Introduction to medical informatics

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"Special thanks to Aseel Badukhon for template"

COLOR CODE: Notes | Imp | Book | Golden notes | Extra

Medical Informatics

Informatics	The science concerned with gathering, manipulating, storing, retrieving and classifying recorded information. Not in 437's lecture but **important**
Medical Informatics	• Is a rapidly developing scientific field that deals with the storage, retrieval, and optimal use of biomedical information,data, and knowledge for problem solving and decision making. • Medical Informatics comprises the **theoretical and practical** aspects of information processing and communication, based on knowledge and experience derived from processes in medicine.Not in 437's lecture but **important**
Important **Biomedical Informatics (BMI)**	• Is the interdisciplinary field that studies and pursues the effective uses of biomedical data, information, and knowledge for scientific inquiry (research), problem solving , and decision making, driven by efforts to improve human health . E.H. Shortliffe and Marsden S. Blois 2014
Bioinformatics[1]	• The collection, organization, and analysis of large amounts of biological data, using computers and databases. • Historically, bioinformatics concerned itself with the analysis of the sequences of genes and their products (proteins), but the field has since expanded to the management, processing, analysis, and visualization of large quantities of data from genomics, proteomics, drug screening, and medicinal chemistry. • It includes the integration and "**mining**" of the ever-expanding databases of information from these disciplines.

Notes

Difference between:
1-Data:
Raw material, not processed and it is not only number; it can be graphs. Data alone does not provide any meaning unless the
person has a reference and a knowledge about this data.
2-Information:
Analysis. You start to refer the data to another value to have a meaning that can be understood and later be compared to other information to get the knowledge. **Examples** are mean and standard deviation.
3-Knowledge:
Interpretation, you are trying to get a message from the information you have; refer to other information.

In a **research**, data is what you collect, your target population. Information is the analysis. Knowledge is the discussion.

-Medical informatics is found to be an important field in medical practice in improving the delivered healthcare and also for the enhancement of patient engagement with the healthcare organizations. **It is to support clinicians not to replace them with robots!** A human can't remember everything because they are influenced by many factors and having a supporting system with them is important to reduce errors.
-Informatics main focus is **not technology** as implicated by many (very common misconception) but it primarily focuses on information. Technology is used to **process the information** which is the focus of this science.
-Informatics has been used in many areas in medical practice for the purpose of improving healthcare; examples of such applications;
1-OVR (this system of reporting errors is advanced nowadays to achieve better errors reporting and get the solutions) (This application is a clinical informatics)
2-Radiology (Telemedicine, to have consultations from experts around the world when needed)(Using technology to obtain better images and still your focus as a physician is the information in which you will be able to write a report about it accurately because your image was good and a teleconsultation with an expert was done)

-Medical informatics is **not only** theoretical but also include practical part.
-In clinics, medical informatics is used for decision support by which we know as "Telemedicine"

1:

-One of the most important **practices** of bioinformatics is **personalized medicine**.
-Try to find explanations for why some medications or treatment work with others while other patients don't work with them **(mining)**
-**How personalized medicine can help?** Radiation used to treat some types of cancer was found to be less effective with those who have darker skin. The radiation was not targeting the cancer cells instead it was accumulating in the patient body leading to negative effect. So when we know the genes of these patients we can personalize the treatment according to them!

Everything you do in practice is relying on information. Patient comes and The first thing we do is taking history (information). Next we look to the patient file (medical information). Then we request for tests (information) then we go to the literature (informational knowledge) and we bring all the information in front of us in order to take a decision so practitioners spend more than 50% of their time dealing with information. This science is focusing on dealing with all these information in order to take the right decision. (from 436 teamwork)

ORIGIN

- **Russian:** informatika 1968 by AI Mikhailov, "Oznovy Informatika" ("Foundation of Informatics") structure and properties of scientific information"
- **French:** informatique de medecine 1968 university departments established with this title
- **English:** first appeared in 1970s Columbia University changed its name from Medical Information Science to medical informatics. Columbia university is a pioneer in the education of informatics for medical graduates

HISTORY

Don't memorize the dates

- **1950s:**
  - In the mid 1950s was the development of expert systems such as **MYCIN** (first medical informatics system) and **INTERNEST-I**.
- **1970:**
  - The international medical informatics association was founded. In the same year the **MUMPS language** and operating system was developed and used for clinical applications.
- **1996:**
  - In the United States in 1996, **HIPAA** (Health Insurance Portability and Accountability Act) regulations concerning **privacy** and medical record transmission created the impetus for large numbers of physicians to **move towards using EMR** (Electronic Medical Record) software, primarily for the purpose of secure medical billing.

This page isn't in 437's lecture but the doctor said it's **important**
+they are included in exams and quizzes

Health Informatics

- **Health informatics:** is the intersection of **information science**, **computer science** and **health care.**

- It deals with resources, devices, & methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine. To understand only.

- **Health informatics tools include clinical guidelines**, **formal medical terminologies**, **information & communication systems**. It is applied to the areas of nursing, clinical care, dentistry, pharmacy, public health and (bio)medical research.

- Biomedical informatics is an **experimental science** characterized by posing questions, designing experiments, performing analyses, and using the information to design new experiments. By:
  1-Basic research: simply to search for new knowledge.
  2-Applications (applied) research: to use the knowledge for practical ends.

- **Biomedical Informatics in Perspective:**

Basic research	Applied Research And Practice Biomedical Informatics Methods, Techniques, and Theories

Health informatics

applied research:	Bioinformatic	Imaging Informatics	Clinical Informatics	Public Health Informatics
	Molecular and Cellular Processes	Tissues and Organs	Individuals (Patients)	Populations And Society

Notes

1. In the past, health informatics was the big umbrella in which all other subtypes of informatics concerned with health are under! Now it is different, **Biomedical Informatics** became the umbrella and all other subtypes are under it. (It is both theoretical and practical) .
2. **Health informatics includes both Clinical informatics and Public health informatics**
3. Informatics is a **spectrum**; found at all levels of patient care starting from the molecular level (Bioinformatics) to population level (Public health informatics).
4. Telehealth and Consumer Health informatics are both examples of Public health informatics.

Application of Medical Informatics

Telemedicine

- It is composed of the Greek word τελε (tele) meaning 'far', and medicine.
- It is therefore the delivery of medicine at a distance.
- A more extensive definition is that it is the use of modern telecommunication and information technologies for the provision of clinical care to individuals located at a distance and to the transmission of information to provide that care.

-Examples of telemedicine:
1-Teleconsultation (this requires the consultant to have an access to the patient information so he/she can do the consultation)
2-Teleradiology

-Telemedicine vs Telehealth:
Telemedicine is from an expert to another while telehealth between the expert and consumers (patients)

أيش الفرق بين telemedicine and tele-health؟
الأولى تعني فقط بتشخيص المرضى وعلاجهم
الثانية تعنى بتقديم خدمات للمرضى, مثلًا الكبار بالسن نتأكد من مراقبته وهو في بيته (مثلًا جهاز يشوف إذا المريض طاح ولا لا) (436 teamwork

Telehealth

The delivery of health related services, enabled by the innovative use of technology, such as videoconferencing, without the need for travel.

-Telehealth was established because of the aging age group who need a support especially those who are lonely to provide support at home and also for home monitoring.

Ehealth

E-health was used for business reasons (selling and buying medical devices and drugs). Nowadays is used for all applications used for healthcare such as heartbeat monitors .. etc

- Also written e-health, is a relatively recent term for healthcare practice which is supported by electronic processes and communication, some people would argue the term is interchangeable with Health Informatics.

- **Four essential components** make the e-health:

1. Medical knowledge (data, information, knowledge) that lends itself to being stored in computer files (digital format)
2. People who are willing/able to share, apply and use this knowledge
3. Data processing equipment to record, store and process this data
4. Telecommunication facilities to transfer (exchange) this data electronically between remote locations.

Cont.

Electronic Medical Record

EMR is important for decision support

if a patient had a pacemaker and you wanted to do an MRI, this system won't allow you to do such a thing and disaster was avoided. Another example is drug-drug interaction and also allergies!

- A general term describing computer-based patient record systems. It is sometimes extended to include other functions like order entry for medications and tests, amongst other common functions.

Dental Informatics

- Is the name given to the application of information technology to dentistry.
- It is often considered a subset of Medical Informatics and Biomedical Informatics.

Dental practice use medical informatics more than medical practice because these practitioners take the case from A to Z alone.

Nursing Informatics

Nursing Informatics is a specialty of Health Informatics (like Medical Informatics, Consumer Health Informatics, and Telehealth) which deals with the support of nursing by information systems in delivery, communication, documentation, administration and evaluation of patient care and prevention of diseases.

Nursing depend on informatics a lot because they do a lot of documentations (A LOT of it!!). Another example, a nurse can't give a patient a medication until they check the patient code with a device that has all patients information about the drugs.

من الأمثلة عليها اللاب توبات الموجودة على العربات الموجودة في كل جناح, تكون الممرضة تكتب اسم الدواء وطريقة إعطاء الدواء والجرعة الصح فالدكتور يستخدم الدواء الصح بالطريقة الصح والجرعة الصح (تيم 436)

Continuing Medical Education (CME):

- **Definition:** The science of medicine advances at such a rapid rate that much of what is taught becomes outmoded, and it has become obligatory for physicians to be lifelong learners, both for their own satisfaction and, increasingly, as a formal government requirement to maintain licensure.
- Doctors who practice in rural areas or other more isolated locations may face considerable obstacles to obtain hours for CME.
- The cost of web-based or **online** CME is much lower than the cost of traditional CME.

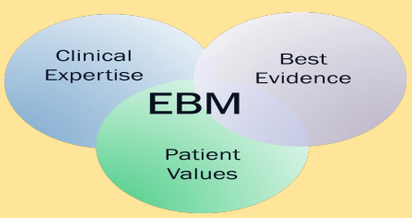
Blackboard used in our college is an example and also DXR

Cont.

Evidence Based Medicine

Why EBM is part of informatics?
Because all knowledge must be up to date and get these we need a medium for that in which all can reach and also a fast one.

-What is the difference between evidence based practice and none?
Latest knowledge!
-EBM is found to reduce errors. The knowledge has to be structured.



- "is the process of systematically reviewing, appraising and using clinical research findings to aid the delivery of optimum clinical care to patients."
- Entails a system that provides information on appropriate treatment under certain patient conditions.
- A healthcare professional can look up whether his/her diagnosis is in line with latest (up to date) scientific research findings.
- The advantage is that the practice can be kept **up-to-date** with published knowledge.
- 'the integration of best research evidence with clinical expertise and patient values' which when applied by practitioners will ultimately lead to improved patient outcome.
- There are three main pillars or components of evidence based practice:

1. **Best evidence:** clinical research that has been conducted using rigorous methodology
2. **Clinical expertise** refers to the clinician's cumulated education, experience and clinical skills
3. **Patients preferences, values and concerns** which patient brings to a clinical encounter.

- It is clear that EBM depends on the structured knowledge databases that contains the most recent and valid clinical research output. It is the integration of best and latest evidence with clinical expertise and patent values component could improve the clinical practice outcome and patients' satisfactions.

Distance learning

- With aid of telecommunications technologies and internet, distance learning is now widely applied in may universities, eg: Open University.
- It is now possible to earn university degrees from home, at every level from bachelor's to doctorate.

Tele-Health Vs e-health?!

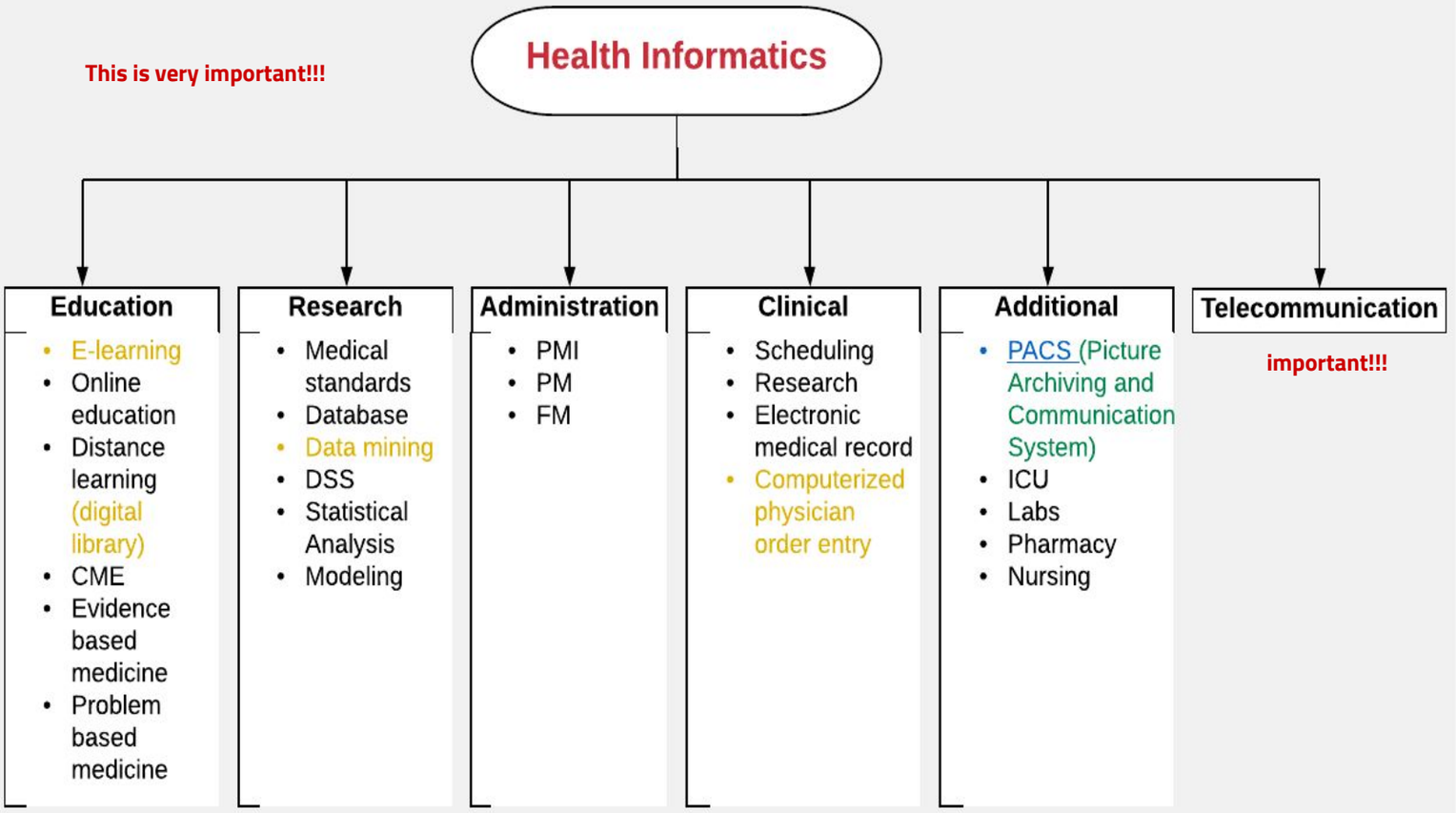
1. E-health is much more than tele-health as tele is a limiting factor to the form of technology in health. E-health could be at distance or local.
2. The practice of telemedicine will become more prominent and will be part of the mainstream of Healthcare.
3. It will become increasingly difficult to differentiate telemedicine from many other uses of technology in the delivery of healthcare.E-health is all inclusive and captures the use of Internet technologies and the rise of the information economy. This includes: **information technology**, **telecommunication technology**, **Data transmission protocols** and **techniques**.
4. E-Health is all inclusive and captures all types of Healthcare and Healthcare professionals: it is not limited to medicine and not limited to doctors.

Why Medical Informatics for Healthcare?

(Read for your own benefit)

- Improve Healthcare quality.
- Better data access.
- Faster data retrieval and storage.
- High quality data.
- Support medical and non-medical decision-making.
- Enhance quality assurance .
- Enhance out-come researches and studying programs.
- Provide unified access to all existing data.
- Eliminate and reduce errors.
- Increase healthcare organization efficiency.
- Reducing cost and achieves quality of healthcare.
- Reduce duplication of efforts .
- Improve staff productivity.
- Sharing medical data.
- Reduce redundant tests, services and information entry.
- Manage billing and payment system.

This is very important!!!



Notes

- Research + Clinical = Evidence Based Medicine
- Research + Administration + Clinical + Additional = HIS (Hospital Information System)
- Clinical + Telecommunication = Telemedicine
- Clinical + Telecommunication + Additional = Telehealth (Additional= more than one specialty (e.g. doctors + nurses + pharmacists...etc) so health information can be applied to different areas such as nursing, dentistry, pharmacy, biology.

-**PMI (Patient Master Index)** is an important system that includes patient basic information which don't change (should be written for once such as name, date of birth, gender, vaccination, allergy..etc). All departments have an access and share it. it concern with registration, out and in patient

-We can use EBM in education when we hand the students a case that requires up to date information to manage it

-Abbreviations:

1-DL (Distance learning)

2-PBM (Problem based medicine)

-E-learning an example of that the stimulation center in the medical education.

-Databases is used to look for patient information for research porpuse (436 teamwork)

-Modeling: مثال عليها في تجربة سووها بحيث جهاز يقرا الصور الإشعاعية للثدي وتحاليل المختبر ثم يشخص إذا فيه سرطان أو لا مقارنة بتشخيص طبيب استشاري ولمن انتهت التجربة لاقوا إن الجهاز دقة تشخيصه ١٠٠% عكس الاستشاري اللي كانت ٧٠% مما يعني إن تطبيق informatics مفيد جدًا للمرضى. (teamwork 436)

Medical informatics definitions

1. “Medical informatics attempts to provide the theoretical and scientific basis for the application of computer and automated information systems to biomedicine and health affairs..medical informatics studies biomedical information, data, and knowledge - their storage, retrieval, and optimal use for problem-solving and decision-making.”Lindberg, D.A.B. NLM Long Range Plan. Report of the Board of Regents, 1987, p. 31.

2. Medical informatics is a developing body of knowledge and a set of techniques concerning the organizational management of information in support of medical research, education, and patient care.

3. Medical informatics combines medical science with several technologies and disciplines in the information and computer sciences and provides methodologies by which these can contribute to better use of the medical knowledge base and ultimately to better medical care.“ definition by Asso. of American Medical Colleges

4. "Medical informatics is the application of computer technology to all fields of medicine - medical care, medical teaching,and medical research." Preliminary announcement for the Third World Conference on Medical Informatics, MEDINFO 80, 1977.

5. "Medical informatics is the application of computers, communications and information technology and systems to all fields of medicine - medical care, medical education and medical research.“ definition by MF Collen (MEDINFO '80, Tokyo, later extended).

6. "Medical Informatics is the interdisciplinary study of the design, development, adoption and application of IT-based innovations in healthcare services delivery, management and planning.“

7. Greenes and Shortliffe described medical informatics as "the field that concerns itself with the cognitive, information processing, and communication tasks of medical practice, education, and research, including the information science and the technology to support these tasks.“ 1

Why so many definitions ?
Because informatics is interdisciplinary field.
In the definition they included all the three (data, information and knowledge) because the focus on one will lead to different conclusion.

Doctor said: don’t memorize all these definitions but understand the main idea

Summary of the book

Terminology

- **Medical computer science:** refer to the subdivision of computer science that applies the methods of the larger field to medical topics
- **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. It is now under the name **cognitive science**
- **Biomedical computing** or **biocomputation:** implying only that computers are employed for some purpose in biology or medicine. it includes such topics as (medical statistics, record keeping, and the study of the nature of medical information itself).

- **Clinical informatics (medical informatics):** applied research and practice topics that focus on disease and the role of physicians and demands patient-oriented informatics application

- **Public Health Informatics:** similar methods of medical information are generalized for application to populations of patients rather than to single individuals يعني نسوي بحث يفيد المرضى والمعالجين لكن على مستوى كبير جدًا وليس على مستوى شخص واحد أو منظمة واحدة

- **Imaging (structural) Informatics:** the set of issues developed around both radiology and other image management and image analysis domains such as pathology, dermatology

- **Biomolecular Imaging:** involves both bioinformatics and imaging informatics concepts

- **Consumer Health Informatics:** includes elements of both clinical informatics and public-health informatics

- **Pharmacogenomics:** the effort to infer genetic determinants of human drug response which requires the analysis of linked genotypic and phenotypic databases, so it is the intersection of bioinformatics and clinical informatics

Summary of the book

❖ Biomedical informatics

- Early people were using the terms (**medical computing** + **medical information science**) but these terms confused with library science so they changed them into **medical informatics**, but this term seem to be more clinically so they changed it into **health informatics**, but this term exclude the biology research so they changed into **biomedical informatics**
- **So it is (medical computing + medical information science → medical informatics → health informatics → biomedical informatics)**

❖ History

- The first practical application of automatic computing relevant to medicine was by punched-card data-processing system in epidemiologic and public health surveys
- One early activity in biomedical computing was the attempt to construct systems that would assist a physician in decision making, the other activity was a total **hospital information system** (system that concern just on the hospital information)

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.

- These are single-entry points into a clinical world in which computational tools assist not only with patient-care matters (reporting results of tests, allowing direct entry of orders or patient information by clinicians) but also administrative and financial topics (e.g., tracking of patients within the hospital, managing materials and inventory), research (e.g., analyzing the outcomes associated with treatments and procedures, supporting clinical trials, and implementing various treatment protocols), scholarly information (e.g., accessing digital libraries, supporting bibliographic search, and providing access to drug information databases), and even office automation (e.g., providing access to spreadsheets and document-management soft- ware).

- Another theme in the changing world of health care is the increasing investment in the creation of **standard order sets**, **clinical guidelines**, and **clinical pathways** to recurring management problems. Several government and professional as well as individual provider groups often putting an emphasis on using clear evidence from the literature creating such **evidence-based guidelines.**

Summary of the book

The importance of Electronic Health Record (EHR)

- One argument that warrants emphasis is the importance of the EHR in supporting **clinical trials** which is experiments in which data from specific patient interactions are pooled and analyzed in order to learn about the safety and efficacy of new treatments or tests and to gain insight into disease processes that are not otherwise well understood.

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.** The challenge facing widespread use of internet as health information resource by general public was language barriers
- Novel mechanism for allowing a defense computers, to share data files with each other and to provide remote access which is now known as **backbone network**
- Value for non-military research recognized, and by 1973 the first medically related research computer had been added. Today, the Internet is ubiquitous, accessible
- The explosive growth of the Internet did not occur until the late 1990s, when the World Wide Web which triggered the growth of medical information that is freely available. It was introduced and popularized, Why? 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.

The Goal: A Learning Health Care System

- straightforward use of electronic health records for direct patient care (writing notes, asking for investigations…etc.) does not meet some of the requirements, we can use the information on research or community-based clinical trials to develop standards for prevention and treatment, with major guidance from biomedical research.
- **learning health care system:** the notion of a system that allows us to learn from what we do, unlocking the experience that has traditionally been stored in unusable form in paper charts, we can envision an interconnected community of clinicians and institutions, building digital data resources using electronic health records.

Summary of the book

Moving Beyond the Paper Record

Joint development and local adaptation are crucial, which implies that the institutions that purchase such systems must have local expertise that can oversee and facilitate an effective implementation process, including elements of process reengineering and cultural change that are inevitably involved.

Experience has shown that clinicians are "horizontal" users of information technology (Greenes and Shortliffe 1990).

clinical trials experiments in which data from specific patient interactions

are pooled and analyzed in order to learn about the safety and efficacy of new treatments or tests and to gain insight into disease processes that are not otherwise well understood.

Despite the success in creating such **evidence - based guidelines** , there is a growing recognition that we need better methods for delivering the decision logic to the point of care. Guidelines that appear in monographs or journal articles tend to sit on shelves, unavailable when the knowledge they contain would be most valuable to practitioners. Computer-based tools for implementing such guidelines, and integrating them with the EHR, present a means for making high-quality advice available in the routine clinical setting.

Many organizations are accordingly attempting to integrate decision-support tools with their EHR systems, and there are highly visible efforts underway to provide computer-based diagnostic decision support to practitioners.

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 health care setting.

Summary of the book

Anticipating the Future of Electronic Health Records

Once the software version has been developed, however, human ingenuity and creativity often lead to an evolution that extends the software version far beyond what was initially contemplated. The computer can thus facilitate paradigm shifts in how we think about such familiar concepts.

powerful desktop-publishing facilities, integration of figures, spelling correction, grammar aids, "publishing" on the Web, use of color, etc. Similarly, today's spreadsheet programs bear little resemblance to the tables of numbers that we once created on graph paper. To take an example from the financial world, consider automatic teller machines (ATMs) and their facilitation of today's worldwide banking in ways that were never contemplated when the industry depended on human bank tellers.

Communications Technology and Health Data Integration

An obvious opportunity for changing the role and functionality of clinical-care records in the digital age is the power and ubiquity of the Internet.

A Model of Integrated Disease Surveillance

- Encryption of data : Concerns regarding privacy and data protection require that Internet

  transmission of clinical information occur only if those data are encrypted, with an established mechanism for identifying and authenticating individuals before they are allowed to decrypt the information for surveillance or research use.

- Standards for data transmission and sharing : Sharing data over networks requires that all developers of EHRs and clinical databases adopt a single set of standards for communicating and exchanging information. The de facto standard for such sharing, Health Level 7 (HL7).

- 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 termi- nology and potentially for the schemas.

Summary of the book

Implications of the Internet for Patients

The penetration of the Internet continues to grow, it is not surprising that increasing numbers of patients, as well as healthy individuals, are turning to the Internet for health information.

In a positive light, the 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, and we now take this kind of interaction with patients for granted. If we extend the audio channel to include our visual sense as well, typically relying on the Internet as our communication mechanism, the notion of **telemedicine** emerges .

This notion of "medicine at a distance" arose early in the twentieth century ,but the technology was too limited for much penetration of the idea beyond telephone conversations until the last 30–40 years. 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).

Education and Training

Computer science training alone is not adequate. Fortunately, we have begun to see the creation of formal training programs in what has become known as **biomedical informatics** that provide custom tailored educational opportunities.

The criteria that are required for successful EHR implementation are sensitive to the need for data integration, public- health support, and a learning health care system.

Questions

Q1:Which of the following represents this definition “the theoretical and practical aspects of information processing and communication,based on knowledge and experience derived from processes in medicine “ ?
A-Medical informatics.
B-Bioinformatics.
C-Telemedicine.
D-Big data.

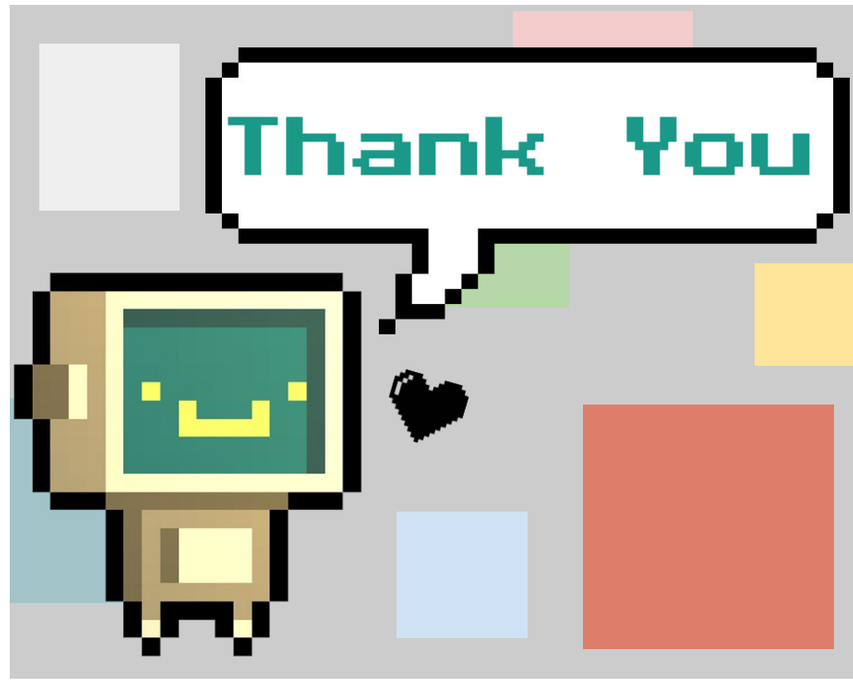
Q2:which of the following terms is interchangeable with Health Informatics?
A-E-health.
B-Medicine.
C-Bioinformatics .
D-Information Science .

Q3:The delivery of health related services ,enabled by innovative use of technology without the need for travel , refers to which of the following?
A-Telecommuting.
B-Telehealth.
C-Telemedicine .
D-Telecardiology.

Q4:The collection,organization and analysis of large amounts of biological data, using computers and databases, is the definition which of the following ?
A-Bioinformatics .
B-Chemoinformatics.
C- Medical informatics.
D-Nursing informatics.

Q5:Which one is pillar for evidence based medicine ?
A-Bioinformatics .
B-E-health.
C-Clinical judgments.
D-Telehealth.

1:A
2:A.
3:B.
4:A.
5:C



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