom
   B. Financial
   C. Laboratory
   D. All of the above

2. _____ informatics focuses on the use of technology to organize information in health care in order to improve health care; it includes the administrative, clinical and special purpose uses of computers.
   A. Financial
   B. Chemo-
   C. Medical
   D. None of the Above

3. _____ informatics uses computer technology to support public health practice, research, and learning.
   A. Public health
   B. Research
   C. Pediatric
   D. Laboratory

4. One important focus of medical informatics is the _____ of HIS, so that the results of one system are immediately available to the others. For example, radiological images would be available in real time in the operating room.
   A. separation
   B. integration
   C. All of the above
   D. None of the above

5. 2004–2014 has been named the _____ decade by the federal government.
   A. public health
   B. health information technology
   C. decade of electronic prescribing
   D. decade of the EHR

6. The _____ is a longitudinal electronic record of patient health information generated by one or more encounters in any care delivery setting.
   A. EMR
   B. EHR
   C. EPR
   D. Both A and B

7. The _____ belongs to one health care institution—a doctor’s office or hospital.
   A. electronic medical record (EMR)
   B. electronic health record (EHR)
   C. electronic personal record (EPR)
   D. Both A and B
8. According to the U.S. Department of HHS, the EHR _____.
   A. has no effect on health care
   B. improves health care
   C. has a negative effect on health care
   D. None of the above

9. Some of the obstacles in the way of introducing the EHR are _____.
   A. the absence of convincing proof that EHR improves health care
   B. resistance from medical personnel
   C. the initial cost
   D. All of the above

10. Regional cooperation is being fostered through the establishment of ____ in
    the United States.
    A. National Health Organizations (NHO)
    B. International Health Organizations (IHO)
    C. RHIOs
    D. None of the above

11. A _____ information system is concerned with the financial details of running
    a hospital.
    A. clinical
    B. radiological
    C. patient
    D. financial

12. _____ information systems are supposed to improve nursing care by using
    computers to manage charting, staff scheduling, and the integration of clinical information.
    A. Clinical
    B. Radiological
    C. Nursing
    D. Financial

13. _____ information systems use computers to manage both lab tests and their
    results.
    A. Laboratory
    B. Radiological
    C. Patient
    D. Financial

14. _____ information systems manage patients in the radiology department
    including scheduling appointments, tracking film, and reporting results.
    A. Clinical
    B. Radiological
    C. Patient
    D. Financial

15. PACS is a system associated with _____ information systems.
    A. Clinical
    B. Radiological
    C. Patient
    D. Financial
Chapter 2  Medical Informatics: The Health Information Technology Decade

True/False Questions

1. The EHR is the property of any one institution or practitioner. _____  
2. The EMR belongs to one health care institution—a doctor’s office or hospital. _____  
3. There are no specific differences between the EMR and EHR. _____  
4. Regional cooperation is being fostered through the establishment of RHIOs. _____  
5. In order to move toward its goal of fully interoperable EHRs, the HHS puts out RFPs that lead to contracts between private, nonprofit groups and the HHS. _____  
6. One of the problems with paper records is that they may be illegible. _____  
7. HIPAA’s goal was to make health insurance portable from one job to another and to secure the privacy of medical records. _____  
8. At the present time a huge majority of doctors make use of e-prescribing. _____  
9. The common emphasis in all definitions of medical informatics is on the use of technology to organize information in health care. _____  
10. When medical data is sent over the Internet it is encrypted using software; that is, it is scrambled; it can only be viewed by someone with a decryption key. _____

Critical Thinking

1 and 2. Describe the objectives of the HIT decade.  
   How would you create reality out of these plans? Where relevant refer to the selected reading. Address some of the following questions:  
a. How would you convince administrators and doctors that EHR and e-prescribing are worth the cost.  
b. You might design a study of a large institution (veterans hospitals) with an electronic system in place.  
c. How would you deal with the negative aspects of introducing EHR and e-prescribing?  
d. How would you deal with the staff who would have to change work patterns to use EHR and e-prescribing.  
3. Define the following  
   • Hospital information systems (HIS)  
   • Laboratory information systems (LIS)  
   • National Health Information Network (NHIN)  
   • Nursing information systems (NIS)  
   • Picture archiving and communication systems (PACS)  
   • Pharmacy information systems (PIS)  
   • Radiology information systems (RIS)  
4. What does interoperability mean? Why is it crucial for the EHR to be nationally interoperable?  
5. What are the differences between the EMR and the EHR? How are they interdependent?


43. Erica Danielson, “A Qualitative Assessment of Changes in Nurses’ Workflow in Response to the Implementation of an Electronic Charting Information System,” A thesis presented to the Division of Medical Informatics and Outcomes Research and the Oregon Health & Science University School of Medicine in partial fulfillment of the requirements of the degree of Master of Science, June 2002.


ADDITIONAL RESOURCES
