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Selected Topics in CS:
Biomedical Informatics and
Knowledge Representation

Part I
Introduction and Motivation
Electronic Health Record EHR

Course No.:

Based on:

- Medical Informatics Practical Guide for the Healthcare Professional Third Edition. Robert E. Hoyt, Melanie Sutton, Ann Yoshihashi, Publishedby:Lulu.com, 2009
- Biomedical Informatics: Computer Applications in Health Care and Biomedicine, Edward H. Shortliffe (Editor), James J. Cimino (Editor) ,Springer, 2006
- Dealing with Medical knowledge Computer in clinical Decision Making. Deutsch, E. Carson, and Endre Ludwig, plenum Press 1994
- Lecture Notes, Bassam Haddadin:
Artificial Intelligence, Data Mining, Data Structures and Algorithms
<https://sites.google.com/site/bassamhaddadlecturenotes>
- University of West Florida's
resource site at www.uwf.edu/sahls/medicalinformatics

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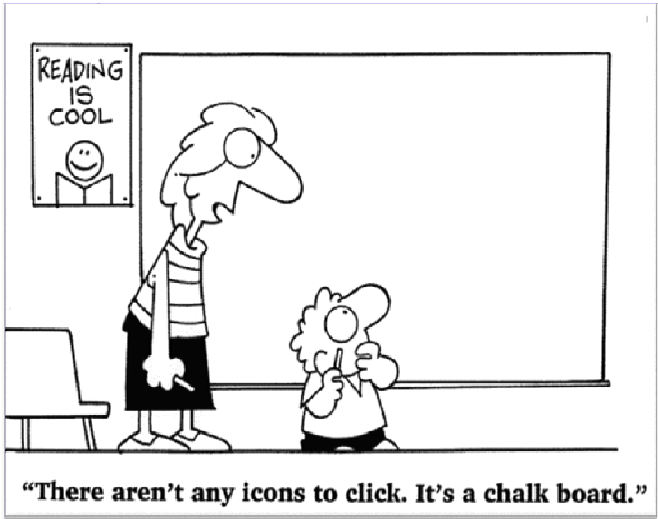
Course Overview:

Topic covered

- Overview of Medical Informatics
- Electronic Health Records
- Medical and health of information Systems
 - Hospital Information Systems
 - Clinic Information Systems
 - Laboratory Information Systems
 - Pharmacy Information Systems
- Systems for Clinical Decision Making
 - Method for Medical Diagnosis
 - Artificial Intelligence in Medicine
 - Expert Systems in Medicine
- Anatomy of Medical Knowledge
- Representing Medical Knowledge
- Public Health Informatics
- International Health
 - In the developing world
 - In the developed world
 - How International Health Agencies work
- Case Study: Computer in Diabetes Management
- Bioinformatics and the Genome Project

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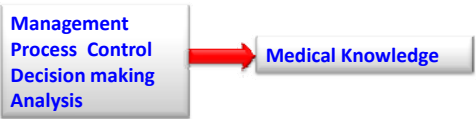
Course Overview:



Definitions: What is Medical Informatics

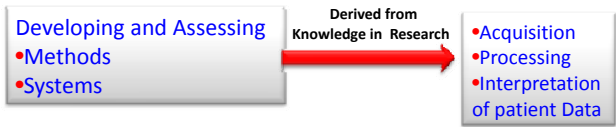
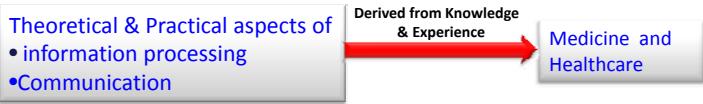
Definition-1

Medical information science is the science of using system-analytic tools to develop procedures (algorithms) for management, process control, decision making and scientific analysis of medical knowledge (Shortliffe)



Definition-2

- Medical Informatics comprises the theoretical and practical aspects of **information processing** and **communication**, based on knowledge and experience derived from processes in **medicine and health care**
- In medical informatics we develop and **assess methods and systems** for the **acquisition, processing, and interpretation of patient data** with the help of knowledge that is obtained in scientific research (J.H. van Bommel).



What is Cybernetics, Informatics , Computer Science medical Informatics

- Cybernetics is the interdisciplinary study of the structure of regulatory systems
- Cybernetics is closely related to
 - Theory of Information
 - Communications
 - Coding
 - Algorithms
 - Probabilities and Stochastic Processes
 - Theory of Control
 - Operations Research
 - Optimization
 - Management Science
 - System theory and Systems Analysis

To broad

Definition (Informatics & Computer Science)

- Informatics is the discipline of science which investigates the structure and properties of scientific information

structure of scientific information

- Study of the structure and behavior of natural and artificial systems that generate, process, store, and communicate information
- The science of processing data for storage and retrieval.
- Information Processing including Decision Making and Systems Analysis
 - Information Technology and Theory
Computers, Communications, Data Processing, Algorithms
 - Decision Theory and Applications
Bayesian Approach, Expert Systems, Artificial Intelligence, Knowledge-based Systems, Algorithms
- Pragmatic reduction to Computer Science in USA
- Definition (Informatics ↔ Computer Science)
- CS translated into INFORMATIQUE in France
- CS translated into INFORMATIK in Germany , Austria and Switzerland (German canton)
- Backward translation of CS as INFORMATICS expanding the scope

Medical informatics is the discipline which investigates the structure and properties of medical information (bio-medicine, Health care, biology)

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Definitions: What is Medical Informatics

Medical Informatics is Multidisciplinary

- It is applies methodologies developed in multiple areas of scientific research
- Bio-Med Informatics as new discipline enrich other these scientific disciplines

Scientific areas relevant to Medical Informatics

- Medicine - Biology
- Mathematics
- Information Systems
- Computer Science
- Statistics
- Decision Analysis
- Economics-Health Care Policy
- Psychology

Medical Informatics Areas

- Hospital information systems
 - Electronic medical records & medical vocabularies (medical terminology)
 - laboratory information systems
 - pharmaceutical information systems
 - radiological (imaging) information systems
 - Patient monitoring systems
- Clinical decision-support systems
 - Diagnosis-interpretation (expert systems)
 - Therapy-management
- Bioinformatics: Closely related tasks and methods

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Definitions: What is Medical Informatics

Medical Informatics aims at

- Reducing medical risks
 - Improving patient care
 - Cut costs of treatment
- In the meanwhile, the term ‘Medical Informatics’ itself has undergone a renovation as terminology such as \longleftrightarrow **Health(care) Informatics**

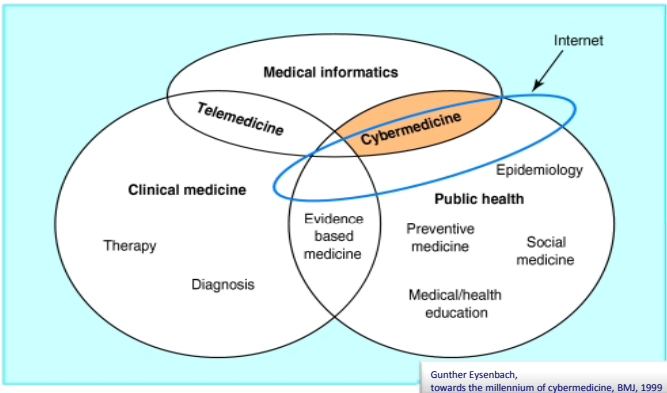
▪This includes

- (Bio)Medical informatics
- Clinical Informatics
- Health Informatics
- Patient Informatics
- Nursing Informatics
- Public Health Informatics

21st Century the Age of Informatics Major Tool of Informatics

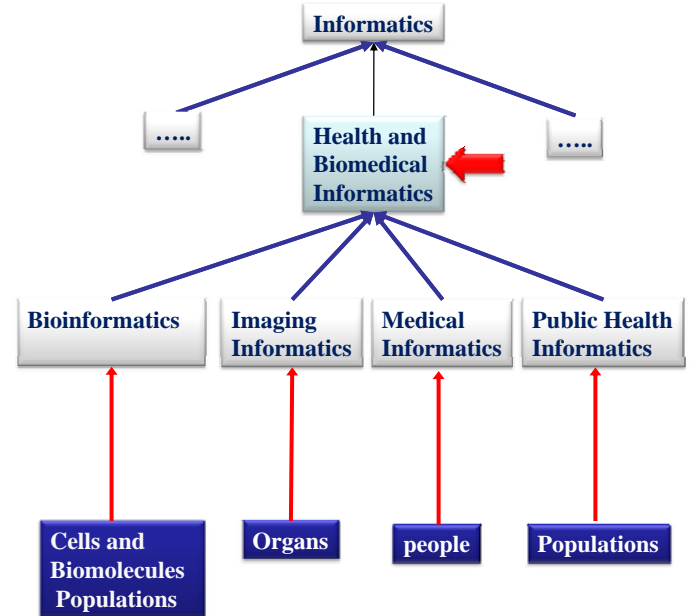
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INTERNET

Cyber medicine (eHealth) and Medical Informatics within the internet



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An overview of “health and biomedical informatics”



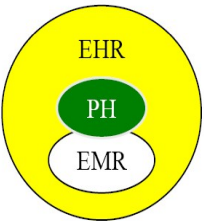
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Electronic health record & (EHR, EMR, EPR, CMR, CPR, ECIS)

What is EHR?

- There is no topic in Medical Informatics as important, yet controversial, as the **electronic health record (EHR)**.
- There is no universally accepted definition of an **HER**.
- EHRs are also known as
 - Electronic medical records(**EMR**),
 - Computerized medical records(**CMR**),
 - Electronic clinical information systems(**ECIS**) and
 - Computerized patient records(**CPR**).

- The **HER** is the larger system that includes **the EMR** and **PHR** and interfaces with multiple other electronic systems
 - locally
 - regionally and
 - nationally
- The **EMR**, on the other hand, is the **electronic patient record** located in an
 - office or
 - hospital
- The **PHR** is a collection of **health information** by and for the patient.
- There is overlap between the EMR and the PHR, since the **PHR** can be part of the **EMR**



Robert E. Hoyt

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Electronic health record , EHR

- **EMR, Electronic Medical Record:** An **electronic record of health-related** information on an individual that can be created, gathered, managed and consulted by **authorized clinicians and staff within one healthcare organization**".
- **EHR, Electronic Health Record:** An **electronic record of health-related information** on an individual that conforms to **nationally recognized interoperability standards and that can be created, managed and consulted by authorized clinicians and staff across more than one healthcare organization**".
- **PHR, Personal Health Record:** An **electronic record of health-related information** on an individual that conforms to **nationally recognized interoperability standards** and that can be drawn from multiple sources while being managed, **shared and controlled by the individual**"
 - ("an electronic, universally available, lifelong resource of health information needed by individuals to make health decisions)
 - individuals should be able to access their health and medical data
 - PHRs will educate patients about their health and common data standards
 - Ideal PHR Features
 - Portable
 - Interoperable, meaning the PHR format can be shared among disparate partners.
 - Controlled by the patient
 - Private and secure
 -

Robert E. Hoyt, 2008 the National Alliance for Health Information Technology

- What about the the PHR strategies and situation in the
- In the developing world ☹ ??????

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Electronic health record , HER and patient Informatics and Patient Web Portals

- A patient Informatics (also known as consumer informatics) is a new aspect of Medical Informatics that largely reflects the empowered health care consumer.
- Patients are aware that many non health care businesses are automating and modernizing their business processes to attract a larger market share.
- ATM machines, as an example, can provide cash in a few minutes regardless where you are located worldwide.
- This innovation required reengineering and the acceptance of universal standards, not unlike many aspect s of health information technology

Secure E-mail

Personal Health Record Tethered or un-tethered

Physician

EHR

Patient Portal

Patient

E-visits

Patient, physician and chart interactions

Robert E. Hoyt

- Web portals are web based programs that patients can access for health related services.
- A web portal can be a stand alone program or it can be integrated with an electronic health record.

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The importance of EHR

Why do we need Electronic Health Records?

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- The paper record is severely limited**
 - It is not structured data that is computable and hence sharable with other computers and systems.
 - shortcomings of paper: expensive to copy, transport and store; easy to destroy
 - Missing data (patient safety)
- The need for improved efficiency and productivity**
 - The goal is to have patient information available to anyone who needs it, when they need it and where the y need it
 - EHRs are more efficient because they reduce redundant paper work and have the capability of interfacing with a billing program that submits claims electronically
- Quality of care and patient safety**
 - An EHR should improve patient safety through many mechanisms:
 - Improved legibility of clinical notes
 - Improved access anytime and anywhere
 - Reduced duplication
 - Reminders that tests or preventive services are overdue
 - Clinical decision support that reminds us of patient allergies, the correct dosage of drugs , etc.
 - Electronic problem summary lists provide diagnoses, allergies and surgeries at a glance.
 - Financial savings.
 - Technological Advances.() The timing seems to be right for electronic records partly because the technology has evolved.
- Public expectations**

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The importance of EHR

Why do we need Electronic Health Records?

Information Missing During Patient Visits	% Visits
Lab results	45%
Letters/dictations	39%
Radiology results	28%
History and physical exams	27%
Pathology results	15%

Types and frequencies of missing information

Robert E. Hoyt

OUTPATIENT HISTORY AND PHYSICAL

NAME: AGE: 45 DATE: 12/18/12

TX: Improved Stable Worse

C:

1-

2-

3-

4-

HYPER: PALPITATIONS: 3 TREMORS: 3 ANXIETY: 3 WT LOSS: 3

HEAT INTOLER: 3 SWEATING: 3 WEAKNESS: 3 HAIR LOSS: 3

DIARRHEA: 3 INSOMNIA: 3 VISION: 3 RASH: 3

MENSTRUATION: 3 OTHERS: 3

HYPO: FATIGUE: 3 DRY SKIN: 3 COLDNESS: 3 MUSCLE SPAS: 3

SLEEPINESS: 3 CONSTIP: 3 VOICE CHAN: 3 WT GAIN: 3

EDEMA: 3

NODULE: 3

DATE FOUND: 3 PAIN: 3 DYSPHAGIA: 3 SOB: 3

VOICE CHAN: 3 HX OF RADIATION: 3 FIX: 3

ALL OTHER SYSTEMS: 3 PSFHX REVIEW: 3

PE: WT: 110 HT: 5'10" BP: 110/70 P: 72 PAIN: 3

EYES: CONJ: 3 EXOPHT: 3 R: 3 L: 3

THYROID: 3

LYMPH: C: 3

LUNGS: 3 SC: 3 BRUIES: 3

HEART: 3

ABD: 3 EXT: 3 PULSE: 3 EDEMA: 3

NEURO: 3 DTRS: 3 SKIN: 3

LABS: TSH: 3 TT4: 3 T3U: 3 FTI: 3 FT4: 3 T3: 3 FT3: 3

AMA: 3 TGA: 3 CBC: 3 LFTS: 3

THYROID US: 3

THYROID UPTAKE/SCAN: 3

RECORDS REVIEWED: 3

1-1: 3

P: 3

LABS: TSH: 3 THYROID PROFILE: 3 TT4: 3 FT4: 3 T3: 3

FT3: 3 AMA: 3 TGA: 3 CBC: 3 LFTS: 3

US: 3 THY UP/SCAN: 3 FNABX: 3 FNABX US: 3

RTO: 3 WKS: 3 MOS: 3 YR: 3


Robert E. Hoyt

Outpatient paper based patient encounter form

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The importance of EHR

Why do we need Electronic Health Records?



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Electronic Health Record Key Components

What does the EHR contain?

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Data

- Patient-centered
- Comprehensive
- Aggregated
- Organized
- High data integrity (data standards)
- Timely
- Structured, semantically understandable
- Sharable
- Accountable
- Secure and private

What does the EHR provide?

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Information for:

- Patient care
- Prevention of medical errors
- Improved quality of care
- Consistency in care
- Cost effective care
- Shared understanding of health and health care among patient and provider
- Health surveillance and biodefense
- Workflow management
- Research
- Epidemiology
- Billing


(based on W. Ed Hammond: <http://www.openehr.org/home.html>)

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[illegible]


Electronic Health Record Key Components

What are we talking about?



- Hospital Information System
- Departmental Systems (laboratory, radiology, pharmacy, materials management)
- Computerized Physician Order Entry Systems
- ePrescribing Systems
- Administrative/Financial/Billing Systems
- Ambulatory Systems
- Specialty Systems (Cardiology, Pediatrics, Nephrology, ...)
- Data Warehouse
- Research Database

How many EHRs are there?



- Inpatient medical record
- Outpatient health record
- Primary care medical record
- Disease-specific record (cardiology, hypertension, diabetes, etc.)
- Intensive care record
- Emergency department record
- Nursing record
- Nursing home record
- Billing/claims record
- Research record

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Electronic Health Record Key Components

The following components are desirable in any HER system

- **Clinical Decision Support Systems (CDSS)** to include alerts, reminders and clinical practice guidelines. CDSS is associated with computerized physician order entry (CPOE). (patient safety:
 - Handwritten reports or notes, manual order entry, non-standard abbreviations and poor legibility lead to errors and injuries to patients
- **Secure messaging (email)** for communication between patients and office staff and among office staff. Telephone triage capability is important
- **Retrieval of lab and x-ray reports electronically**
- **Retrieval of prior encounters and medication history**
- **Computerized Physician Order Entry(CPOE).** Primarily used for inpatient order entry but ambulatory CPOE also important.
- **Electronic patient encounter.** One of the most attractive features is the ability to create and store a patient encounter electronically. In seconds you can view the last encounter and determine what treatment was rendered
 - (Encounter serves as a focal point linking clinical, administrative and financial information)
- **Multiple ways to input information** in to the encounter should be available: freetext (typing), dictation, voice recognition and templates.
- **The ability to input or access information via a PDA,** smart phone or tablet PC

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Electronic Health Record Key Components

- Remote access from the office or home
- Electronic prescribing
- Integration with a Picture Archiving and Communication System (PACS)
- Knowledge resources for physician and patient, embedded or linked
- Public health reporting and tracking
- Problem summary list that is customizable and includes the major aspects of care: diagnoses, allergies, surgeries and medications. The ability to label the problems as acute or chronic, active or inactive
- Ability to scan in text or use optical character recognition (OCR)
- Ability to perform evaluation and management (E&M) determination for billing
- Ability to create graphs or flow sheets of lab results or vital signs
- Ability to create electronic patient lists or disease registries
- Backup systems in place

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Electronic Health Record Key Components

CPOE

- CPOE is an HER feature that processes orders for medications, lab tests, x-rays, consults and other diagnostic tests.
- Reduce medication errors.
 - CPOE has the potential to reduce medication errors through a variety of mechanisms. Because the process is electronic, you can embed rules –engines that allow for checking allergies, contra indications and other alerts.
- Reduce costs.
 - Several studies have shown reduced length of stay and overall costs in addition to decreased medication costs with the use of CPOE
- Reduce variation of care.
 - One study showed excellent compliance by the medical staff when the drug of choice was changed using decision support reminders.

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