Informatics revolutionized medicine and medical research: expectations and reality

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Learning Objectives

- Define medical informatics
- Get a sense of what medical informatics encompasses
- Why is medical informatics important
- Some examples of applications

Why Learn Medical Informatics?

- To behave as a conscious Medical Professional, a Physician or a scientist of any kind of today has to know the basics of Information Technology **as well as** the basics of Physiology and Pharmacology, Internal Medicine, Molecular Biology or so
- Information Technology alone cannot help you without the intellectual components of Informatics: Decision (Theory).
- Goal(s): what to do?
- The proper way: how to do?
- Where, when, why etc. orientation

An Evolving Field

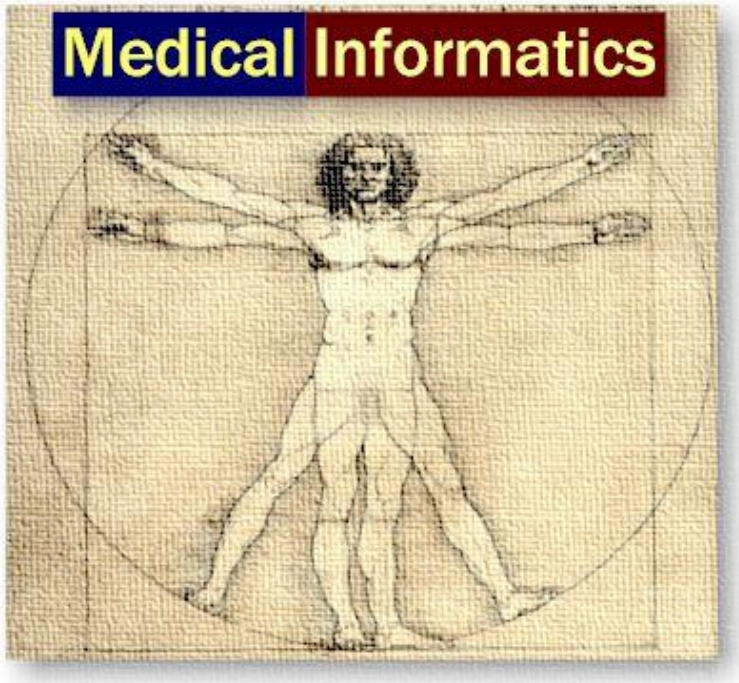
- 1950s Intuitively: “medical applications of computer science”
- Medical computer science
- Medical information science
- Biomedical computing
- Medical informatics
- Health or healthcare informatics
- Clinical informatics

History

- 1949 Gustav Wager
- 1950 United States National Bureau of Standards
- mid 50's MYCIN
- 1965 Medline
- 1968 Homer Warner founded the department of medical informatics
- 1970 IMIA, MUMPS language and OS

Define Medical Informatics

- Systematic study
- Deals with all forms of "data"
  - Biological data
  - Medical data
  - Associated data
- Problem solving
- Decision making



Define Medical Informatics

Medical informatics is a **scientific/systematic** field of study that deals with the **acquiring, storage, retrieval, and processing** of **medical, biological and associated data, information and knowledge** for the purpose of **problem solving and decision making**

Data, Information, Knowledge

- Data are the raw facts obtained
- Information is outcome of analyzing data
- Knowledge is obtained from analyzing information

Computerized Medical Records

Computer-Aided Instruction

Medical Software Security

Veterinary Informatics

Telemedicine

Medical Informatics

Nursing Informatics

Policy Making

Physician Order Entry Systems

Medical Expert Systems

Medical Software Engineering

Health Information Networks

Clinical Information Systems

Medical Informatics

Definitions

- 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 - *Ted Shortliffe*
- 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 - *Jan van Bemmel*

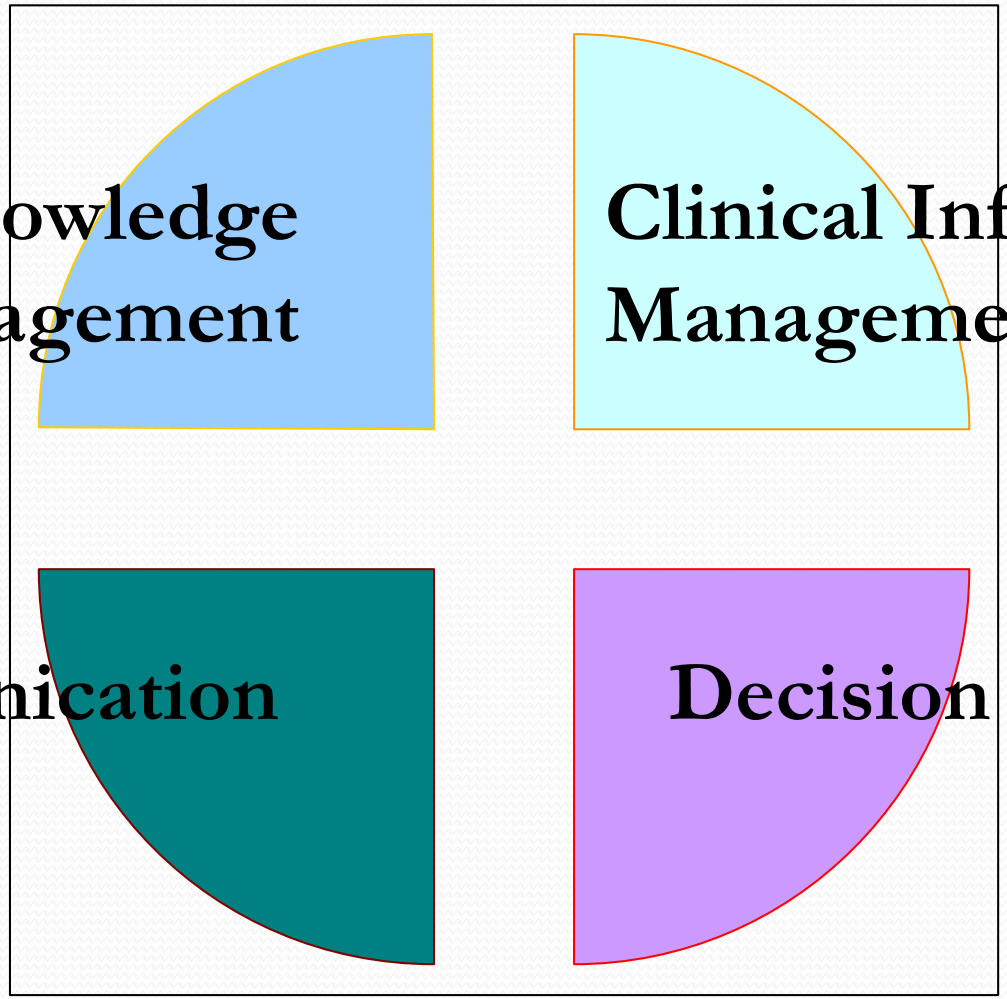
Medical informatics

- **Medical informatics** is the intersection of **information science, computer science, and health care**. It deals with the resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine

Medical Informatics

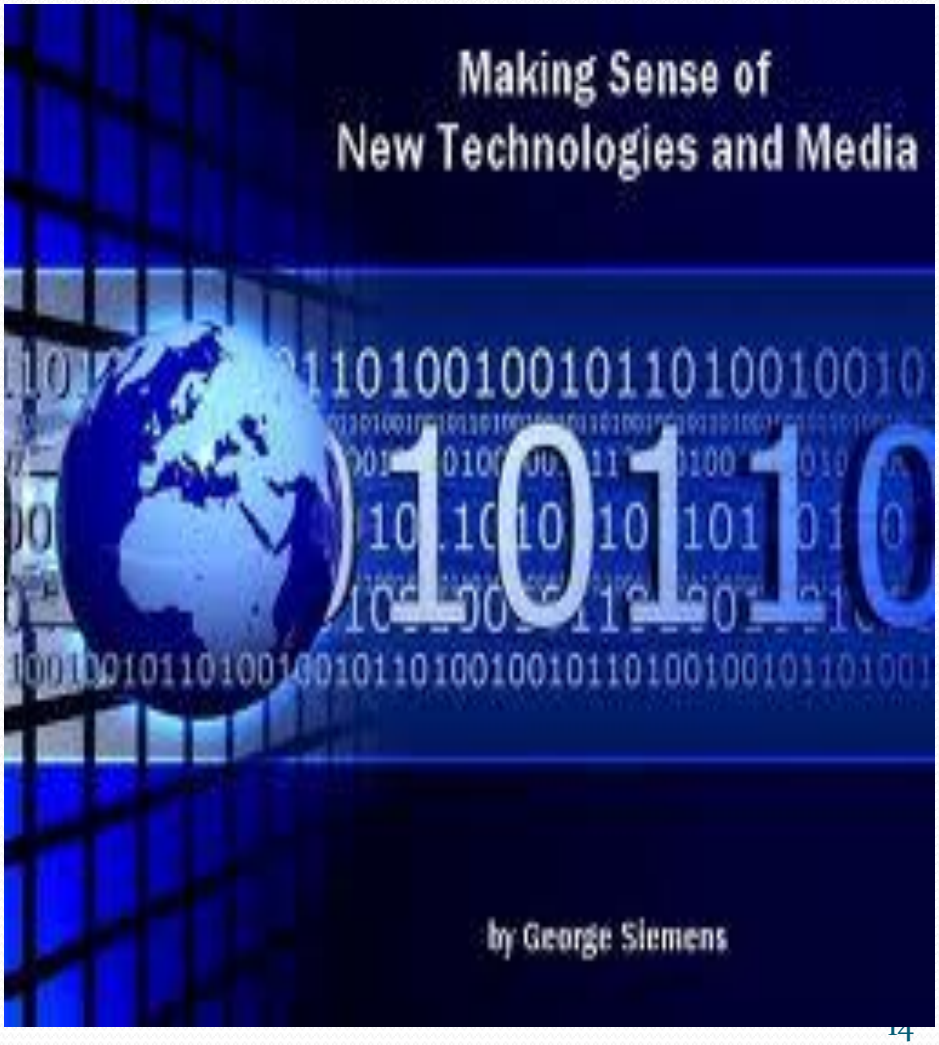
- Medical informatics has been also defined as the field that "concerns itself with the cognitive, information processing, and communication tasks of medical practice, education, and research, including information science and the technology to support these tasks

Medical Informatics



Technology needs

- Laptops for each student
  - Microsoft Office Professional
  - Stedman's Medical Spellchecker
  - Endnotes
  - Adobe Photoshop Elements
  - Medical References



Personal Digital Assistant keep you update anywhere

- **PDAs** for each student
  - Evidence Based Ref.
  - Disease Reference
  - Medical Calculator
  - Drug Reference
  - Medical Dictionary
  - The CDCS system
- Computer Lab
  - Student teaching
  - Faculty development

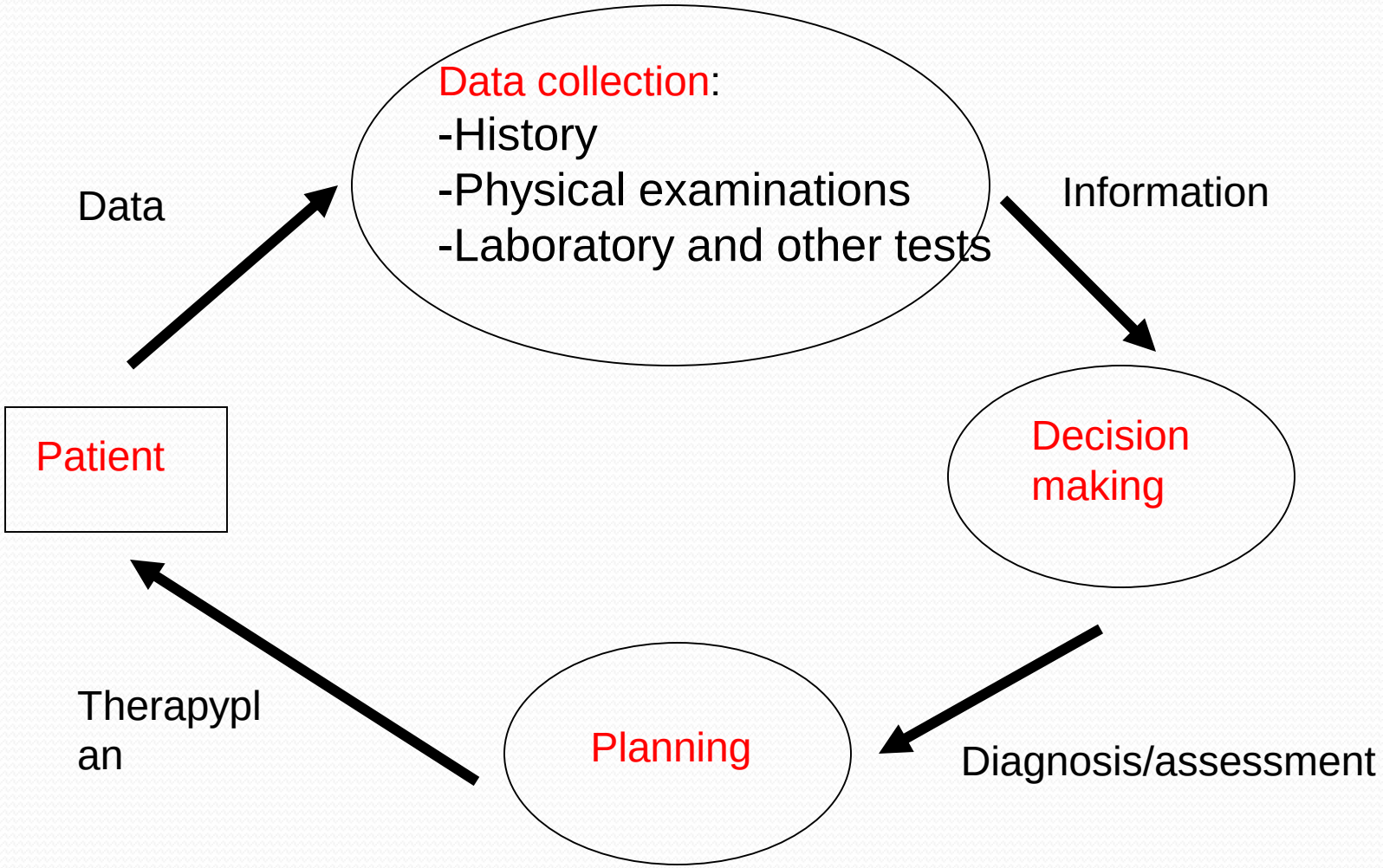
Medical Informatics Improves Educational Strategies

- Didactic vs problem solving
- Competencies
  - Word processing
  - Information retrieval
  - Information management
  - Data analysis
  - Presentation
  - Communication skills
    - E-mail, file transfer, web

Informatics Use in Health Care

- Communication
  - Telemedicine
  - Tele-radiology
  - Patient e-mail
  - Presentations
- Knowledge management
  - Journals
  - Consumer Health information
  - Evidence-based medical information
- Decision Support
  - Reminder systems
  - Diagnostic Expert Systems
  - Drug Interaction
- Information Management
  - Electronic Medical Records
  - Billing transactions
  - Ordering Systems

Computer make the Diagnostic-Therapeutic Cycle, Simplified



Medical Informatics? Why We Learn

- Computers are cool today.
- If you don't know a little bit about what "coils" are inside -
- you will get frustrated and will bother other people.
- And yet we want computers and IT now!

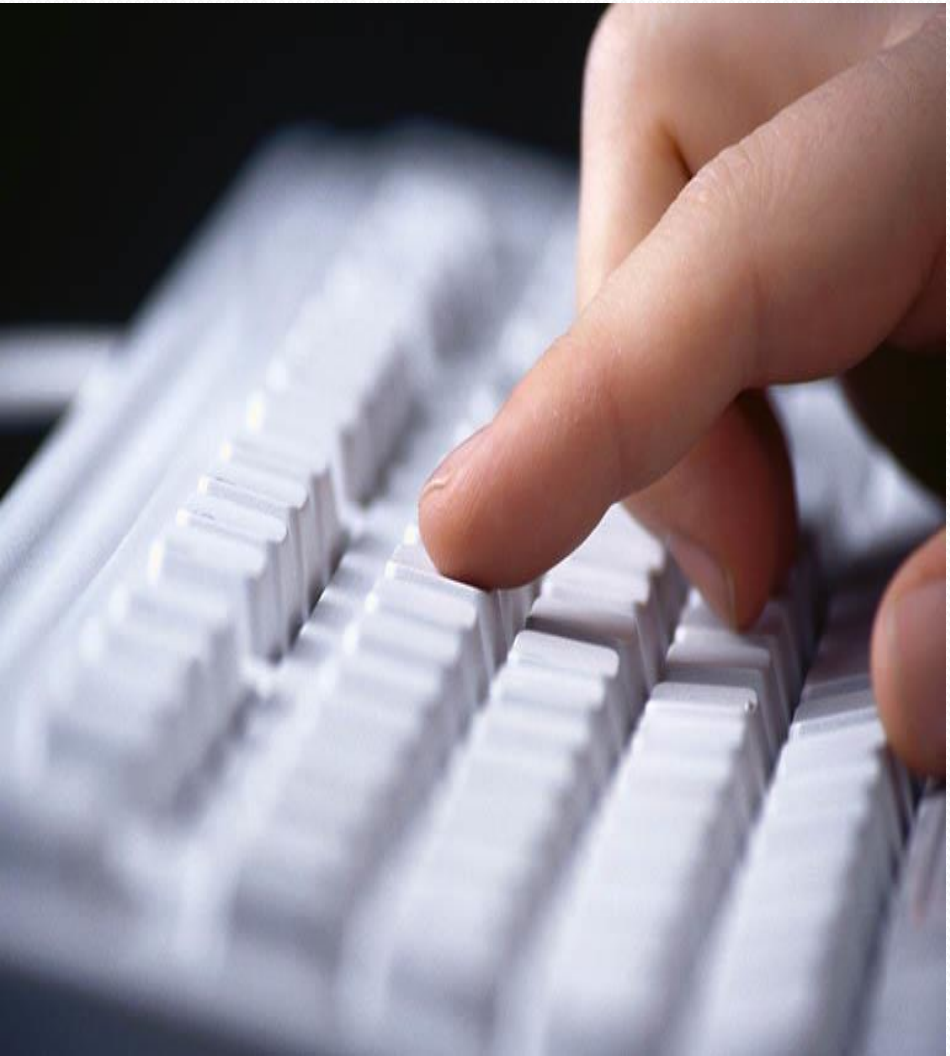
Library resources becomes Electronic

- The modern library places an increasing amount of its material in electronic format and increasing numbers of journals are available either on CD- -ROM or over the Internet. This represents a considerable saving in storage space and manpower. Many students who wish to pursue their studies using library facilities can now do son in electronic fashion, and often from their own home

Faculty should be provide electronic information

- Faculty must identify the prerequisite information and skills that students need to enable them to access electronic information sources, as well as the course content the student needs to "know" and the information the student needs to "know how to access" electronically.

Students should develop interest in electronic information



- Students' attitudes toward their education may also have to change. Students need to learn that they must be information seekers as well as information managers. They also need to acquire knowledge about relevant sources of information, and the skills to access electronic information.

Handheld Applications

- ePocrates
- 5 Minute Clinical Consult
- Medical Calculators
- Immunization schedule

Medical informatics Empower Students

- Helping students to become independent learners, information seekers, and proficient users of computer technology have long been goals that were often inadequately implemented throughout the medical school curriculum.

Orientation by teachers is the primary goal

- By making our primary goal the preparation of students to be medical information managers, we have a strong rationale for the inclusion of medical informatics applications into the curriculum. This goal also provides a criterion by which the appropriateness of curricular offerings can be judged and the outcomes of instruction can be evaluated.

Examples of Medical Informatics Areas

- Hospital information systems
  - Electronic medical records & medical vocabularies
  - laboratory information systems
  - pharmaceutical information systems
  - radiological (imaging) information systems
  - Patient monitoring systems
- Clinical decision-support systems
  - Diagnosis/interpretation
  - Therapy/management

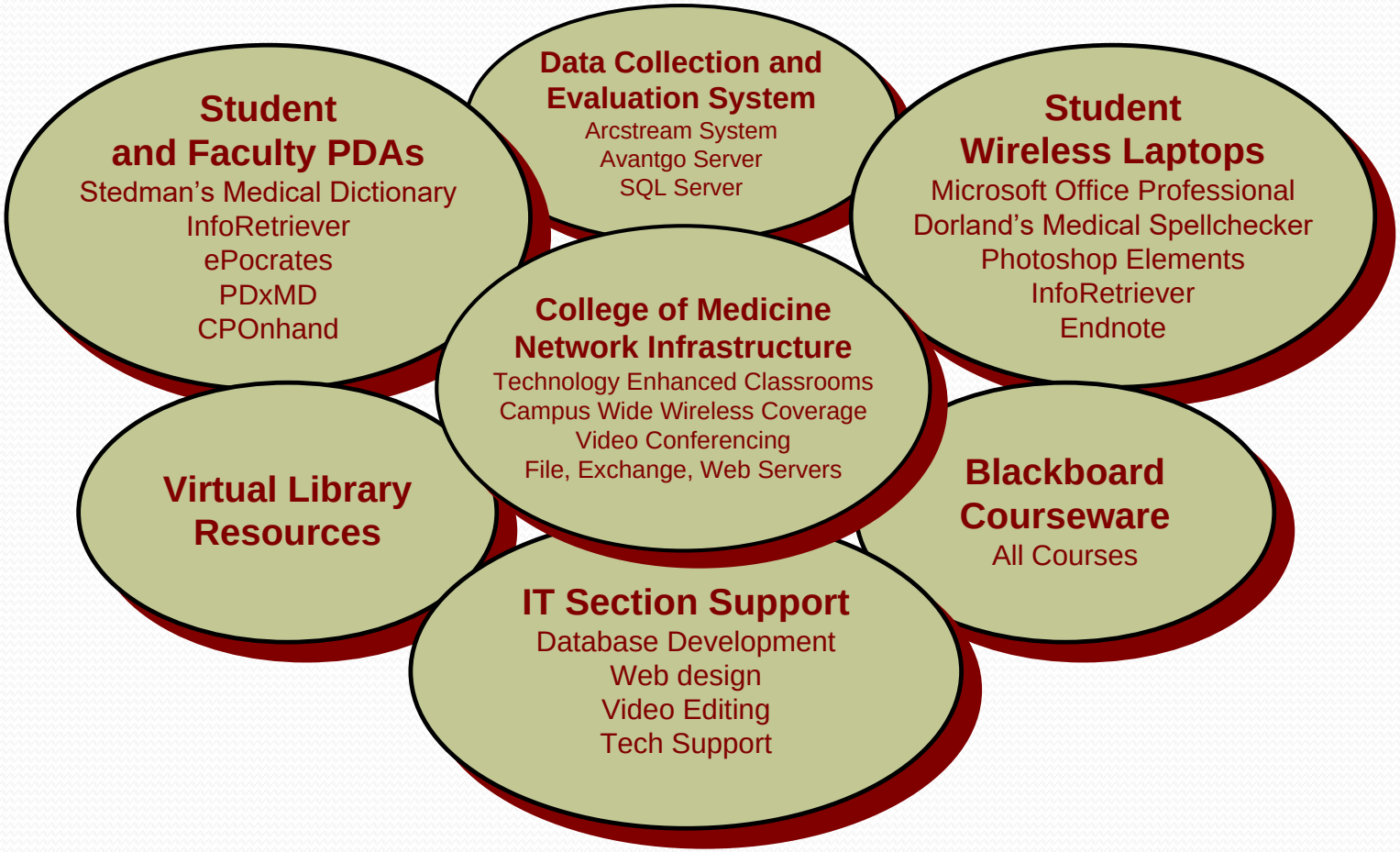
Health Informatics Tools

- include not only computers but also clinical guidelines, formal medical terminologies, and information and communication systems. It is applied to the areas of nursing, clinical care, dentistry, pharmacy, public health and (bio)medical research.

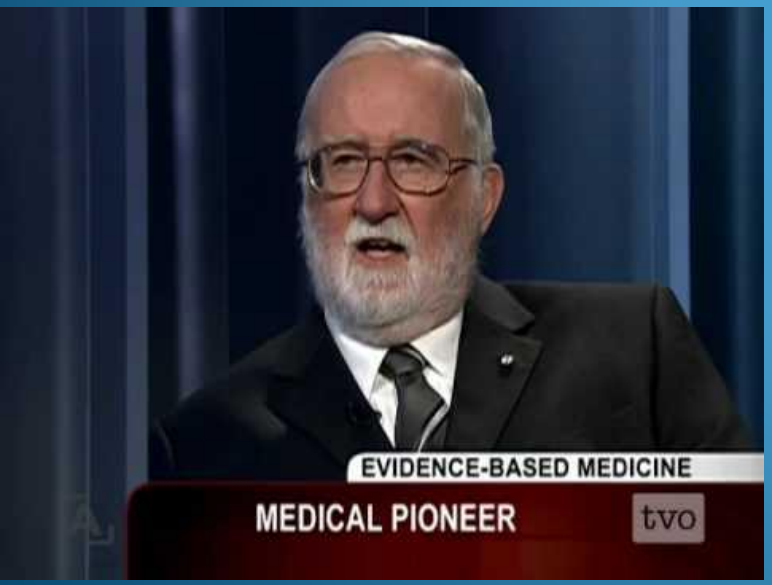
Infrastructure to Support Informatics Curriculum.

- Hardware/Software
- Support Issues
- Workflow/Mindset Issues
- Training Issues
- Budgeting Issues

Infrastructure for Medical Informatics



"Textbooks don't smell as their contents rot, so readers will need to develop alternative crap detectors to avoid poisoning their minds and robbing their patients of current best care."



David Sackett, MD
Pioneer of Evidence Based Medicine (EBM)

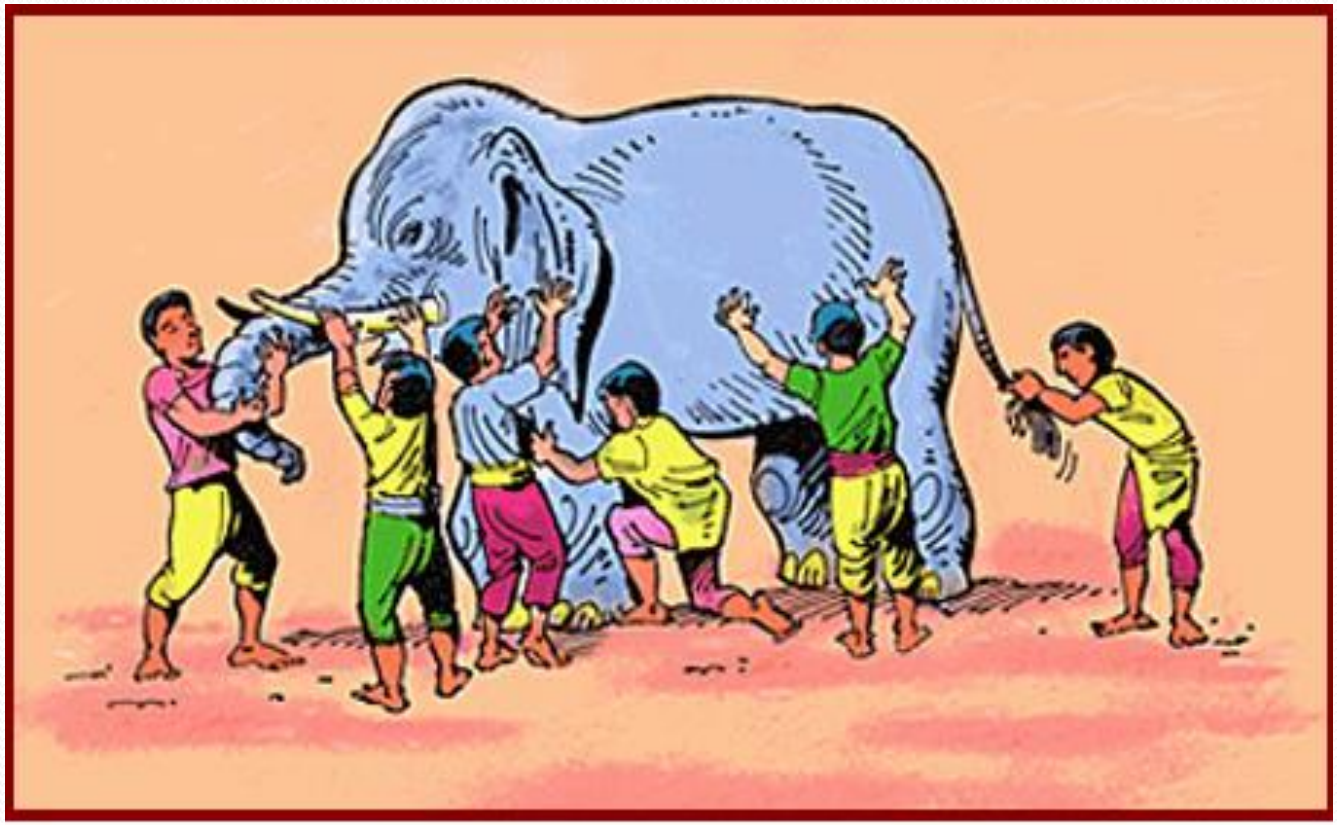
(The half life of medical information is estimated at 5 years.)

Doctors' Tablet Use Almost Doubles in 2012

1. **Medscape**
2. **MicroMedex (gyógyszer rendelés, kölcsönhatások stb.)**
3. **Calculate by QxMD (számítások, gyógyszerelés)**
4. **Patient Education apps: Draw MD series / Cancer.net / inMotion 3D**
5. **AHRQ ePSS** (Agency for Healthcare Research and Quality & Electronic Preventive Services Selector)
6. **Radiology 2.0: One Night in the ED**
7. **Free iBooks**
8. **3D Virtual Simulation Medical Apps: Upper Respiratory Virtual Lab / iLarynx**
9. **Free Journals and PDF management solutions:**
   Lancet / Circulation / Dropbox / Evernote
10. **MedPage Today (**an online medical news service for physicians and healthcare professionals.)

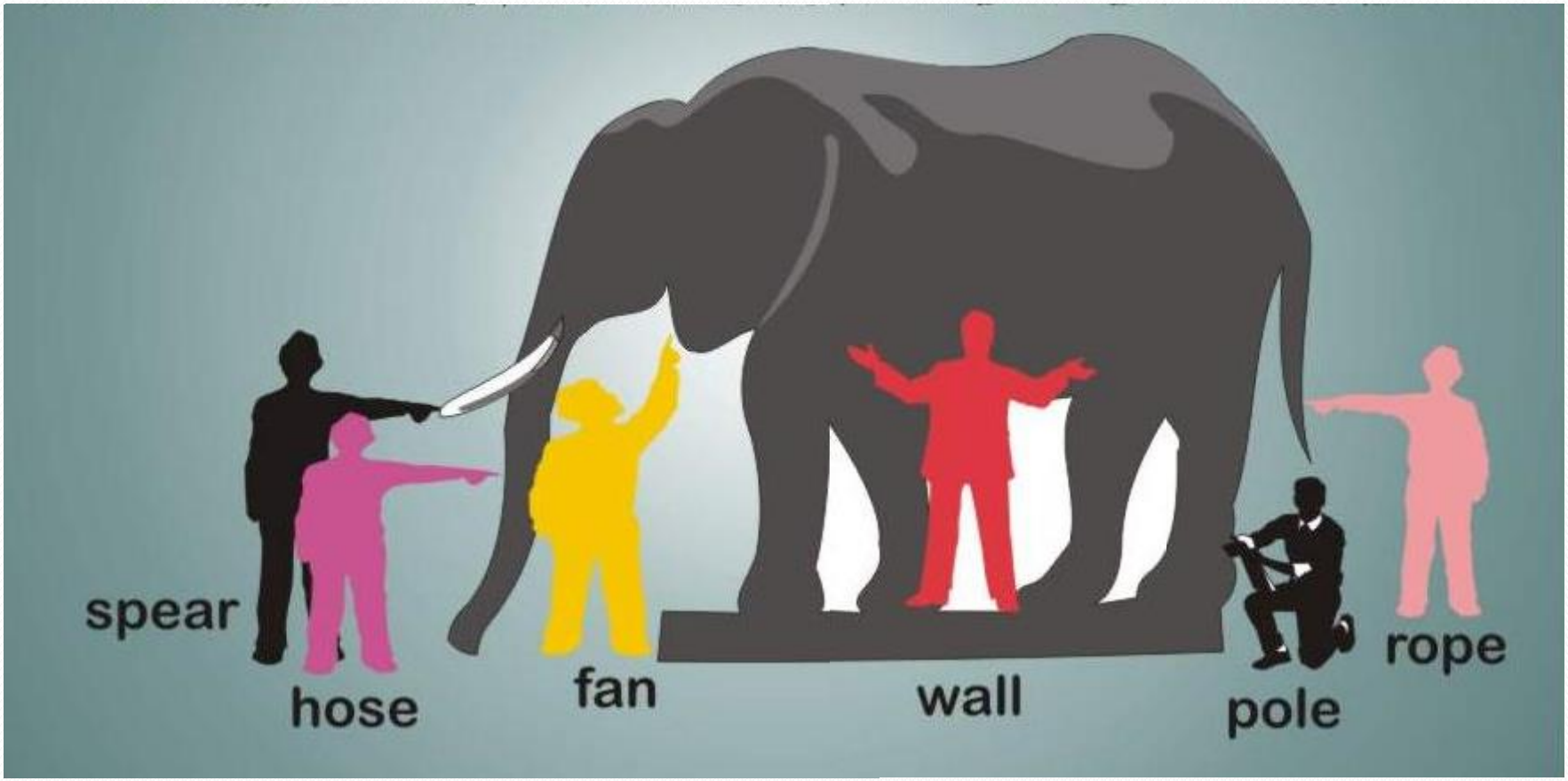
Tablets have become mainstream, and physician adoption for professional purposes almost doubled since 2011, reaching 62% in 2012's survey.

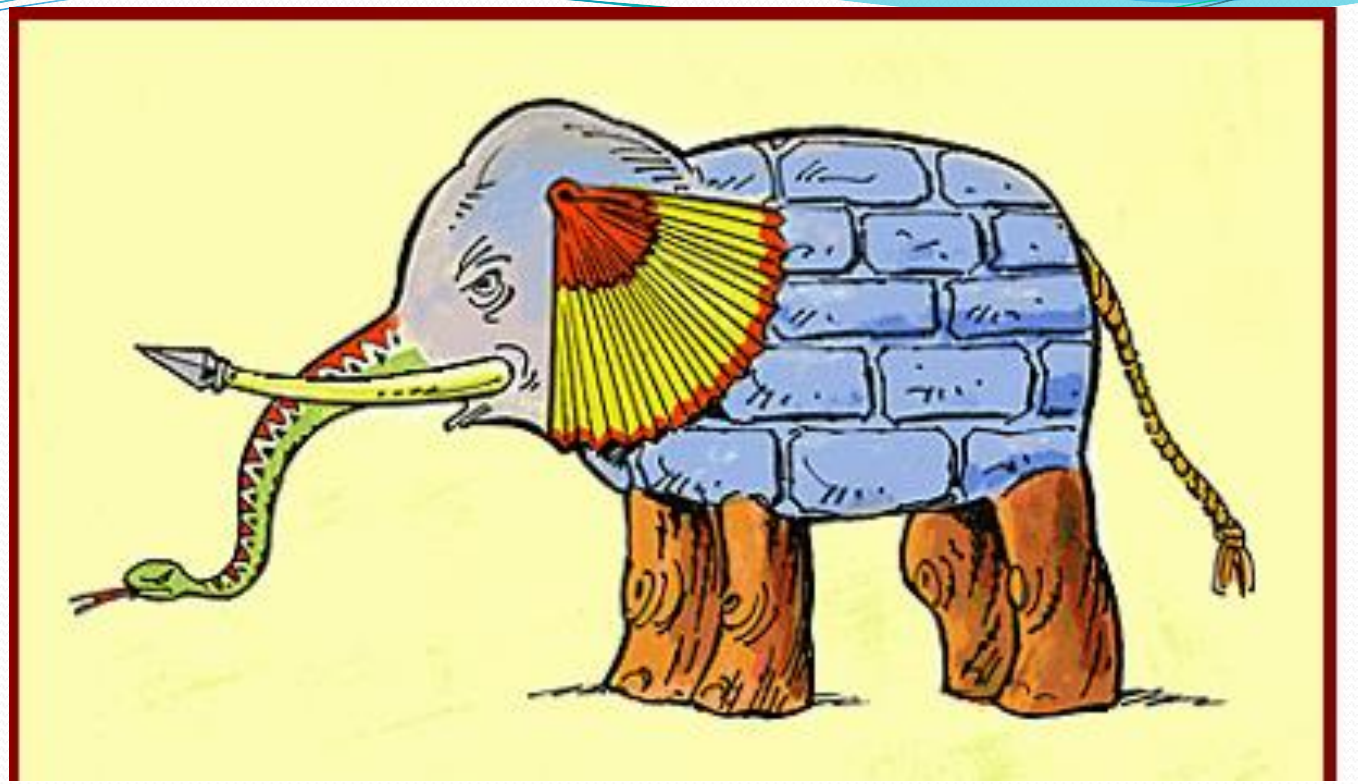
What does it mean: medical informatics ?



It was six men of Indostan
To learning much inclined,
Who went to see the elephant,
Though all of them were blind
That each by observation
Might satisfy his mind.

Biomedical Informatics is...





And so these men of Indostan
Disputed loud and long,
Each in his own opinion
Exceeding stiff and strong.
Though each was partly in the right
And all were in the wrong.

Biomedical Informatics is…

"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."

Greenes RA. Shortliffe EH.
JAMA 1990 Feb 23; 263(8): [illegible]

Biomedical Informatics is...

- The art and science of organizing knowledge of human health and disease, and making it useful for problem solving

The Spectrum of Problem Solving

- Science base of biology and medicine
- Collection and interpretation of signals
- Application of science and data in clinical care
- Extension of clinical care to populations

What is Medical Informatics?

Nancy B. Clark, M.Ed.
Director of Medical Informatics Education
Florida State University

Health (Medical) Informatics

Simplistic definition:

- 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.
  MF Collen, MEDINFO '80, Tokyo

Health (Medical) Informatics

- Medical informatics is the rapidly developing scientific field that deals with resources, devices and formalized methods for optimizing the storage, retrieval and management of biomedical information for problem solving and decision making.
  Edward Shortliffe, M.D., Ph.D. What is medical informatics? Stanford University, 1995.

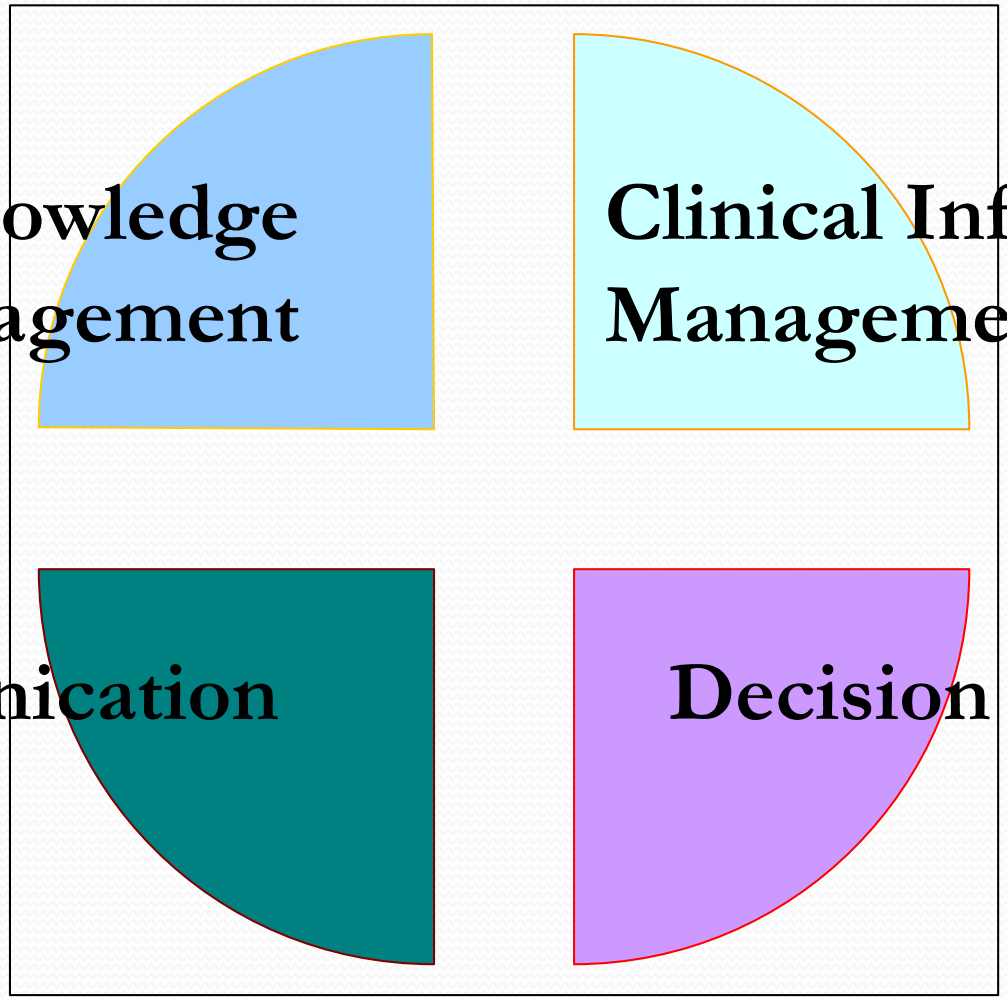
Health (Medical) Informatics

- Medical Informatics is the branch of science concerned with the use of computers and communication technology to acquire, store, analyze, communicate, and display medical information and knowledge to facilitate understanding and improve the accuracy, timeliness, and reliability of decision-making.
  Warner, Sorenson and Bouhaddou, Knowledge Engineering in Health Informatics, 1997

Health Informatics Defined

- Information Technology
  - Health care
  - Research
  - Education
- Fundamentals
  - Communication
  - Knowledge Management
  - Decision support
  - Clinical Information Management

Medical Informatics



Informatics Use in Health Care

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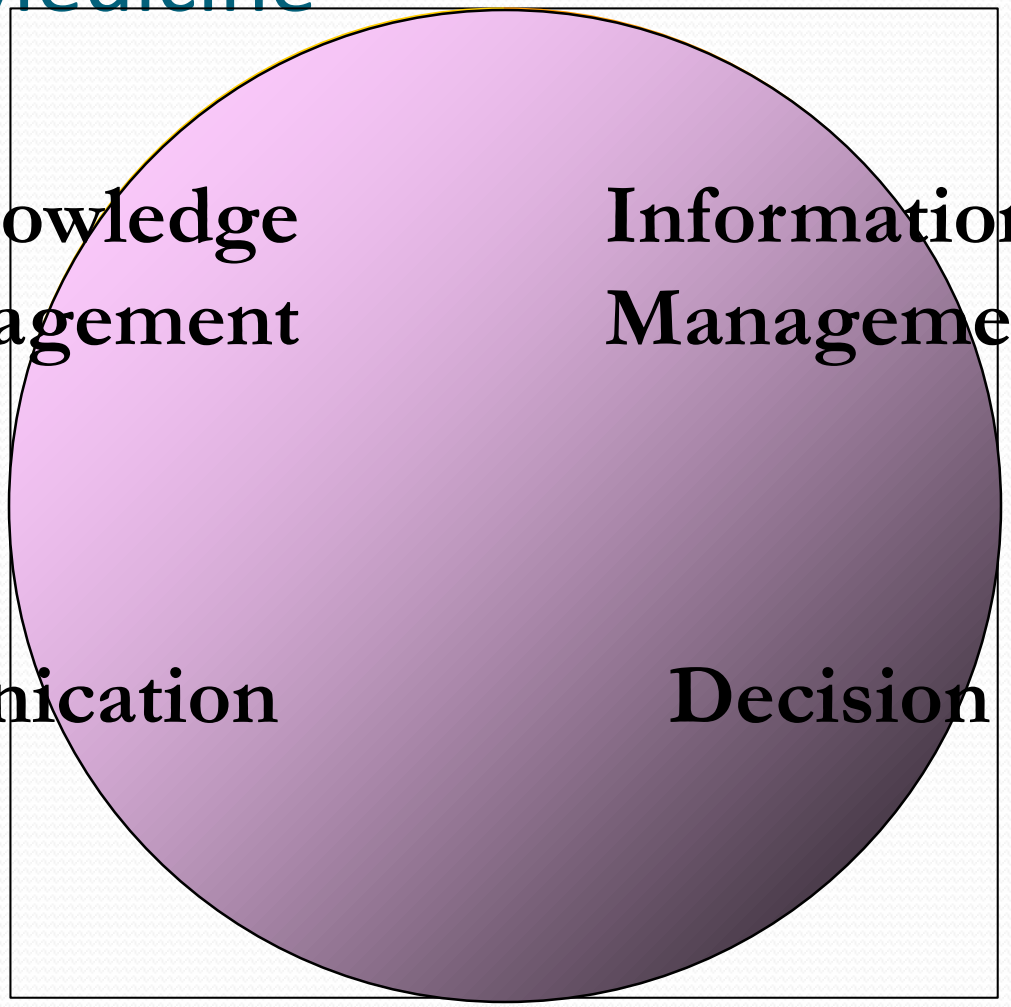
Medical Informatics Changing Medicine



Vision of Quality Chasm Report

- Standardized information infrastructure
- Support care teams - Enhances patient-centered care
- Supports care coordination
- Measure outcomes - Improve outcomes
- Enhance safety - Reduces errors
- Enables quality measurement/monitoring - Reward quality

The Case of Betsy A. Lehman

"How long, Oh Lord, must this continue? …That's 21 years ago…Isn't it time that basic computerization be part of the expected, and required, care at medical facilities?"

Reducing Errors

- Order entry systems
  - Reduce medication errors
  - Detect potential drug interactions
- Clinical decision support systems
  - Improve drug dosing
  - Improve preventive care
  - Not diagnosis

Informatics Programs

- Degree
- Fellowships
- Certificates
- Short courses

- Medical schools
- Information Studies
- Nursing schools
- Public health schools
- Dental schools
- Health care organizations

What's in a Name?

- "Bioinformatics"
  - Really *biomolecular informatics*
- "Medical informatics"
  - Really *clinical informatics*
- "Biomedical informatics"
  - Covers both and more

Building Blocks

- Representation of data and knowledge
- Storage and retrieval of information (structured and unstructure)
- Signal processing
- Natural language processing
- Decision analysis
- Expert systems
- User interface design
- Standards

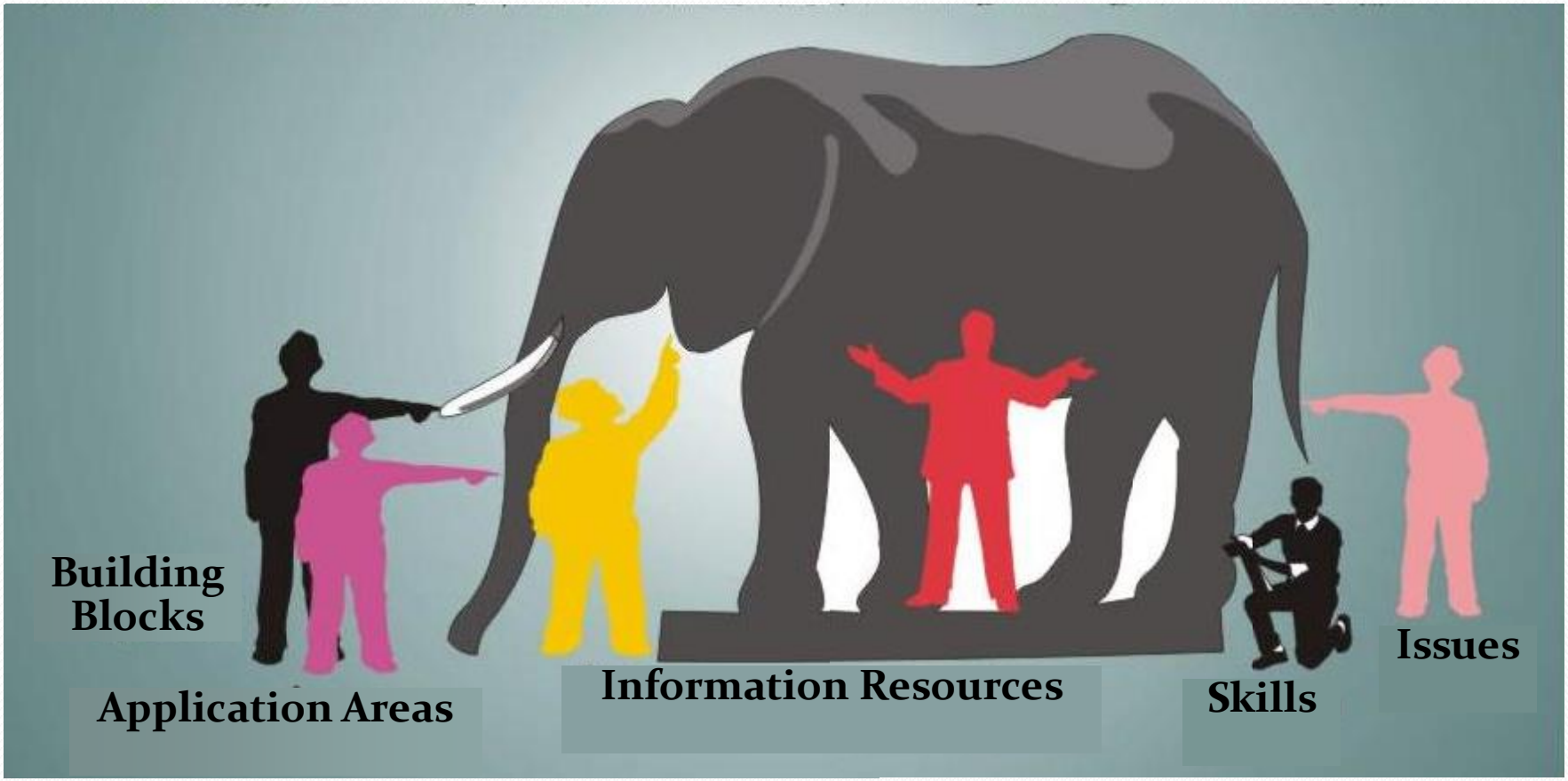
Application Areas

- Biomolecular modeling
- Digital imaging systems (PACS)
- Cardiology systems
- Electronic health records
- Telemedicine
- Public health information systems
- Educational tools
- etc

Biomedical Informatics is...

- Concepts
- Technologies
- Skills

Biomedical Informatics is...



Why informatics - evidence based medicine

Biological data requires careful analysis –
if the data collection is incorrect - gaps can not be filled by informatics or so

Internet Protocols

- FTP (file transfer protocol) serves to exchange data with a remote computer
- Telnet allows to run programs on a remote computer

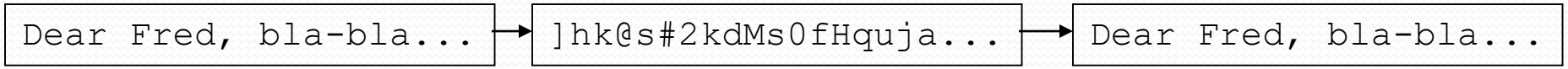
Terms:

Upload - send TO a remote recipient
Download - receive FROM a remote sender

Security: Cryptography and more

I send message to Fred

Fred reads my message



Fred's public key

Fred's private key

Fred answers my message

I read Fred's answer

My public key

My private key

VIRUS!!!!! ?????

"This is an urban myth. It is like the history of the crocodiles in the sewers of New York. All world knows of them, but nobody has seen them."

-- Peter Norton

"The problem of the virus is fleeting and will only last for a few years"

-- John McAfee

Telemedicine

- Definition:
  - The use of electronic information and communications technologies to provide and support health care when distance separates the participants (IOM 2001)
- Used For:
  - Patient Monitoring
  - Medical Consultations
  - Patient Education
- Technology is already here

Telemedicine

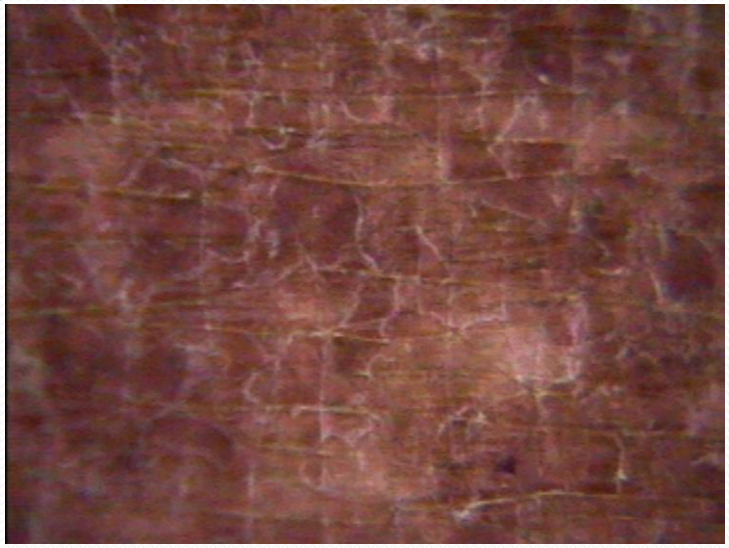
Medical Consultations

Monitoring Equipment by Philips

Patient Education by Philips

Some Examples of Telemedicine

- Teleconsultation: Connect professionals to share data and obtain expert opinion (e.g.: example teleradiology, video consultation)of more complicated case presented with images like x-Ray, E CG, Ultrasonogram, CT MRI interpetation
- Telemonitoring: Monitor patient remotely. Can include alarm monitoring and security, patients use wireless devices in their homes to take daily vital signs measurements their weight, heart rhythm, blood pressure, blood sugar and pulse. This information is automatically and securely transmitted over phone lines to clinical review software, which care managers can access via the Web.
- Telediagnosis: To perform diagnosis remotely Patient-to-doctor connection (vs. doctor to doctor connection in teleconsultation)
- Teletreatment: Treatment at a distance.E.g. Telesurgery
- telecare-provision: help-advice (and feedback)
- store and forward: Central data storage for distributed consultancy. Example: database for dermatology (skin diseases). Database can be accessed via dedicated software or web browser. Images can be shared by large group of specialists.



Dermoscope View

General Exam View

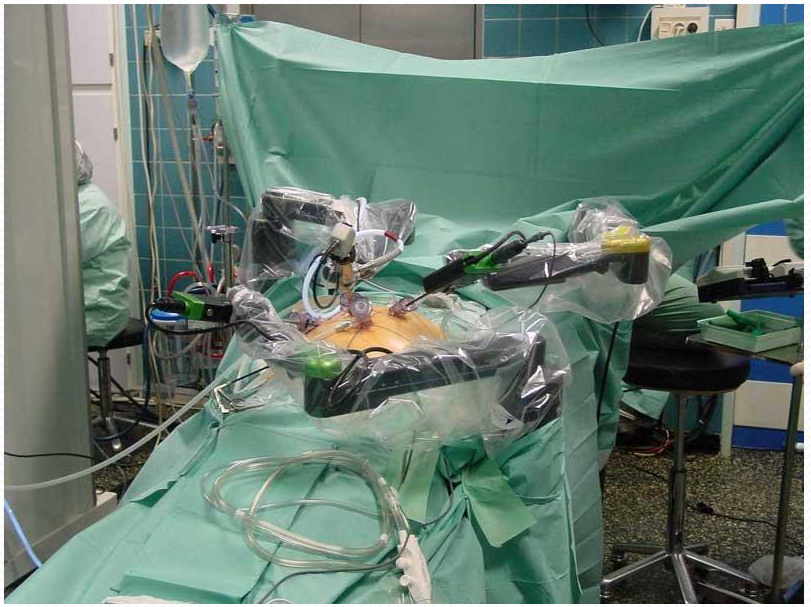
Application of Medical Robotics

- Telesurgery
  - Surgeon sits at a console
  - Has controls to move the robotic arms
  - Does not operate on the patient directly
  - Mainly used in minimally invasive surgeries

LINDBERGH OPERATION

- Laparoscopic Cholecystectomy

•Zeus Robotic Surgical System



Standards

- SQL
- HL7
- XML
- OVT

Without standards there is no effective communication
Standards make life easier (but simpler)
Who cares
The efficienty vs standards
To minimize bias/ fatal errors – not only communication, it is more (security in data transfer- self corrections etc)

Problems with standards

- Not all standards are of equal quality
- Once a bad standard is set in stone you are creating problems for your children and for your children's children
- Standards, especially bad standards, have costs

Making data (re-)usable through standards

- Standards provide
  - common structure and terminology
  - single data source for review (less redundant data)
- Standards allow
  - use of common tools and techniques
  - common training
  - single validation of data

Problems with standards

- Not all standards are of equal quality
- Once a bad standard is set in stone you are creating problems for your children and for your children's children
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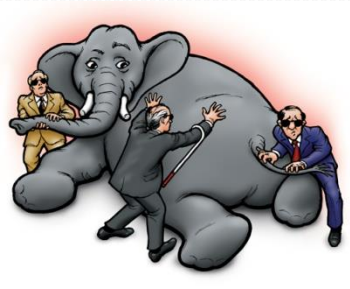
Major Fields of Biomedical Informatics

- Building blocks
  - Databases
  - Controlled terminology
  - Decision analysis
  - Evidence-based practice
  - Image informatics
  - Internet
- Information resources
  - Bibliographic resources
  - Expert systems
- Personal skills
  - Web pages
  - Databases



Application areas
- Bioinformatics
- Clinical systems
- Order entry
- Telemedicine
- Consumer systems
- Personal records
- Public health
- Education

Issues
- Privacy
- Evaluation
- Managing teams

Multiple kinds of data in multiple kinds of silos

Lab / pathology data
Clinical trial data, including regulatory data
Electronic Health Record data
Patient histories (free text)
Medical imaging
Microarray data
Protein chip data
Flow cytometry
Mass spectrometry data
Genotype / SNP data
Mouse data, fly data, chicken data ...

How to find your data?

How to find other people's data?

How to reason with data when you find it?

How to work out what data you do not have?

How to understand the significance of your own data from 3 years ago?

Biomedical Informatics Needs Data

- Four sides of the equation of translational medicine
- Biological data + clinical data
- Access + usability

Problems of gaining access to *clinical* data

1. privacy, security, liability
2. incentives (value of data ...)
3. costs (training ...)

I can prove it or disprove it, what do you want me to do?

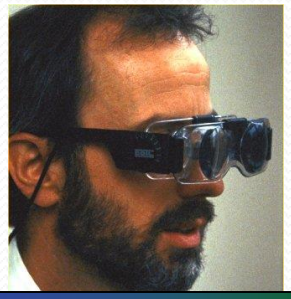
Validity of the data – hypotheses

Real data collection – exact measurement - what to measure, how to measure,

how to store - structure of stored data

Translational Medicine …

…needs a connection



Hypothesis Validation
Experiment design
Predictions
Personalized medicine

Biomedical Informatics

Semantic Web research aims at providing this connection!

Etiology
Pathogenesis
Clinical findings
Diagnosis
Prognosis
Treatment

Pubmed

Clinical Trials.gov

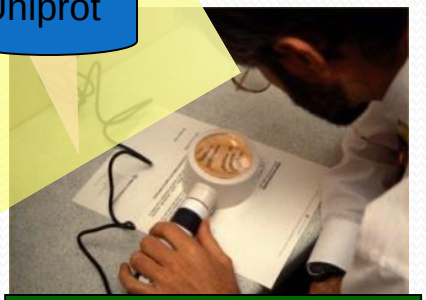
Genbank

Uniprot

Genome
Transcriptome
Proteome
Metabolome
Physiome
…ome

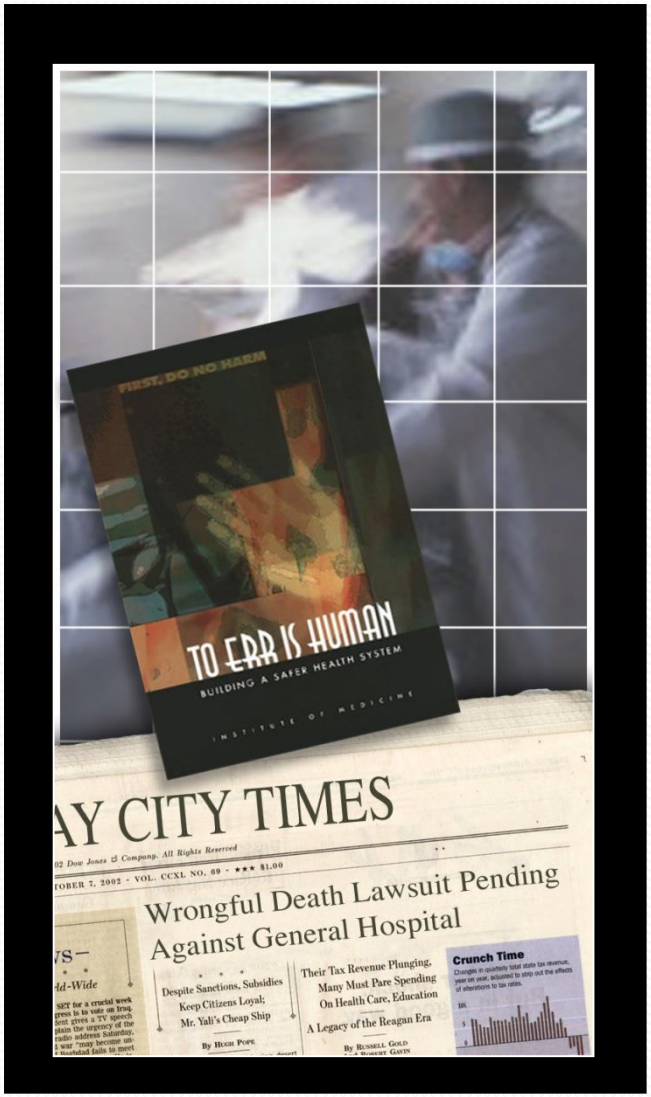
More advanced capabilities for
search,
integration,
analysis,
linking to new insights and discoveries!

Medical Informatics



Bioinformatics

Challenges for Clinicians



- **We practice with incomplete information**
- **We have alarming error rates**
- **We spend 30-50% of time on administrative activities**
- **Errors are associated with surveillance, change in venues, and patient handoffs**
- **Fragmented, incomplete records can cause confusion, communication breakdown, and the opportunity for error.**
- **We need to reduce burdens related to documentation**