1.1.1 Integrated Access to Clinical Information: The Future Is Now

- Encouraged by health information technology (HIT) vendors, most healthcare institutions are seeking to develop integrated computer-based information-management environments.

- The key idea, however, is that at the heart of the evolving integrated environments lies an electronic health record that is intended to be accessible, confidential, secure, acceptable to clinicians and patients, and integrated with other types of useful information to assist in planning and problem solving.

1.1.2 Moving Beyond the Paper Record

- The contents of the paper record have traditionally been organized **chronologically**—often a severe limitation when a clinician seeks to find a specific piece of information that could occur almost anywhere within the chart.
- Thus, the EHR is best viewed not as an object, or a product, but rather as a set of processes that an organization must put into place, supported by technology.
- One argument that warrants emphasis is the importance of the EHR in supporting clinical trials—experiments.
- Medical researchers were constrained in the past high costs associated with randomized prospective research protocols.
- The use of EHRs helps to eliminate the manual task of extracting data from charts or filling out specialized datasheets.
- One advantage of using EHR in research : the record environment can help to ensure compliance with a research protocol, pointing out to a clinician when a patient is eligible for a study or when the protocol for a study calls for a specific management plan given the currently available data about that patient.

- Role of electronic health records (EHRs) in supporting clinical trials. With the introduction of EHR systems, the collection of much of the research data for clinical trials can become a **by-product** of the routine care of the patients. Research data may be analyzed directly from the clinical data repository, or a secondary research database may be created by downloading information from the online patient records. In addition, the interaction of the physician with the EHR permits **two way communication**, which can greatly improve the quality and efficiency of the clinical trial. Physicians can be reminded when their patients are eligible for an experimental protocol, and the computer system can also remind the clinicians of the rules that are defined by the research protocol, thereby increasing compliance with the experimental plan

- Another theme in the changing world of healthcare is the increasing investment in the creation of **standard order sets**, **clinical guidelines**, and **clinical pathways.**

- There are at least four major issues that have consistently constrained our efforts to build effective EHRs: (1) the need for standards in the area of clinical terminology; (2) concerns regarding data privacy, confidentiality, and security; (3) challenges in data entry by physicians; and (4) difficulties associated with the integration of record systems with other information resources in the healthcare setting.

1.2 Communications Technology and Health Data Integration

- The **Internet** began in 1968 as a U.S. military research in Advanced Research Projects Agency (ARPA). **Internet** was known as the **ARPANET**
- Novel mechanism for allowing a defense computers, to share data files with each other and to provide remote access.
- Value for non-military research recognized, and by 1973 the first medically related research computer had been added
- Today, the Internet is ubiquitous, accessible
- Why WWW caused growth? Navigating the Web is highly intuitive requires no special training provides a mechanism for access to multimedia information that accounts for its remarkable growth as a worldwide phenomenon.
- Wireless networking is ubiquitous, and inexpensive mechanisms for connecting to the Internet without using conventional computers (e.g., using cell phones or set-top boxes)
- **Wireless networking**
    - Affecting the way that individuals seek health-related information
    - Enhancing how patients can gain access to their health care providers and to their clinical data.

1.2.1 A Model of Integrated Disease Surveillance

Full impact of this use of electronic resources will occur when data from all such records are pooled in regional and national surveillance databases mediated through secure connectivity with the Internet.

Most of the barriers for Pooling and integrating clinical data are logistical, political, and financial rather than technical in nature:

- ***Encryption of data*****:** Concerns regarding privacy and data protection require that Internet transmission of clinical information occur only if those data are encrypted +

mechanism for identifying and authenticating individuals before decrypt the information for surveillance or research use.

- ***HIPAA-compliant policies*:** The privacy and security rules that resulted from the Health Insurance Portability and Accountability Act (HIPAA) do not prohibit the pooling and use of such data.
- ***Standards for data transmission and sharing*:** Sharing data requires all developers of EHRs and clinical databases adopt a single set of standards for communicating and exchanging information. The standard for such sharing, **Health Level 7** (HL7),
- ***Standards for data definitions*:** A uniform "envelope" for digital communication, such as HL7, does not assure that the contents of such messages will be understood or standardized. The pooling and integration of data requires the adoption of **standards for clinical terminology**.
- ***Quality control and error checking*:** must be complemented by a rigorous approach to quality control and error checking. It is crucial that users have faith in the accuracy and comprehensiveness of the data that are collected in such repositories, because policies, guidelines, and a variety of metrics can be derived over time from such information.
- ***Regional and national surveillance databases*:** require mechanisms for creating, funding, and maintaining the regional and national databases. The role of state and federal governments will need to be clarified, and the political issues addressed (including the concerns of some members of the populace that any government role in managing or analyzing their health data may have societal repercussions that threaten individual liberties, employability, and the like).

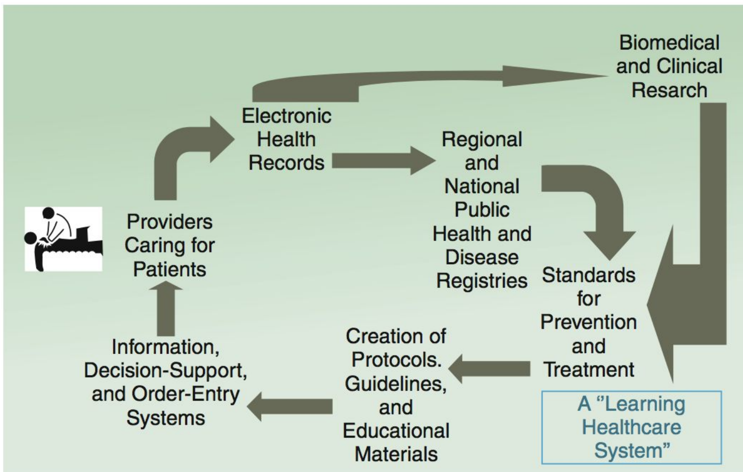
The databases can help to support the creation of **evidence- based guidelines**, or clinical research protocols, which can be delivered to practitioners through the feedback process.

Thus one should envision a day when clinicians, at the point of care, will receive integrated, non-dogmatic, supportive information regarding:

- Recommended steps for health promotion and disease prevention
- Detection of syndromes or problems, either in their community or more widely
- Trends and patterns of public health importance
- Clinical guidelines, adapted for execution and integration into patient-specific decision support rather than simply provided as text documents
- Opportunities for distributed (community- based) clinical research, whereby patients are enrolled in clinical trials and protocol guidelines are in turn integrated with the clinicians' EHR to support protocol-compliant management of enrolled patients

1.2.2 The Goal: A Learning Health Care System

Information cycle: capture > organization > interpretation > ultimate use



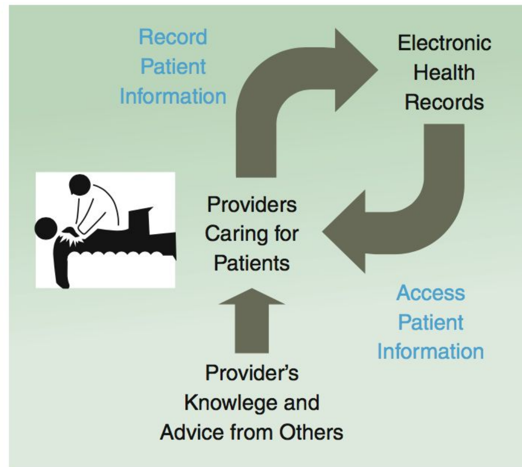


Fig. 1.7 There is a limited view of the role of EHRs that sees them as intended largely to support the ongoing care of the patient whose clinical data are stored in the record

The ultimate goal is to create a cycle of information flow, whereby data from distributed electronic health records (EHRs) are routinely and effortlessly submitted to registries and research databases. The resulting new knowledge then can feedback to practitioners at the point of care, using a variety of computer-supported decision- support delivery mechanisms. This cycle of new knowledge, driven by experience, and feedback to clinicians, has been dubbed a "learning healthcare system"

If we only used EHR without connection to regional and national registry.

1.2.3 Implications of the Internet for Patients

- Penetration of the Internet continues to grow, patients, as well as healthy individuals, are turning to the Internet for health information.
- As a result, physicians and other care providers must be prepared to deal with information that patients discover on the net

- Much of the health information on the Web lacks peer review or is purely anecdotal. People who lack medical training can be misled by such information, just as they have been poorly served in the past by printed information in books and magazines.
- However, new communications technologies offer clinicians creative ways to interact with their patients and to provide higher quality care.
- Years ago medicine adopted the telephone as a standard vehicle for facilitating patient care. If we extend the audio channel "telephone" to include our visual sense as well, typically relying on the Internet as our communication mechanism, the concept of telemedicine emerges. (**<u>Telemedicine = medicine at a distance</u>**)
- The use of telemedicine has subsequently grown rapidly, and there are specialized settings in which it is already proving to be successful and cost-effective (e.g., rural care, international medicine, teleradiology, and video-based care of patients in prisons).

1.2.4 till 1.4

- Many of the trainees are life science researchers, physicians, nurses, pharmacists, and other health professionals who see the career opportunities and challenges at the intersections of biomedicine, information science, computer science, decision science, cognitive science, and communications technologies.
- A national initiative of cooperative planning and implementation for computing and communications resources within and among institutions and clinics is required before practitioners will have routine access to the information that they need. A recent federal incentive program for EHR implementation is a first step in this direction . The criteria that are required for successful EHR implementation are sensitive to the need for data integration, public-health support, and a learning healthcare system.

1.4 .1 Terminology

- **Information science** (occasionally used in conjunction with computer science): originated in the field of library science and is used to refer to management of both paper-based and electronically stored information. It's now drawing evolving interest under the name cognitive science .
- **Information theory:** physics of communication technology; evolved into what may be viewed as a branch of mathematics. Had little effect on our understanding of human information processing.
- Biomedical computer science (for the methodologic issues)

- Biomedical computing or biocomputation (to describe the activity itself)
- total hospital information system(HIS)

Medical informatics: The term is broader than medical computing (it includes such topics as medical statistics, record keeping, and the study of the nature of medical information itself).

Health informatics: the adjective "medical" is too focused on physicians and fails to appreciate the relevance of this discipline to other health and life-science professionals, thus the term "health informatics" gained some popularity, even though it has the disadvantage of tending to exclude applications to biomedical research and focus the field's name on application domains (clinical care, public health, and prevention).

Biomedical informatics: the name medical informatics gradually gave way to biomedical informatics (BMI). It has become the **most widely accepted term** for the core discipline and should be viewed as encompassing broadly all areas of application in health, clinical practice, and biomedical research. Biomedical informatics component sciences include computer science, decision sciences, statistics, cognitive science, information science, and even management sciences.

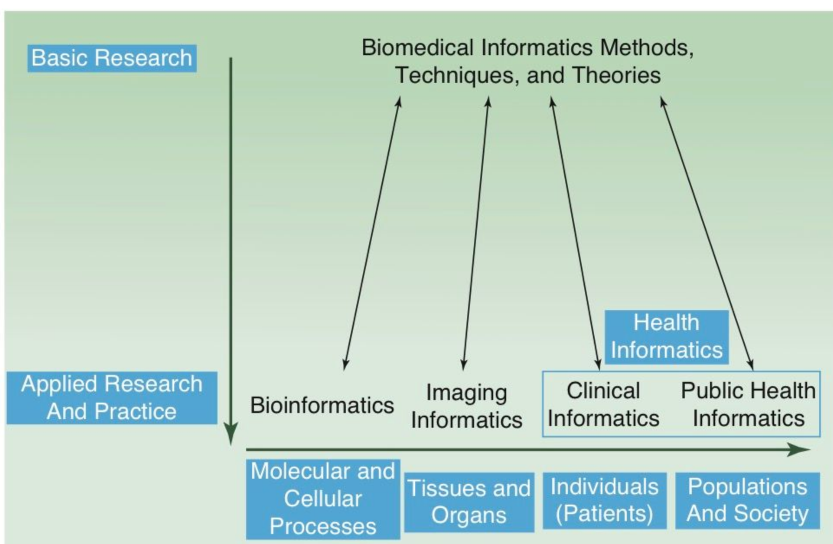
Definition of Biomedical Informatics (published in AMIA's journal)

Biomedical informatics (BMI) is the interdisciplinary field that studies and pursues the effective uses of biomedical data , information, and knowledge for scientific inquiry , problem solving , and decision making , driven by efforts to improve human health .

- **Scope and breadth of discipline :** BMI investigates and supports reasoning, modeling, simulation, experimentation, and translation across the spectrum from molecules to individuals and to populations, from biological to social systems, bridging basic and clinical research and practice and the healthcare enterprise.
- **Theory and methodology :** BMI develops, studies, and applies theories, methods, and processes for the generation, storage, retrieval, use, management, and sharing of biomedical data, information, and knowledge.
- **Technological approach :** BMI builds on and contributes to computer, telecommunication, and information sciences and technologies, emphasizing their application in biomedicine.
- **Human and social context :** BMI, recognizing that people are the ultimate users of biomedical information, draws upon the social and behavioral sciences to inform the design and evaluation of technical solutions, policies, and the evolution of economic, ethical, social, educational, and organizational systems.

1.4.3 - Relationship to Biomedical Science and Clinical Practice

- **clinical informatics:** an area of activity that demands patient-oriented informatics applications.
- It includes several sub topics and areas of specialized expertise, including patient-care foci such as *nursing informatics* , *dental informatics* , and *veterinary informatics.*
- Closely tied to clinical informatics is **public health informatics.** Where similar methods are generalized for application to populations of patients rather than to single individuals.
- In **bioinformatics**, workers deal with **molecular** and **cellular** processes in the application of informatics methods.
- Workers focus on tissues and organs, which tend to be the emphasis of **imaging informatics** work (also called: **structural informatics**)
- Biomedical informatics and bioinformatics are **not synonyms** and it is **incorrect** to refer to the scientific discipline as bioinformatics, which is, rather, an important area of application of **BMI** methods and concepts.
- The term **health informatics,** which refers to applied research and practice in clinical and public-health informatics is also **NOT** an appropriate name for the core discipline, since **BMI** is applicable to *basic human biology as well as to health.*



Picture: The relationship between biomedical informatics as a core scientific discipline and its diverse array of application domains that span biological science, imaging, clinical practice, public health.

- Many areas of applied informatics research involve *more than* one of the categories. **For example,**
  - Biomolecular imaging involves both bioinformatics and imaging informatics concepts.
  - Analysis of linked genotypic and phenotypic databases, and therefore lies at the intersection of bioinformatics and clinical informatics.
- A particular topic in the study of medical decision making is **diagnosis.**
- Although a diagnosis may be one of the first things physicians think about when they see a new patient, **patient assessment** (diagnosis, management, analysis of treatment results, monitoring of disease progression, etc.) is a *process that never really terminates.*

1.4.4 - Relationship to Computer Science

- Many computer science programs were located in departments of electrical engineering, because major concerns of their researchers were computer architecture and design and the development of practical hardware components.
- At the same time, computer scientists were interested in programming *languages* and *software*, undertakings **NOT** particularly characteristic of *engineering*.
- **Biomedical informatics** draws from all of these activities—development of hardware, software, and computer science theory.
- **Biomedical computing** generally has **NOT** had a large enough market to influence the course of major hardware developments; i.e., computers have **NOT** been developed specifically for biomedical applications.
- For several years **MUMPS** was the most widely used language for medical record processing. (**MGH Utility Multi-Programming System, known as the MUMPS language**)
- Does BMI differ from biomedical computer science? Is the new discipline simply the study of computer science with "biomedical flavor"? Ans "Definition of BMI"
- Biomedical informatics is *more than* simply the biomedical application of computer science.
- The issues that it addresses NOT only have broad relevance to health, medicine, and biology, but the underlying sciences on which BMI professionals draw are inherently interdisciplinary as well (*and are not limited to computer science topics*)
- ***FOR Example:*** successful BMI research will often draw on, and contribute to, computer science, but it may also be closely related to the decision sciences

(probability theory, decision analysis, or the psychology of human problem solving), cognitive science, information sciences, or the management sciences.
- A biomedical informatics researcher will be tightly linked to some underlying problem from the real world of health or biomedicine.

1.4.5 Relationship to Biomedical Engineering

- **In biomedical engineering,** the emphasis is on medical devices; in BMI, the emphasis is on biomedical information and knowledge and on their management with the use of computers. In both fields, the computer is secondary, although both use computing technology.

1.5 The Nature of Medical Information

- Aspects of biomedical information include an essence of uncertainty—we can never know all about a physiological process—and this results in inevitable variability among individuals. These differences raise special problems and some investigators suggest that biomedical computer science differs from conventional computer science in fundamental ways.
- **In biomedicine,** there are other higher-level processes carried out in more complex objects such as organisms (one type of which is patients). Many of the important informational processes are of this kind. When we discuss, describe, or record the properties or behavior of human beings, we are using the descriptions of very high-level objects, the behavior of whom has no counterpart in physics or in engineering. The person using computers to analyze the descriptions of these high-level objects and processes encounters serious difficulties
- the general enterprise known as **artificial intelligence (AI)** can be aptly described as the application of computer science to high-level, real-world problems.
- **Biomedical informatics** thus includes computer applications that range from processing of very low-level descriptions, which are little different from their counterparts in physics, chemistry, or engineering, to processing of extremely high-level ones, which are completely and systematically different.

- It is difficult or impossible to assume that all propositions have truth values when we deal with the many high-level descriptions in medicine or, indeed, in everyday situations. Such questions as “Was Woodrow Wilson a good president?” cannot be answered with a “yes” or “no” (unless we limit the question to specific criteria for determining the goodness of presidents). Many common questions in biomedicine have the same property.

1.6 Integrating Biomedical Informatics and Clinical Practice

We can summarize several global forces that are affecting biomedical computing and that will determine the extent to which computers are assimilated into clinical practice:

1. New developments in computer hardware and software.
2. A gradual increase in the number of individuals who have been trained in both medicine or another health profession and in BMI
3. Ongoing changes in health care financing designed to control the rate of growth of health- related expenditures.

- Clinical personnel will continue to be unwilling to use computer- based systems that are poorly designed, confusing, unduly time-consuming, or lacking in clear benefit.

Done By:

- Alanoud Alsalman
- Deema Alfaris
- Lina Alshehri
- Luluh Alzeghayer
- Munera Alomari
- Renad Alqahtani
- Rifan Hashim
- Samar Alotaibi
- Sara Alkhalifah
- Sara Alqahtani
- Shaden Alomran