

Introduction to EHR

1.1 Introduction

Use of Information Technology (IT) is common in all areas, including healthcare. Many healthcare organizations use IT-enabled healthcare applications for simplifying healthcare processes such as administration, managing health records across departments, and billing. On the other hand, some organizations are still struggling with conventional healthcare processes and paper-based health records.

Increase in population, complemented with new and complex treatments for diseases, have increased demand for better and more efficient healthcare services globally. Due to complexity of health problems, multiple healthcare providers are involved in treatment of a patient, making healthcare process more complex. Need for complete health information of a patient—such as patient's history, allergies, laboratory tests, medication, and so on—at one place for his/her better care is increasing. Researchers have now realized that increased application of IT to healthcare with Electronic Health Record (EHR) is a way to deal with these issues. Hence, many countries are promoting increased use of IT in healthcare services and use of EHR for enhancing continuity of care to patients.

In the fifth century B.C., Hippocrates developed the first known medical record with two specific goals [EHR Overview 2006]:

1. Preserving course of a disease
2. Indicating probable cause of a disease

These goals are still precise. However, with advancement in IT and introduction of EHR, expectations have increased, such as depicting healthcare workflow, secured and authorized access to health information, faster access to health records irrespective of place and time, and so on.

1.2 Definition of EHR

A simple generic definition of an EHR is health records of a patient in electronic form. However, this definition is not comprehensive. Some definitions of EHR and associated terminologies as found in the literature are:

An ***Integrated Care EHR*** defined by ISO/DTR 20514: “*A repository of information regarding the health of a subject of care in computer processable form, stored and transmitted securely, and accessible by multiple authorized users. It has a standardized information model, which is independent of EHR systems. Its primary purpose is the support of continuing efficient and quality-integrated healthcare and it contains information, which is retrospective, concurrent, and prospective*” [ISO/TR 20514]

An EHR defined by Health Information and Management Systems Society (HIMSS): “*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 via interface including evidence-based decision support, quality management, and outcomes reporting*” [HIMSS 2011]

From both definitions it is clear that EHR is not owned by any single healthcare provider and contains complete records of encounters of a patient throughout the visited healthcare organizations for that particular encounter. EHR aims at providing care to a patient across healthcare organizations.

While surveying the literature, we came across many terminologies that have evolved together with EHR. These terminologies are either subsets of EHR or used by different groups to mean the same thing. However, our analysis indicates that the term EHR is more widely accepted globally, which defines the broadest scope of health information systems. Below we provide definitions of some commonly used related terminologies found in the literature [Diween and Garg 2006]:

- ***Electronic Medical Record (EMR)***. EMR is often used in parallel with EHR. It is a fully interoperable electronic health record of a patient within a healthcare organization. However, some people consider EMR as a set

of records of a patient related to a single encounter or a single care episode. According to this view, EMR is a point-in-time view of a larger EHR. This approach considers an EHR to be sum total of all EMRs of a patient.

- **Computer-Based Patient Record (CPR).** CPR was first used to conceptualize the idea of EHR [Richard et al. 1997]. It is a lifetime health record of a patient, which includes information from all specialties. It requires full interoperability (potentially international interoperability) that may be achieved in the near future.
- **Electronic Patient Record (EPR).** EPR is similar to CPR, but does not necessarily contain a lifetime record and focuses on relevant information only.
- **Personal Health Record (PHR).** PHR is managed and controlled by a patient. It is mostly considered to be web-based. Usually, PHR is another patient-side view of an EHR/EMR maintained by a particular group of healthcare providers.

1.3 Functions of EHR

Margaret and Steven [2005] described EHR as a system of hardware, software, people, policy, and processes that work together to collect data from multiple resources, thus providing information and decision support to multiple healthcare providers irrespective of time and place.

Accordingly, an EHR system should offer the following basic functions:

- **Health Information and Data.** It should store and provide access to health information of patients such as patient's history, allergies, laboratory reports, diagnosis, current medications, and so on, to healthcare providers for taking appropriate clinical decisions for better patient care. It should integrate data from various sources and make it available to the people involved in the care of a patient.
- **Replicate the Workflow.** It should be able to work in-sync with the original workflow of the healthcare organization.
- **Efficient Interaction.** It should be able to work effectively, saving time of care providers by keeping things concise.
- **Clinical Decision Support (CDS).** It should support provision of reminders, prompts, and alerts. Such features help in improving clinical and preventive practices and reduce frequency of adverse events.
- **Patient Support.** It should empower patients to access their health information, enabling them to be involved in their own healthcare.
- **Messaging and Data Processing Capability.** It should enable exchange of data in known/standard formats for interoperability of healthcare applications. Additionally, it should enable processing of incoming data in known/standard formats.

- **Administrative Tools.** It should provide administrative tools, such as scheduling systems, for improving efficiency of clinical practices and timely service to patients.

1.4 Significance of EHR

An EHR system helps to provide an integrated view of healthcare records by enabling integration of various healthcare applications such as Hospital Information Systems (HIS), Pharmaceutical Systems, Imaging Systems, and Health Insurance Systems. In turn, an EHR system plays a significant role in better healthcare services by offering the following advantages [IOM 2003]:

- **Ease of Maintaining Health Information of Patients.** An EHR system enables paperless medical treatment with less space required for storing health data of patients. Additionally, with proper backup policies, the lifespan of EHRs can be increased. This reduces the cost of generating, storing, and maintaining patient records in healthcare organizations.
- **Efficient in Complex Environments.** Large healthcare organizations have many specialty departments, laboratories, training and research centers, and so on. An EHR system helps in improving clinical processes or workflow efficiency across these units of a healthcare organization. For example, it enables an administrator to obtain data for billing, a physician to see progress of treatments, a nurse to report an adverse reaction, and a researcher to analyze efficacy of medications on patients.
- **Better Patient Care.** Often, multiple healthcare providers are involved in treatment of a patient. An EHR system allows sharing of the patient's information among them. Moreover, it enables point-in-time data insertion, retrieval, and update, thereby providing immediate access of patient data from any specialty center whenever required. This enables healthcare providers to make timely decisions for better patient care. Availability of health information, such as past medical history, family medical history, and immunization, through EHR helps in taking preventive measures and managing chronic diseases more effectively.
- **Improve Quality of Care.** EHR helps to decrease reporting and charting time during treatment, thereby improving quality of care. EHR also helps in improving risk management and accurate diagnosis, thereby improving quality of care.
- **Reduce Healthcare Delivery Costs.** Due to the availability of health information data from all healthcare organizations, a healthcare provider can refer to the required test reports, thus avoiding repetition of expensive tests.
- **Accelerates Research and Helps Build Effective Medical Practices.** EHR provides a large database at one place, enabling its use for disease surveillance for providing preventive measures. It also helps in analyzing treatment

patterns of medicine, providing new ideas and ways of drug discovery. Decision support with EHR enables effective medical practices.

- **Better Safety.** Through access, audit, and authorization control mechanisms, an EHR system provides better safety to a patient's health records as compared to a paper-based system.

1.5 Factors Affecting Implementation of EHR

An EHR system needs to deal with multiple healthcare applications and various types of healthcare providers. Hence, its implementation is a complex task that usually requires more time and effort than implementation of several other IT applications. The following factors usually affect the implementation of an EHR system and need to be dealt with properly:

- **Significant Changes in Clinical Workflow.** Implementation of an EHR system in a healthcare organization often requires significant changes in the organization's clinical workflow. Hence, it is always good to make EHR a part of the strategic vision of the organization. Design of the system needs involvement of clinical staff with inclusion of organization's policies and workflow processes [Hamilton 2011].

Although an EHR can be customized for a specific medical practice, clinical workflow varies from one specialty to another. Thus, an EHR having a specific workflow for practicing medicine is usually not adaptable easily.

- **Privacy and Security.** An EHR implementation must deal with privacy and security issues with great care because health care providers are concerned about alteration of EHR without their knowledge, and patients are concerned about unauthorized access to their private data.

An EHR system must also meet the privacy and security regulations for health data imposed by regulatory bodies in the country. This provides assurance to patients and providers that the health data is securely stored and privacy is maintained, while healthcare applications deliver appropriate services. The system should audit log the accesses made to an EHR with strict access policies.

- **Unique Identification.** Duplication of EHR records of a patient in the same EHR system is an important issue in EHR usage. This issue arises because healthcare data of a patient is often collected from various healthcare organizations, with each organization having its own registration process. In the process, different organizations assign different identifiers to the same patient. While integrating such data, an EHR system must properly link all data of a patient to create his/her single EHR.
- **Interoperability.** An EHR system consolidates patients' healthcare data generated from various healthcare systems. Hence, it should be capable of integrating data from all such systems. Moreover, it should enable interoperability among various healthcare applications and systems that are developed independently.

- ***Consistent Use of Standards.*** To support interoperability and information sharing across various healthcare applications and systems, an EHR system requires consistent use of standards such as clinical vocabulary and standardized data formats. Different healthcare applications usually offer different sets of features supporting different structures and data formats. Additionally, these applications usually do not make consistent use of security and data integrity standards. An EHR system must, therefore, make consistent use of standards and upgrade consistently to newly developed standards for addressing these issues.
- ***Ethical and Legal Issues.*** An EHR system must also carefully handle ethical and legal issues that are linked to accuracy, confidentiality and access rights of healthcare data.
- ***Unknown Return on Investment (ROI).*** An EHR system mostly provides intangible benefits. These include improved quality and patient care, patient safety, more efficient tracking of patient data, improved documentation, and better audit of accessed information. Certainly, an EHR system also provides some financial ROI, such as increase in income with expanded patient load due to time efficiency, and reduced material costs such as paper, charts, and printing supplies. Convincing an organization's decision makers to invest in implementing an EHR system on the basis of intangible benefits or related saving only is rather difficult.
- ***Difficult to Operate.*** Some healthcare providers find it more difficult and time-consuming to use computers for data entry than handwriting. Therefore, they need special training, which adds to the cost of implementing an EHR system.
- Additionally, paper-based records have some advantage over EHR. For example, they are less structured and hence offer more flexibility in terms of writing text and putting diagrams. Also, reading text on paper is 40% faster than reading text on a computer screen [Walsh 2004; Lewis 2009].

In spite of the issues listed above for EHR implementation, the question of moving from paper-based system to an EHR system does not arise today. The whole world is moving toward it, and several implementation issues are being addressed gradually.

1.6 Role of Standards

Implementation of an EHR system requires healthcare applications to be interoperable, enabling sharing of data across all such applications. Health Information Technology (HIT) standards provide a foundation for interoperability of healthcare applications. Additionally, implementation of a regionwide or nationwide healthcare information store requires uniformity in:

1. Clinical and business processes of healthcare service providers
2. Information structure for healthcare data
3. Quality of healthcare services
4. Privacy and security regulations and techniques in healthcare services, and so on

Internationally accepted standards are the way to achieve this.

Many Standard Development Organizations (SDOs) and Special Interest Groups (SIGs) are working toward addressing these issues and have evolved and proposed several Healthcare IT standards for the same. The second part of the book includes study of various such standards that have become popular. Standards for EHR specifications, EHR communication/exchange, EHR concepts and processes, and EHR functional specifications are discussed in separate chapters in the first part of this book.

1.7 Role of Clinical Coding Systems

For natural interoperability and common semantics, the healthcare community at large identified the need for developing standard codes for commonly used concepts and terms in healthcare delivery. Hence, code-based vocabularies, terminologies, and classifications were developed. Standardization work in this area involves development of standard code-sets for generally used concepts, terms, disease names, procedures, entity names, laboratory tests, observations, devices, clinical findings, body structure names, pharmaceutical products, organisms, and so on. These code sets primarily assist in meaningful interpretation of healthcare information exchanged across healthcare systems.

Many international organizations have built standard code sets for various categories of health information recorded in electronic health records. To develop an interoperable EHR framework, knowledge of these coding systems is essential to understand their scope, structure, and importance in representing healthcare information. The third part of the book deals with various coding systems supporting different clinical specialties.

1.8 Role of Standard Frameworks

A framework is a complete specification of a system with all structures and operations to be performed for a given objective. Frameworks usually adhere to standard guidelines/specifications for a system and provide mechanisms through APIs or components to build such a system. In healthcare IT, well-developed frameworks for EHRs, coding systems, and clinical data interoperability help in achieving integrated healthcare environment. Thus, it is important to study frameworks in healthcare IT to analyze them for their applicability to enable

integrated healthcare environment. The fourth part of this book describes standard healthcare IT frameworks.

1.9 Case Studies of National EHR Implementations

A single EHR for every individual in a nation has been the dream of many countries. This requires a nation to build a nationwide healthcare IT infrastructure. Hence, the prime design focus for a nationwide EHR is to identify requirements for building a national healthcare IT infrastructure. Because the health of an individual is an important issue with social and private implications, such an infrastructure requires proper consideration for security, legal, and ethical aspects.

Countries with ongoing initiatives for building such an infrastructure are good candidates for case studies of applicability of standards discussed in this book for creating a national EHR framework. Although parameters differ from one country to another due to diversity in expectations, as well as rules and regulations, study of national EHR efforts of various countries will be helpful in visualizing a rich set of situations and their solutions. Such a comprehensive study also helps in listing out issues resulting from geographically, legally, and ethically diverse conditions. Finally, it helps in evolving a matured architecture for a national EHR framework that takes care of existing issues and incorporates the best-known solutions to circumvent those issues.

The fifth part of this book covers case studies of various countries that are building an operational model for a national IT infrastructure, enabling exchange of healthcare information across various healthcare facilities and systems.

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