Electronic Health Records
Changing the way healthcare manages information

In healthcare today the search for the holy grail is the quest to discover how information technology can be used to meet current and future health care delivery challenges. This paper introduces the topic of electronic health records, identifies the issues of implementing EHR systems in the U.S., and delves into the associated system integration and interoperability difficulties at the heart of these challenges. The resulting recommendations utilize basic change management principles to develop a framework to guide and coordinate the efforts and initiatives focused on this important aspect of healthcare delivery.

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# LEARNING OBJECTIVES

- Understand defining characteristics of Electronic Health Records within U.S. healthcare system
- Identify goals and expectations for EHR
- Identify challenges facing EHR implementation
- Understand the general and specific meanings of the terms Integration and Interoperability
- Identify information exchange challenges facing EHR implementation
- Identify commonly used data communication standards and other standards initiatives within health care
- Understand the roles played by the technical components within the EHR landscape
- Identify the different layers of data protection and security
- Understand the differences between physical and logical data storage

# TOPICAL OUTLINE

- **EHR definition and characteristics**
- **EHR Stakeholder goals, expectations and requirements**
- **EHR issues and concerns**
- **Integration and interoperability definition and characteristics**
- **Integration and interoperability issues and concerns**
- **Communication standards and standards initiatives**
- **Technical components within the EHR landscape**
- **Data protection and security**
- **Physical and logical data storage**
- **Recommendations: applying change management principles to foster technology implementation in healthcare**

# KEYWORDS

1 What are Electronic Health Records?

In many industries, the proliferation of digital technology has dramatically changed the market. For those industries, significant evolution is well underway. Technology is morphing every component and every process into something new. In Healthcare, however, the use of new technology has not been so rapidly embraced. Healthcare appears to be slow to exploit the benefits and reap the gains made possible by technological changes. In Healthcare, investment in information technology, including computer hardware, software and services is only about $3000 per average worker, but in private industry it is about $7000 per worker on average and nearly $15,000 per average worker in banking. In health care today, compared to other industries, we see neither the same levels of investment nor the same level of results. (Lohr, 2004).¹ Health care has been slow to exploit its unique practical and strategic functionalities by effectively integrating technology into the health care environment.²

It isn’t for lack of trying. Healthcare has certainly entered the world of digital technology. Diagnostic imaging exams are captured with digital technology today, not film any more. Administrative systems run on digital information systems, not paper any more. But the greatest influence of technology on health care is yet to come because the most critical core patient care-related functions remain largely untouched by technology. The holy-grail of healthcare IT is becoming clearer. We are starting to call it by a name, and that name is “the Electronic Health Record”. Efforts to define a common terminology and achieve consensus on definitions to name things that we find ourselves needing to communicate about are an important sign that the “search is on” and in fact we are in pursuit of a holy-grail.

With so much focus on Electronic Health Records, and such high expectations for what this change will yield, do we clearly know what it is we’re looking for? We are implementing away, but do we understand how the new technology we’re building really needs to work?

What is the difference between an Electronic Health Record (EHR), an Electronic Medical Record (EMR) and a Personal Health Record (PHR)? Is PHR the same thing as Personal Health Information (PHI)? How do the numerous digital systems like electronic Practice Management (PM) and Enterprise Master Patient Index (EMPI) fit together relative to the definition of Electronic Health Records? KLAS, a company that monitors and reports on the functionality and quality of electronic healthcare systems, delineates over 85 different categories of electronic health information system (each with their own acronym, of course). Is there a framework for understanding how all these different types of data and systems make sense together? Can we define Electronic Health Records (EHR) in a way that empowers our efforts to have digital technology bring significant improvement for the quality and cost of health care deliver?

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¹ Kovner, Anthony R., PhD, Jonas & Kovner’s Health Care Delivery in the United States, P466.

² Shortliffe, Edward H., Biomedical Informatics, p4.
1.1 EHR: a fixed but flexible definition to meet the needs of a rapidly evolving aspect of healthcare delivery

To understand what EHR is, it is necessary first to understand the origins of the concept. In the most rudimentary sense, the notion of the EHR includes the concept of a paperless, computer-based clinical record. This is because the common approach to developing computer applications is to create an automated version of the current paradigm. The present-day paradigm for the health record dates back to the nineteenth century and is built on the concept of a paper-based incarnation of a personalized lab notebook that clinicians used to record their observations and plans to remind themselves of pertinent details when they last saw a patient.

As new concepts emerge, the incremental-change approach is usually made as a first step. However, in the realm of digital technology, shortly after making that first move, or in the midst of making that first move, application developers and system users recognize that going digital changes everything.

Old boundaries disappear. Physical impossibilities become digitally possible. The previous limitations that formed and defined the original paradigm no longer exist in the new digital world order. A whole new paradigm needs to be created.

Thinking about EHR as a digital collection of data from various sources merged into a single object that is generally organized in a chronological order was the innovative first step. It opened the door to consider what the new paradigm for EHR needs to be. However, the early notions of EHR no longer suffice and the paradigm is expanding.

The definition of EHR is undergoing a phase-change. Digital technology is widening the paradigm of EHR to include not only the clinical matters but also administrative and financial topics, research, scholarly information, supporting education and training activities and even office automation. The key idea is that at the heart of all this automation lies the EHR in a new incarnation: electronic, accessible, confidential, secure, structured, aggregate-able, acceptable to clinicians, patients and government, and integrated with other types of non-patient-specific information.

The complexity associated with defining the EHR is best appreciated by analyzing the processes associated with the creation and use of the information it represents. Rather than thinking of the record as an object that needs to be moved around within an institution, think of the EHR as both the data and the processes for capture and management of that data. The EHR is what makes it possible to access, display, analyze and share the data among colleagues and with secondary users who are not in direct patient care. The new paradigm for the EHR is not an object-based concept, but rather, it is a flow-based concept that includes both objects and actions. The definition of EHR has expanded beyond the previous data-constrained boundaries to encompass, also, the processes that an organization uses to create and manage that data. EHR technology enables execution of the processes that support the full range of

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3 Shortliffe, Edward H., Biomedical Informatics, p5.

4 Shortliffe, Edward H., Biomedical Informatics, p5.
requirements for the data. In 2008, implementing EHR is not solely about product development and system installation in the traditional way it has previously been approached. We now understand that EHR inherently is about systems integration and interoperability. Adoption of this new paradigm is critical to achieving the expectations for EHR technology.

Figure 2 Diagram showing the shifting EHR paradigm from the old, object-oriented concept to the new flow-oriented concept that addresses objects and actions.

1.1.1 EHR: the object component
The U.S. Department of Health and Human Services provides the following definition for EHR:

“An electronic health record is a digital collection of a patient’s medical history and could include items like diagnosed medical conditions, prescribed medications, vital signs, immunizations, lab results and personal characteristics like age and weight.”

The problem with creating this type of enumerated-list definition of EHR is that the definition will continually need revision as EHR technology evolves and matures. During periods with high rights of change, the definitions we rely on to maintain the vision that charts the course cannot require frequent revision. The type of definition needed to provide both stability and flexibility must be built in a way to move and morph without losing form. For this reason, a more generalized definition that identifies the core components, but does not enumerate them specifically, may offer more utility.

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5 Shortliffe, Edward H., Biomedical Informatics, p6.

6 “Overcoming Barriers to Electronic Health Record Adoption”. HFMA. p3.
The diagram in the figure below shows four generalized categories that can be used to describe the universe of possible data types present in an EHR.

Figure 3 Diagram showing the 4 basic categories of data that together describe the universe of data types present in an EHR.

Identification data

Identification data meets the need for a system to identify data and gives the digital system a means to identify what something is. Data, in order to be stored, retrieved and related must be identified within the systems that manage it. As simple as this requirement may sound, it creates complex challenges for information management systems. Nearly every data object requires identifying elements, usually called keys or IDs, which serve to identify and index the data stored or accessed by the system. Patient IDs, Physician IDs, procedure IDs (Ices), billing IDs (DRGs) and inventory IDs all pose complex requirements for a digital system. Often the identification data must be unique to permit the logic of the system to operate correctly. Controlling uniqueness within a system is difficult, but even harder is the problem of maintaining uniqueness when data must interoperate between disparate systems. A category of application called and Enterprise Master Patient Record has evolved to address this challenge across integrated delivery networks (IDNs) where a single patient may be known by more than one ID across the IDN or multiple patients could have the same ID but within different locations. Some form of data
identification is always required whether it be only an internally meaningful reference, or an externally meaningful reference.

**Demographic data**

Demographic data includes vital statistics that are meaningful when studying or categorizing a population. The data is typically expected and commonly collected such as birth date, sex, weight, height, etc. It may also include common behavior indicators to categorize activities such as smoking and alcohol consumption. Demographic data must be collected and managed in a structured format to permit data about the object being identified to be searched and aggregated. The information further characterizes relevant information associated with the data. Demographic data is not always required.

**Content data**

Content data is the core data itself. It could be any information that can be captured digitally. It could be test results, lab results, images from a diagnostic procedure, measurements or findings in a standard structured format, waveforms from an Electrocardiograph or in some cases it could be a PDF (Portable Document Format) file generated by scanning a paper data source. Primary content data does not always get physically stored in the same database that manages its index. It may in fact be stored as electronic objects that reside on a separate storage medium and the database merely keeps track of its location. Content data is not always required.

**Metadata**

Metadata is data about the data. Examples include audit information that keeps track of who created which information and when, who accessed it, how many versions or amendments have been made. Another example is data that records if a measurement is an average from other data elements, or a "selected value" among a set of measurements, etc. Metadata is not always required, but regulations such as HIPAA and other security requirements make it unlikely for metadata not to be a part of the needed information. In order to audit access to healthcare information protected under HIPAA regulation, information systems designed for use in healthcare must be able to answer questions like: "Who has accessed this patient information?" and "What information has Dr. Xyz accessed?" To address new legal requirements implied by HIPAA regulation, storing information that makes audit queries possible will require metadata to be accumulated for all types of protected health information.

**1.1.2 EHR: the action component**

Adapted from work done by the Health Financial Management Association, the table shown in the figure below identifies the functions currently viewed as being within the scope of EHR. This list of broad functional areas provides a framework for organizing and studying the processes and actions that today’s EHR systems aim to automate.

<table>
<thead>
<tr>
<th>FUNCTIONAL AREA</th>
<th>PROCESSES/ACTIONS AUTOMATED BY EHR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order Entry/Order Management</td>
<td>Clinical tests, consults, and medication orders entry are all managed electronically.</td>
</tr>
<tr>
<td>Results Management</td>
<td>Physicians are able to enter and access information about patient care that is being or has</td>
</tr>
</tbody>
</table>
been delivered.

<table>
<thead>
<tr>
<th>Electronic Health Information/Data Capture</th>
<th>All patient health information is contained in a computerized repository and stored in a structured way that enables data to be aggregated and interpreted using automated processes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative Processes</td>
<td>Scheduling, resource management, billing, inventory control, and interoperability with other administrative systems.</td>
</tr>
<tr>
<td>Electronic Connectivity</td>
<td>Effective electronic exchange of data among various stakeholder-users of the system.</td>
</tr>
<tr>
<td>Clinical decision support</td>
<td>Clinical performance enhancement through digital tools that aid in diagnosis and disease management.</td>
</tr>
<tr>
<td>Health outcomes reporting</td>
<td>Automatic extraction of information for quality indicator reporting.</td>
</tr>
<tr>
<td>Patient access</td>
<td>Remote, secure access to authorized individual patient records.</td>
</tr>
</tbody>
</table>

**Figure 4** Table of functional areas defining the processes and actions automated by EHR

### 1.2 Defining the landscape of EHR

If EHR is the holy-grail of the quest, the answer in the search, the result of the functioning of technology within healthcare, it is like the y in y=f(x) in a mathematical sense. How then do we express the emerging equation making up the mixture of components that create the complex formula describing EHR?

![Diagram](image-url)  
**Figure 5** Diagram conceptualizing EHR as a function of many electronic system components working together to create the landscape of EHR
The table shown in the figure below provides definition for several of the key components that are often discussed within the scope and context of EHR. Recent efforts by the United States Congressional Budget Office in conjunction with the National Alliance for Health Information Technology and BearingPoint, Inc. to achieve consensus on the definition of health IT terms have provided several recently published definitions.  

Wikipedia also offers generally accepted definitions being compiled within the information technology IT domain.

| Electronic Health Record (EHR) | A computer accessible, interoperable resource of clinical and administrative information pertinent to the health of an individual. EHR differs from EMR in that information is drawn from multiple sources and used primarily by a broad spectrum of people involved in the individual's care, enabling them to deliver and coordinate care and promote a person's wellness. An EMR is a component within the EHR. |
| Electronic Medical Record (EMR) | The digital equivalent to the paper-based medical record that is currently maintained by a healthcare provider about a patient. |
| Personal Health Record (PHR) | A computer-accessible, interoperable resource of pertinent health information on an individual that is managed and controlled by the individual. The information originates from multiple sources and is used by individuals and their authorized clinical and wellness professionals to help guide and make health and wellness decisions. In contrast to the EMR which providers enter data into, the PHR data is entered or data entry is controlled by the individual. |
| Payer-based Health Record (PBHR) | A type of electronic health record that is owned and administered by a health plan. It includes whatever data are available to the health plan but primarily those related to claims. It may include patient demographic information provided during enrollment and additional clinical information required to support claims made to the payer. |
| Practice Management (PM) | An electronic application that deals with the day-to-day operations of a medical practice. The system frequently allow users to capture patient demographics, schedule appointments, maintain lists of insurance payers, perform billing tasks, and |

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<table>
<thead>
<tr>
<th>Clinical Basic Information</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Computerized Physician Order Entry (CPOE)</strong></td>
<td>An electronic application used to order procedures, lab tests, medications or ancillary services requested by physicians and clinical care providers. CPOE systems are typically used within a hospital and they work in conjunction with other IT systems within the hospital.</td>
</tr>
<tr>
<td><strong>Electronic Prescribing (E-prescribing)</strong></td>
<td>An electronic application or functionality that electronically transfers a prescription from the prescribing physician’s location to a pharmacy. E-prescribing functionality can be found within other applications such as CPOE or PM systems and may work in conjunction with CDS systems to reduce transcription and other errors. E-prescribing systems may be offered as an independent system that interoperates with other systems.</td>
</tr>
<tr>
<td><strong>Clinical Decision Support (CDS)</strong></td>
<td>An electronic application used to assist physicians with decision making by providing reminders, suggestions, and support in diagnosing and treating diseases and conditions. CDS applications are typically used in conjunction with CPOE systems within hospitals.</td>
</tr>
<tr>
<td><strong>Hospital Information System (HIS)</strong></td>
<td>An electronic application that provides a comprehensive, integrated information system designed to manage the administrative, financial and clinical aspects of a hospital. The system may encompass paper-based information processing as well as data processing machines.</td>
</tr>
<tr>
<td><strong>Radiology Information System (RIS)</strong></td>
<td>An electronic application used by radiology departments to store, manipulate and distribute patient radiological data and imagery. The system generally consists of patient tracking and scheduling, result reporting and image tracking capabilities. A RIS is a highly configurable application which is customized to facilitate a wide variety of radiology department workflow models.</td>
</tr>
<tr>
<td><strong>Cardiovascular Information System (CVIS)</strong></td>
<td>An electronic application used by cardiology departments to store, manipulate and distribute patient cardiovascular data and imagery. The system generally consists of patient tracking and scheduling, result reporting and image tracking capabilities. A CVIS is a highly configurable application which is customized to facilitate a wide variety of cardiology department workflow models.</td>
</tr>
<tr>
<td><strong>Picture Archive Communication System (PACS)</strong></td>
<td>An electronic system that includes computers, networks and storage systems dedicated to the storage, long-term archive, retrieval, distribution and presentation of images. The most common format for image interchange is DICOM (Digital Imaging and Communications in Medicine). The medical images are stored in an independent format which may be proprietary or DICOM-based. Most PACSs handle images from various medical imaging instruments, including ultrasound, magnetic resonance, PET, computed tomography, endoscopy, mammograms, etc.</td>
</tr>
<tr>
<td><strong>Laboratory Information System (LIS)</strong></td>
<td>An electronic application which handles receiving, processing and storing information generated by medical laboratory processes. Disciplines of laboratory science supported by LIS' include hematology, chemistry, immunology, blood bank (Donor and Transfusion Management), surgical pathology, anatomical pathology, flow cytometry and microbiology. A LIS often must interface with instruments and other information systems such as hospital information systems (HIS). An LIS is a highly configurable application which is customized to facilitate a wide variety of laboratory workflow models.</td>
</tr>
</tbody>
</table>

**Figure 6 table summarizing generally accepted terms used to define components of the EHR landscape.**

Creating precise, shared terminology is an important aspect of growing the knowledge-base related to EHR. Articulating and differentiating the nuances of these terms helps navigators in the search for the holy-grail communicate about what they are finding, learning and creating. The science of EHR is becoming more refined and for individuals closely involved in the quest, the specific meanings associated with the expanding set of terms are important. However, for more general purposes, many of these emerging terms such as “EHR” and “EMR” are used interchangeably to describe the use of technology in healthcare in a broader sense.

### 1.3 Stakeholders in the implementation of Electronic Health Records: the spectrum of vantage-points within the Healthcare environment

Stakeholders in the implementation of Electronic Health Records include the government; federal and state, integrated delivery networks, healthcare management organizations (HMOs), regional healthcare information organizations (RHIOs), hospitals, physicians, consumers, and system vendors. A stakeholder is anyone who has an interest or share in an undertaking or enterprise.
What is the government’s interest in the EHRs implementation process? Let us begin with the federal government. President Bush has endorsed the implementation of electronic health records throughout his administration. Here are two major priority areas—data standardization and experimentation in models. Data standardization as it relates to standards-based approaches to health data collection and exchange. The federal government should encourage, finance, coordinate, and help disseminate findings from a wide range of experiments to find the most successful EMR applications and models.

The state governments as well recognize the need to implement and use EHRs. Their focus is in

- Reducing the variations of interpreting and application of the Health Insurance Portability and Accountability Act (HIPAA) and the need to have common interpretations and applications of the HIPAA rules and develop uniform policies.
- Implement adequate audit processes that include addressing potential privacy and security risks based on an established set of audit criteria that matches the organization needs.
- Secure transmission of personal health information
- Implement well-defined, operational, and deployable models for regional networking
- Consolidate statues, and to identify conflicting or outdated state laws/policies
- Development of a standard national data format
- Educational campaigns directed at consumers, providers, and organizations

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• Provide adequate funding to implement EHRs.\(^9\)

Integrated delivery networks are focusing on bringing back financial stability through leveraging information technology. IDNs are moving towards using wireless communication networks and a centralized medical record database to help facilitate provider’s access to patient data “digital hospitals”. Integrating devices will be essential to their success.\(^10\) HMOs focus is similar, as they want to provide efficient patient-centric care while containing and managing costs. Regional Healthcare Information Organizations priorities are to have a system that supports existing information systems and private-provider healthcare model, be scalable, maintain patient privacy, accommodate heterogeneous data, and provide improved consumer-centric services.\(^11\)

Barriers to hospitals implementing EHRs are:

• Lack of national information standards and code sets
• Inadequate implementation funding
• Concern about physician usage of the system
• Lack of interoperability
• Return on investment.\(^12\)

Provider stakeholders would like to see new ways to enable doctors to use promising new technology; pioneering new methods to measure and improve the quality of care; preventing errors by studying ones that have happened without the threat of lawsuits. Their initiatives also include directing more resources and effort towards disease prevention and helping Americans lead more healthy lifestyles.\(^13\)

Another way to state their agenda is provide an accurate diagnosis, appropriate therapy, resulting in healthier outcomes.

Consumers, which include patients, families, and individuals, want compassion as well as skill with clear communication from their providers. They also want their health information protected for privacy.

System vendors are also stakeholders in the implementation of electronic health records. Their needs are similar to the other stakeholders in that they require their systems to

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\(^9\) Privacy and Security Solutions for Interoperable Health Information Exchange by Linda L. Dimitropoulos, June 20, 2007

\(^10\) Burns and Pauly, “Integrated Delivery Networks: A Detour On The Road To Integrated Health Care”, July/August 2002

\(^11\) Kaufman, Deen, “From Regional Healthcare Information Organizations to a National Healthcare Information Infrastructure”, December 5, 2005

\(^12\) Overcoming Barriers to Electronic Health Record Adoption, www.hrma.org/EHR.pdf

\(^13\) AMA’s National Health Care Policy Agenda, AMA in Washington, May, 01, 2008
- Extraction and sharing of data among systems, while ensuring privacy and security
- Ability to present evidence when clinical decisions are required
- Speed of data entry
- System flexibility
- Be compliant with standards, regulations, and legal requirements.\textsuperscript{14}

### 1.4 Major challenges in the implementation of Electronic Health Records

In an article published in 1999 titled, “Using Information Technology,” the Institute of Medicine’s Committee on Quality of Health Care in America stated that “much of the potential of IT to improve quality is predicated on the automation of at least some types of clinical data” and they discussed four barriers to overcome: privacy concerns, the need for standards, financial requirements, and human factor issues. In a 2006 survey and roundtable discussion conducted by the Healthcare Financial Management Association (HFMA) the top barriers to be: lack of national information standards and code sets, lack of available funding, concern about physician usage, and lack of interoperability. The challenges in 2006 are largely the same as they were in 1999, with one exception, the challenge of interoperability.

A decade ago, when EHR efforts first emerged applications were being developed to address small portions of the overall scope of the EHR problem. As the landscape of EHR systems matured, boundaries and edges became blurred and the interconnected complexity of the total situation began to be revealed. Integration and interoperability challenges were not fully appreciated beforehand. Ten years into the quest, progress is being made, but it has been slow. According to the HFMA survey, only 32% of the larger hospitals surveyed cited high levels of adoption and the adoption rates were progressively lower as the size of the hospital decreased. Clearly, the challenges and barriers to EHR adoption are more significant that many suspected. High rates of customer dissatisfaction with EHR implementations would indicate the progress which has been made is not meeting the expectations.

Perhaps because healthcare got started with EHR implementation relatively late, progress in other industries will continue to fuel dissatisfaction in healthcare until the industry catches up. To compensate for the delayed advance, the healthcare industry needs to act with even greater urgency to overcome the barriers to EHR adoption.

#### 1.4.1 Challenges stemming from the culture, beliefs and delivery models practiced in the U.S.

Human factors encompass a diverse area of the EHR picture. They include EHR adoption challenges such as user interface preferences, comfort utilizing computer systems, and acceptance of using computers for transactions that previously happened between people. The culture of the United States also presents barriers. Blocking progress are issues of privacy, skepticism towards big government and a mistrust regarding harmful ramifications to individuals if too much access to personal health information is shared. Unlike in countries where socialized medicine reduces some of these barriers, the highly

\textsuperscript{14} State of the EHR: The Vendor Perspective, AHIMA, 2004
competitive and independent structure of U.S. medical practices makes top-down procedural changes difficult. Additionally, the U.S. is a highly litigious culture. It is not uncommon, or frowned on to bring legal suites in medical situations. The additional proof and documentation that EHRs provide may open new avenues for individuals and lawyers who are interested in using the information to win damages against physicians. Fear and uncertainty about the legal ramifications of implementing EHRs may be slowing acceptance. Finally, there are differing opinions on whether patients can appropriately interpret their medical information without a physician’s guidance. Humans are an integral part of the system and so non-technical issues must be considered as an integral part of EHR adoption.

1.4.2 Hardware and device challenges
Rapidly changing hardware technology compounds the complexity of EHR development and implementation. There are many challenges for EHR implementation when it comes to hardware. When selecting hardware, decision-makers need to consider many things. What type of server should the organization purchase? Some widely supported servers are Intel-based, IBM RISC or Sun. Reliable storage that could include SANs (storage area networks) or RAID 5 server-based disk arrays. Other hardware considerations are will server redundancy be necessary? What client alternatives are widely supported by vendors? What type of vendor support is available? What type is needed, twenty-four by seven support or business hours support? Has the vendor appropriately sized the hardware for the organization? Can the hardware be upgraded?

Along with hardware selection, organizations face device challenges. Devices can include printers and medical devices. Printer integration can be challenging as they need to be managed, locations must be strategically mapped out for deployment, and connectivity options configured. Medical devices have their own challenges.

Healthcare providers need not only to be HIPAA compliant but they must provide adequate security for their medical devices as stated in recent FDA recommendations to the healthcare community. Medical devices much be secure without interfering with clinical functions, data exchange or device maintenance. Securing medical devices will no doubt have an effect on the development and adoption of electronic health records.

1.4.3 Standards challenges
Development and adoption of standards have been and continue to be ongoing challenges. In May 2003, the AHIMA recommended to the secretary of HHS to establish a national strategy for (1) defining activities for ensuring that the various standard-setting organizations coordinate their work and reach consensus on the definition and use of standards, (2) establish milestones for defining and


implementing all standards, and (3) create a mechanism to monitor the implementation standards throughout the healthcare industry.  

There are several standards utilized in healthcare applications. Some of the more known standards include HL7 (health level seven), HL7 Clinical Document Architecture (CDA), continuity of care record (CCR), HL7 XML, DICOM (digital imaging and communications in medicine), CCOW (clinical context management specification), LOINC (logical observation identifiers names and codes), and X12 which provides for electronic exchange of business transactions-electronic data interchange (EDI).

1.4.4 Integration and Interoperability Challenges
Integration and interoperability challenges are arguably the largest and most challenging barriers we face in adoption of EHR and the successful realization of performance gains and cost improvement possible from implementing new technology. It is the largest challenge because overcoming it would require independent, competing vendors, hospitals, and providers to act in cooperative and coordinated ways when there are few countervailing forces to illicit that behavior. This is the greatest deterrent. Integration and interoperability challenges are delaying the progress and diminishing the results currently possible for EHR implementations.

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2 Integration and Interoperability

“Integration and interoperability” historically has been used as a compound term representing a single concept. Alternatively, the two words are sometimes used as synonyms, but again representing a single concept. Many people, even those involved with software and system development, use the terms without clearly understanding what they mean. There certainly are similarities between the two terms. In the broadest sense, they both describe the same thing: information exchange. So, why make any distinction in the terms? In order to describe the nature of the challenges facing the adoption of technology, further clarification is becoming necessary. As complex issues become more understood and new challenges present stumbling blocks, words to describe the situation more accurately also emerge.

2.1 Definitions

New definitions are evolving to add more precise meaning to the terms integration and interoperability. Definitions found on Wikipedia.org represent the latest understanding for the terms, but these subtle distinctions are not commonly understood or necessarily generally accepted. The emerging definitions may prove useful within the population of healthcare professionals addressing the move to Electronic Health Records.

Integration – is the bringing together of subsystems into one system and ensuring that the individual subsystems function together as a system or can be described as linking of systems together of different software systems physically or functionally.18

Interoperability – is a property referring to the ability of diverse systems to work together or the capability of different programs to exchange data via a common set of standard formats, read and write the same file formats and to use the same protocols.19

In the most detailed use, integration describes bringing two or more disparate systems together so that information can be exchanged between the systems. The systems may use different data standards, storage formats and communication protocols. This type of communication sharing can be considered “forceful”, almost like the two systems were not meant to communicate with each other. Interoperability, while it aims to achieve the same mission, enabling the flow of information, the objectives are different. Interoperability describes a seamless exchange and non-interrupted flow. To the end user, systems that are interoperable utilize information from across the organization without requiring the user intervening to bridge the flow as disjoint junctures. Integrated systems may be apparent to the end user. They also store, use and transmit redundant data that remains in each of the different systems. Think of having an interface engine so that a Lab module can communicate with a hospitals HIS system, this would represent an integrated system. Now, think of having the same functionality but without having the interface engine, the lab module simply “writes” the relevant data to the hospitals HIS database. This is would represent an interoperable system, no middle man to

18 http://en.wikipedia.org/wiki/Integration

facilitate the communication, the system is designed to use the same standards and formats. The goal is to have an interoperable system across the functional scope that yields efficiency and valuable operational results. Then, enable those systems to interoperate where sharing of information makes sense and adds value. More generally, however, both terms are used to express the broad topic of data exchange.

2.2 Functions that are not being met due to lack of integration and interoperability and Common integration and interoperability issues

When it comes to standardization, the most important aspect is interoperability and this term can be broken up into different levels. The first level can be described as the ability of two or more systems to exchange information and is only concerned whether it is readable by the receiver, this is called functional interoperability. The second level is called semantic interoperability and this can be thought of as the ability to share information by the systems so that the information is understood at the level of formally defined domain concepts. The first level you achieve an integrated system and by adhering to both levels you achieve interoperability. Semantic interoperability is absolutely necessary for the automatic information exchange and is where the real value of utilizing decision support systems and care planning applications.

As stated earlier, integration and interoperability is by far one of the most challenging aspects of realizing true quality, cost and performance improvements in healthcare through implementing new technology. One challenge is the ability to cross-reference clinical, quality, financial and patient satisfaction data for reporting and data analysis purposes. The quick solution has been to replicate data into multiple databases. The obvious danger to this type of solution is poor data accuracy and consistency. Another common problem to this solution is the maintenance of multiple systems and databases, more IT personnel, more hardware and higher network traffic. Without some type of interoperability, clinical, financial, and quality information will remain in silos, therefore limiting the ease of cross data analysis and reporting.

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21 Ibid.

3 Data Communication

3.1 Communication Standards and Technology

The success of EHR implementation is dependent upon the establishment and use of common
information management language. The relative lack of robust standards-based technology that
operates in a consistent way to support efficient and effective information exchange within and across
applications has been a major limiting factor in the adoption of EHR.

3.1.1 Clinical Terminology

Clinical terminology is the structured language used within a clinical environment to describe the
treatment of patients. An EHR system requires standard clinical terminology for the safe transfer and
exchange of clinical information. The ability to share information would be severely challenged if
several terms and definitions existed for the same clinical terms. Therefore, standards are required to
ensure an EHR presents consistent and easily understood information about a patient’s medical history
and core morbidities and to enable proper diagnosis and treatment.

The healthcare environment leverages the following standards for defining a structured clinical
terminology.

SNOMED Clinical Terms

SNOMED CT (Systematized Nomenclature of Medicine–Clinical Terms) is a comprehensive clinical
terminology standard endorsed by the U.S. government and is being adopted internationally to facilitate
the exchange of electronic clinical information. The Health and Human Services Secretary Mike Leavitt
stated in April of 2007, “International implementation of SNOMED CT is good for everyone engaged in
developing electronic health records, and it will open up new opportunities for international
collaboration in research and public health surveillance. This use of a standard terminology will enable
the use of health information across borders, facilitate public health surveillance and support evidence-
based research.” SNOMED was originally created by the College of American Pathologists (CAP) but is
now owned by the international group International Health Terminology Standards Development
Organization (IHTSDO)

LOINC

LOINC (Logical Observations Identifiers, Names, Codes) is another standard for clinical terminology that
defines terms for laboratory test orders and results, and other clinical observations. LOINC uses HL7
messages and a coding system to identify clinical observations such as a patient’s vital signs information
(i.e. weight, height, and pulse rate). The LOINC database contains over 30,000 observation terms of
which 25,000 are laboratory test observations. The adoption of LOINC codes will enable EHR systems to
import laboratory results in a common language without requiring translations.

ICD

The ICD (International Classification of Disease) has become the international standard and was first
published in 1893. It has been updated on almost a consistent basis of about every ten years and ICD-9
(Ninth Revision) was published in 1977 and ICD-10 (Tenth Revision) was published in 1992. The World Health Organization (WHO) took over the responsibility in 1948. Currently the ICD-9-CM is being utilized in the clinical setting and United States has not adopted the newest ICD-10 revision. The ICD-10-CM is a clinical modification of the WHO ICD-10 and is maintained by the National Center for Health Statistics (NCHS). It is a morbidity based classification system for diagnoses that is alphanumeric and is comprised of anywhere from 3-7 characters. The ICD-10-PCS is a classification system for procedures and is developed by the Center for Medicare and Medicaid Services (CMS). The structure of the code is alphanumeric containing seven characters.

CPT
CPT (Current Procedural Terminology) was developed in 1966 by the American Medical Association and the most recent version is CPT 2007. Every year the codes are updated to reflect the changes in medical practice and technology.

3.1.2 Physical Communication
The physical devices that collect, transfer, translate, disseminate patient information are required to be connected through a physical or wireless connection to share information between devices. The transport methods between the devices are one of the most significant challenges for hospitals adopting EHRs. A study in 2006 by Healthcare Financial Management Association found that 62% of hospital administrators identified the lack of national information standards and code sets to be the most significant barrier to EHR adoption.

The following diagram provides an example of the typical landscape of devices that communicate and share information to support an EHR.
Common EHR landscape

Enterprise Domain

Hospital Enterprise Network

Network Protocols
- HL7
- DICOM

Patient Care Device Domain

Patient Care Network

Network Protocols
- Proprietary
- IEEE Point of Care

Figure 8 Diagram identifying typical components connected and exchanging data in support of data generation and management for EHR implementations

Patient Care Device Domain

The Patient Care Device Domain addresses information exchange with devices that touch the patient and are used in emergency rooms, intensive care units, operating rooms, and step-down units to mention only a few. The patient care devices can be any device or system that collects real-time or episodic physiological data and passes data to the network. That data may further pass through gateways or other devices for integration into the Hospital Enterprise Network.

The communication interfaces supported by devices functioning in the patient care domain includes two different layers:

Lower Layer Standards

The lower layer describes the transport method used to transfer data to the network. Lower layer standards are typically “off-the-shelf” standards and examples include:

- IEEE 802.1.1b and g
Upper Layer Device Messaging Standards
The upper layer describes the message protocol devices use to send patient data. The protocol defines the structure and content of the messages. There are many proprietary communication protocols that enable vendors to communicate between their own devices but there is limited acceptance of an open standard for device connectivity. IEEE 1073 is a standard that defines a protocol for device connectivity but has had little adoption by vendors.

A more recent effort by manufactures of point-of-care (POC) devices focus on the goal of establishing full connectivity of these devices with the enterprise domain. POC devices have become ubiquitous in healthcare facilities and provide immediate results from administered tests. However, these results are typically printed out or manually entered in a patient charts. This process is vulnerable to translation errors as the information flows to the EHR.

The POC industry has recognized these integration challenges and have come together to create standards for integration into the healthcare network. The Connectivity Industry Consortium (CIC) created three specifications to address specific goals that will eventually enable transparent exchange of POC devices to the EHR domain.

Enterprise Domain
The Enterprise Domain addresses interoperability between electronic patient administration systems, practice management systems, laboratory information systems, dietary, pharmacy and billing systems, as well as electronic medical record and electronic health record systems. Figure 6 includes a gateway device that may be used to translate data from the Patient Care Domain to the Enterprise Domain. A gateway device, for example, may convert data from a proprietary device to a standard protocol that allows devices in the Enterprise Domain to consume the data. The following sections summarize some key standards and initiatives that enable the interoperability of devices and enable workflow efficiencies in the networked, multi-department, multi-vendor environment.

Digital Imaging and Communications in Medicine (DICOM)
The advancements of digital diagnostic imaging equipment in the 1970s identified the need for transferring images and data between device manufactures. The American College of Radiology (ACR) and National Electrical Manufactures Association (NEMA) developed a standard to:

- “promote communication of digital image information, regardless of device manufacturer
- facilitate the development and expansion of picture archiving and communication systems (PACS) that can also interface with other systems of hospital information
- Allow the creation of diagnostic information data bases that can be interrogated by a wide variety of devices distributed geographically.23

The standard has evolved since the original adoption by digital image manufactures based on technology advancements in the areas of a networked environment. The standard has also established levels of conformance based on options implemented by a device manufacturer.

DICOM uses TCP/IP communication protocol to transfer files between two devices. The actual file contains both image data and patient data (i.e. name, ID) so there is a direct correlation between patient and data.

**Health Level Seven (HL7)**

HL7 is the most command and recognized standard framework for exchanging clinical information in a clinical environment. HL7 committee is an all volunteer organization that is represented by key stakeholders from the healthcare system. The organization is accredited by the American National Standards Institute that has defined a collection of message formats and clinical standards. The fact that HL7 only provides a framework for exchange of non-imaging information, one can infer that HL7 is really not a standard. Hospitals and related clinical care facilities typically have unique interpretation of HL7 message formats and therefore a standard clinical model for information exchange in the Enterprise Domain does not exist.

There are two major versions of HL7 since the deployment in the 1990s. HL7 V2.1, released in 1990, was created by clinical interface specialists that were responsible for resolving the interface challenges of disparate clinical applications. The goal of the HL7 committee was to solve 80 percent of the clinical interfacing problems and thereby reduce the cost of integration. HL7 V2 suffered from the lack of documentation and a lack of engagement from the healthcare community.

However, the adoption of HL7 V2 continued to grow as newer versions of V2 were released and the goal of defining 80% of the framework began to be realized. Government agencies and the international community further enhanced the popularity of HL7.

The initial version of HL7 V3 was released in 2005, the Normative Edition 2005. The primary goal of the V3 release was to define a more concise standard with an explicit data model and clear definitions that limits the flexibility of message elements. The V3 standard is not compatible with HL7 V2 because of its rigid framework and has contributed to the slow adoption of the standard by vendors.

The HL7 organization has also developed standards for the representation of clinical documentation such as progress notes and summary reports. HL7 Clinical Document Architecture (CDA) Framework was approved as an ANSI standard in 2000. The CDA Framework defines the structure and semantics of the documents by using XML representation. A document can include text, images, sounds and other media.

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content and can be sent inside an HL7 message. The CDA Framework will be a critical component to enable interoperability between diverse systems in the Enterprise Domain.

3.1.3 Standards Organizations
There are many organizations involved in creation and adoption of EHR technology in medicine. Three have been highlighted below to demonstrate the differentiated missions, yet overlapping goals, of standards organizations operating in the healthcare IT space.

Integrating the Healthcare Enterprise (IHE)
The IHE organization was formed by a common interest of multiple healthcare vendors to define “frameworks” to resolve the gaps that persist in existing standards. “IHE solves issues involving "multiple, heterogeneous information systems" by way of consensus and cooperation between existing healthcare standards agencies.24 It coordinates the use of established standards like DICOM and HL7 but answers issues that remain unresolved within the ambit of DICOM and HL7.25 The frameworks are formalized based on profiles that describe the transactions use to communicate clinical information. IHE uses a four stage process to define the profiles used to improve workflow:
   a) Interoperability problem identification;
   b) Integration profile specification;
   c) Implementation and testing at “connectathon” and
   d) Integration profile conformance statements.26

IHE Profiles eliminate ambiguities, reducing configuration and interfacing costs and ensuring a higher level of practical interoperability.27

Healthcare standards like DICOM and HL7 and initiatives like POC and IHE are critical to achieve efficiencies in workflow in the Patient Care and Enterprise domains.

The Certification Commission for Healthcare Information Technology (CCHIT)
CCHIT is a private not-for-profit organization that serves as the recognized US certification authority for electronic health records (EHR) and their networks. CCHIT was founded in 2004 with support from three leading industry associations in healthcare information management and technology: the American Health Information Management Association (AHIMA), the Healthcare Information and Management

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25 Ibid.

26 Ibid.

27 Ibid.
The medical EHR, serving working granted by HHS securely does functionality, At the United States companies evaluate how the EHRs have been funded CCHIT including the California Healthcare Foundation, payers such as United HealthGroup, providers such as HCA, and software vendors such as McKesson. In October 2006, HHS officially designated CCHIT as a Recognized Certification Body (RCB). Despite the funding and power granted to CCHIT by the federal government, the organization is not an extension of the federal government. 

Because there is little consensus on what should constitute an EHR and how those systems should securely share data, The CCHIT has taken on the task of defining the key functional components of an EHR, how EHR should communicate with other systems and how it should protect patient information. The CCHIT criteria consist of a list of detailed product capabilities against which EHRs are evaluated. At the very least, the CCHIT has created a functional requirements checklist for EHR buyers and developers. At this point, the CCHIT does not evaluate the ease-of-use of EHR software, the financial viability of the companies offering EHR solutions, or the quality of customer support provided by those companies. Nor does CCHIT evaluate EHRs against the requirements of medical specialties. The organization does intend to begin evaluating EHRs for cardiology and pediatrics in 2008. Although the organization already has working groups in ten specialty areas, it will take time for the CCHIT to develop the capabilities it needs to evaluate the full range of specialty EHRs and specialty templates. CCHIT working groups include:

- Ambulatory
- Inpatient
- Network
- Foundation
- Interoperability
- Security
- Child Health
- Cardiovascular Medicine
- Emergency Department
- Privacy & Compliance

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American Health Information Community (AHIC)

AHIC is a federal advisory body, chartered in 2005 to make recommendations to the Secretary of the U.S. Department of Health and Human Services on how to accelerate the development and adoption of health information technology. AHIC was formed by HHS Secretary Michael Leavitt to help advance efforts to achieve adoption of electronic health records. Most respondents indicate that this body will have some impact, but will not ensure adoption of health information technology (IT) solutions. At the time the organization was announced, Vantage Point, a monthly publication of HIMSS, published results of a survey that polled 366 healthcare IT professionals to determine attitudes about the new organization. Most respondents indicated that this body will have some impact, but will not ensure adoption of health information technology (IT) solutions. More specifically, respondents indicated harmonization of standards and the creation of prototypes for Internet-based NHIN architecture would have the most impact on AHIC's ability to direct standards adoption.\(^{31}\)

The organization is organized into smaller working groups that facilitate detailed analysis and harmonization work in each different area. In additional to delivering recommendations to the Secretary, the organization publishes detailed use cases that document the information and actions involved in various workflows that are critical in the delivery of healthcare.

Initial set of working groups:
- CC - Chronic Care
- CE - Consumer Empowerment
- CPS - Confidentiality, Privacy and Security
- EHR - Electronic Health Records
- PHC - Personalized Healthcare
- Pop Health - Population Health and Clinical Care Connections (formerly BSV-Biosurveillance)
- QU – Quality

List of use cases published by the AHIC:

2008 Use Cases
- Remote Monitoring
- Patient - Provider Secure Messaging
- Personalized Healthcare
- Consultation and Transfers of Care
- Public Health Case Reporting
- Immunizations & Response Management

2007 Use Cases
- Emergency Responder — Electronic Health Record
- Consumer Empowerment: Consumer Access to Clinical Information
- Medication Management
- Quality

2006 Use Cases
- Harmonized Consumer Empowerment (Registration & Medication History)

• Harmonized Electronic Health Record (Laboratory Result Reporting)
• Harmonized Biosurveillance (Visit, Utilization, and Lab Result Data)

The Community decided at its November 29, 2005 meeting to form workgroups in the following areas: biosurveillance, consumer empowerment, chronic care, and electronic health records. Subsequently, at the May 16, 2006 Community meeting, two additional groups were formed: the Biosurveillance Data Steering Group as a sub-workgroup within the Biosurveillance Workgroup (renamed Population Health and Clinical Care Connections Workgroup), and the Confidentiality, Privacy & Security Workgroup, which was created as a cross-cutting workgroup responsible for an issue relevant to all the workgroups. More recent, at the August 1, 2006, meeting, the Community formed the Quality Workgroup to address the need for the development of quality measures; and at the October 31, 2006, meeting, the Personalized Healthcare Workgroup was formed to develop and make recommendations on standards for interoperable integration of genomic test information into personal e-health records.

Workgroup meetings are open to the public. Notices for each meeting appear in the Federal Register. Members of the public can listen to the meetings via the Web. Details on how to access each Workgroup meeting are available under that Workgroup’s page on this Web site. The public has the opportunity to submit comments at the end of each meeting. In addition, the Office of the National Coordinator for Health IT provides a conference room at the Department of Health and Human Services in Washington, D.C., in which the public can listen to the meetings. Registration is not required for these meetings. To attend a meeting in an HHS building, members of the public must sign in at the Security Desk at the building entrance, and provide identification which includes a photograph.  

3.2 Data Protection and Security

Once data is captured and the communication protocol is chosen for system interconnectivity, how will this transaction be secured in order for the EHR system to be compliant with privacy and security laws? The application of information technology to healthcare has generated growing concern about the privacy and security of medical information.  

HIPAA Title II, along with the Health Insurance Reform, Security Standards Final Rule, addresses electronic protected health information. The security standards defined basic administrative, physical and technical safeguards to protect electronic protected health information from unauthorized access, alteration, deletion and transmission.

1 American Health Information Community, http://www.hhs.gov/healthit/community/background/


Securing data is executed in layers like an onion. Currently, there are no procedures in place to assess these standards collectively. Each layer must be addressed independently. The figure below illustrates the levels of security.

![Diagram showing levels of security](image)

**Figure 9 Diagram showing how the levels of security providing data protection build upon each other.**

Data security concepts include authentication, authorization and transport security. The diagram above (Figure 9) encompasses the key data security concepts. The data security concepts are addressed in the following levels: 1) data transport in Physical Facility Control level, 2) authorization in Procedural Controls and 3) authentication in the Information System Controls level.

Transporting data in interconnected systems poses a security risk. During transmission, data can be viewed making encryption a healthcare system requirement. Data encryption garbles information that is being transmitted. If viewed or intercepted, data is not decipherable; thereby, preventing disclosure of private information. Utilization of web-based applications increases security vulnerability. In the case of internet data, the risk of data interception is highly probable.

The next security standard, authorization, must be implemented at various levels to safeguard the privacy of medical records. Authorization refers to the privilege of accessing confidential information. Authorization security first must be implemented at the site level to determine if a location should have access to particular information. Next authorization security must be executed at the user level. Some database management systems (DBMS) allow data access authorization at the table-space level, or even more granular control is available at the record and field levels.

Authentication of data ensures the integrity of the data in the EHR. Entry points for data elements managed by the system should be identified and approved. For example, admissions personnel should not be able to enter diagnosis or pharmaceutical requests into the EHR system. With the growing

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dependence on information from the internet and web-based systems, it is imperative that data providers are also identified and approved to help alleviate the threat of system viruses and worms.

The application of technology to manage healthcare information poses security threats inside and outside of the system that must be addressed. Failure to address data security requirements and vulnerabilities by healthcare providers or EHR systems providers may result in monetary fines and legal recourse for not being HIPAA compliant.

### 3.3 Physical and Logical Storage

Contributing to the integration and interoperability challenges, the method in which data is stored introduces additional barriers for EHR adoption. To understand data storage you must understand its physical and logical attributes.

Physical storage is the tangible location of data placement. Physical storage includes storage media, files and databases. Storage media is commonly referred to as any technology used to place, keep, and retrieve data. More specifically, it is any object on which data is preserved. Examples of storage media include magnetic disk, optical disk, and magnetic tape. A file is a collection of information that a computer uses. It is always in a particular format. Common examples of files are flat, text, Microsoft Word files, KSDS (Key Sequenced Data Sets), and VSAM (Virtual Storage Access Method). According to The American Heritage Dictionary, a database is a collection of information arranged for ease and speed of search and retrieval. Data in an EHR is typically stored in a database. Databases have physical storage requirements that must be carefully considered when planning and designing systems. In an EHR system, it is not uncommon to have a separate database for each business unit or for each application domain.

Logical storage is the virtual representation demonstrating the manner in which data is placed. Logical storage may refer to the hardware architecture that increases data storage capacity, improves data availability and speeds data retrieval performance. In order to utilize benefits of having a separate logical storage system, the physical fixed-disk storage hardware architecture must support a distinct logical storage structure. Data can appear to be contiguous to the user, but can be stored discontiguously on the physical volume. This allows data to be stored more efficiently and more safely across multiple physical volumes. Figure 10 is the visual representation of a logical storage hardware architecture utilized in order to save data.

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37. [http://www.sunstarco.com/Education/What%20is%20.....html](http://www.sunstarco.com/Education/What%20is%20.....html)
Figure 10 Diagram showing logical storage hardware architecture utilized to save data.

The figure below depicts a relational database model. The diagram below is yet another representation of how data is stored logically.

Figure 11 Diagram showing logical storage architecture of a relational database.

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The utilization of a database encompasses both logical and physical storage. There are several database models an EHR system can utilize: relational, object oriented, hierarchical, XML, and network. Hierarchical, network, and relational are the most common. Hierarchical database models structures are organized in a top-down or inverted tree-like structure.\(^{40}\)

**Hierarchical Database Structure**

![Hierarchical Database Structure Diagram](image)

**Figure 12** Diagram showing the design of a database with a hierarchical structure.

The structure of a network database is a logical extension of the hierarchical model. Instead of having various levels of one-to-many relationships, the network structure represents a network of many-to-many relationships. The figure below depicts the structure of a network database.\(^{41}\)

**Network Database Structure**

![Network Database Structure Diagram](image)

**Figure 13** Diagram showing the design of a database with a networked structure.

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41. Ibid.
In a relational database, data elements are placed in two-dimensional tables that are the logical equivalent of files.\textsuperscript{42} Data in the relational model, (in most cases) can be linked according to the actual relationship of the various data elements (i.e., one-to-one, one-to-many or many-to-one, and many-to-many). Figure 13 below depicts a relational database structure and shows how key fields are used to relate the information stored in the different tables.\textsuperscript{43}

Figure 14 Diagram showing the design of a database with a relational structure.

The information storage component of EHR systems must address both the logical and physical organization of the data. Regardless of which type of database is implemented, the key factor for integration and interoperability is the ability to interchange data between databases. The use of various types of database structures does not inherently create barriers in integration and inoperability for EHR. The autonomous nature of a database and its inability to communicate is the barrier. A database, by its nature, is solely a storage repository. Often, only the application that created it has any knowledge of how to access the data within the database in a meaningful way. Therein lays the barrier to information exchange. By resolving the disparate databases, abilities to communicate will revolutionize and remove many integration and interoperability challenges for EHR systems.

\textsuperscript{1} Ibid.


\textsuperscript{43} Ibid.
4 What can be done to promote adoption of Electronic Health Records and address the technology goals for improving healthcare delivery in the U.S.?

This is the section where we would put the recommendations about what can be done at different levels. Using the same stakeholder breakout, we should come up with what we think each segment should be aiming for. This structure would basically allow us to address question EHR-6.

4.1 Federal and State Government

Provide incentives to hospitals, payers, physician practices and individuals.

Establish standards.

Create a government-run think tank that tests and validates applications for integration and interoperability. Organization is a non-profit and is neutral and objective about establishing standards and best practices that facilitate data sharing. They also publish papers and develop applications that are in the public domain for all to use – creating a sort of “middleware” layer that protects vendors private intellectual property, yet facilitates collaboration.

4.2 Health Insurance Payers

Health insurers can provide incentives to hospitals, businesses and individuals promoting practices that are weighted to improve measures and outcomes. It will encourage mutual cooperation among stakeholders.

4.3 Hospitals, Integrated Delivery Networks (IDNs), Healthcare Management Organizations (HMOs), Regional Healthcare Information Organizations (RHIOs)

Hospitals are in a unique position in that they have personnel that have experience and knowledge of EHR and various healthcare information systems. With this knowledge and experience we think hospitals within local communities and regions should collaborate, discuss and work together on potential solutions to integration and interoperability. The topic of discussion could literally be what type of EHR’s are being utilized or what kind of standards are being used for communication. Hospitals could also form RHIOs within their regions so that data can be reported and analyzed effectively and accurately. Then the regional RHIOs could be formed into larger ones on a national level and in turn would force some type of standards to be used. This would set a precedence on standards and soon vendors would follow so that hospitals would not have to “message” their data as much to submit to the local RHIOs and eventually we would move to a more interoperable environment instead of just an integrated one.

4.4 Physician Practices

Provide incentives to individuals. Reduced wait times if patients keep their medication records up to date before visits. Increased communication with care providers via e-mail. Decreased need to come for
a visit if issues can be ruled out prior to coming for an appointment. Easier scheduling to be able to view open appointments and schedule themselves. Automate request to schedule an appointment if certain data samples like weight or fatigue or diabetic sugar-levels or blood pressure are recorded as out of range in the person’s EHR.

4.5 Communities
Provide support and education to change the health culture in the area.

Provide services that help to fill the gaps between the new envisioned role of the individual in their healthcare and the current reality.

4.6 Individuals
Individually play an important role in the adoption of electric health records. Each person is in a position to take a more active and pro-active role in understanding and managing their own health and the health of their children, spouse or aging parents under their responsibility. Options for individuals include:

- Create a personal health record. Create them for your kids and talk with your parents to have them begin tracking and recording their health and medical care information. Talk to everyone you can about the benefits you have experienced from having a personal health record and share information about how to do it.

- Hold medical providers more accountable to supply copies of your health information and insist on having them explain what test results and other quantitative measurements mean. Discuss what health indicators you could be tracking such as weight, blood pressure, calcium scores, cholesterol level, PSA test. Request to have a DICOM CD of each imaging procedure, such as mammograms or cardiac ultrasound exams that are evaluated for changes over time.

- Encourage politicians to keep the 2014 mandate for electronic health records on their “agenda” so they will keep this issue on their radar.

- Utilize the personal health record information about the type of procedures and prescriptions you and your family typically utilize in a year to research, compare and consider alternate health insurance plans to determine if you are taking advantage of the best options available to you.

- Encourage employers to provide incentives for employees who participate in health promoting programs.

4.7 System Vendors
Recognize opportunities to provide collaborative “partnerships” with other vendors to deliver more optimal, “whole” solutions to end customer. “The goal of [EHR] is not to automate the paper chart, rather to use automation to provide users with multisource access, concurrent data analysis, and
appropriate warnings and alerts. Fully functional automated systems improve patient care, clinical outcomes, and caregiver productivity.\textsuperscript{44}

Larger companies can become the primary interface to the customer, reducing the number of vendors they must have relationships. Smaller companies can continue to develop new technology and “manufacture” software sub-components that can be marketed, sold and delivered through select partner arrangements, reducing the overhead small companies must invest in staffing to provide customer training and support.

\textsuperscript{1} \textsuperscript{44} Kreider, Nancy A. and Haselton, Becky J., The Systems Challenge, American Hospital Publishing, Inc., 1997, 1\textsuperscript{st} edition.
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