What is Medical Informatics?

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Erroneous opinions and misconceptions

- There is great confusion regarding the ‘definition’ of Medical Informatics.
- Often used to describe a broad range of intertwined disciplines
- Involving all of medical computing and any related disciplines.

*Let us trace the genesis of the term and the discipline of ‘Medical Informatics’*
Claude Shannon

Father of Information Technology
In 1948, he published "A Mathematical Theory of Communication" in the Bell System Technical Journal. This paper founded the subject of information theory.
Origin of Medical Informatics

• Field of Medical Informatics is >30 years
• Origins of general discipline of ‘informatics’ traced to a Russian publication
  – *Oznovy Informatiki* (Foundations of Informatics) – 1968
Origin of Medical Informatics

• Concept of information science was described within context of an emerging computer age.
• Focussed on structure and effects of medical information
• **NOT** the electronic scaffolding necessary to shuttle the electronic signals to and fro.
OED Definition

• ‘Informatics is the discipline of science which investigates the structure and properties of scientific information’

• Thus, medical informatics is the discipline which investigates the structure and properties of medical information.
Medical Informatics Discipline

• *Medical Informatics* recognized as a discipline presumably in 1974
• 1st described in document:
• Although this is the earliest this discipline was given a name, informatics principles date much earlier.
Dr Roget – Scottish surgeon

• Devised novel method of representing knowledge on the principle that:
  – All things are ‘concepts’
  – Concepts could be described by ‘terms’
  – Different terms that described the same concept were called ‘synonyms’

• Developed thesaurus to address problem of synonymy
  – Roget’s Thesaurus of English Words and Phrases – 1852
Dr John Shaw Billings

- Surgeon General of Army
- Founding editor of Index Medicus
- Established National Library of Medicine
- 1st director of NLM in 1887
Dr John Shaw Billings

• Dr. Billings was charged with tabulating the U.S. census
• Devised specific methods of information storage and data manipulation – 1890
• Conceptualized the genesis of information revolution
• Described electromechanical device that would tabulate census automatically through punch cards.
Herman Hollerith – Govt statistician

• Given job of making this concept a reality
• Constructed punch-card tabulating machine
• 56 Hollerith machines were used in 1890
• Processed census information for 62 m. people
• Completed 2 years ahead of schedule!
• $5 million under budget!!
Herman Hollerith

- Hollerith left government job in 1896
- Establish International Tabulating Machines
- Became International Business Machines (IBM); a.k.a. Deep Blue in 1924
  – (Collen, 1986).
Evolution of IBM Logo

International Time Recording Company (1888)
Computing Scale Company (1891)
Computing-Tabulating-Recording Company (1911)
International Business Machines (1924)

IBM (1947)
IBM (1956)
IBM (1972)
Dr John Shaw Billings established and became 1st director of NLM.

1st stacks of NLM were his personal medical library donations
NLM – 1887
MEDLINE / MEDLARS

- Dr. Billings’ work intersected technology again in 1966
- Computerization of Index Medicus
- The resulting system known as MEDLARS
- 1st publicly accessible online information system.
- Today, such systems are ubiquitous in many aspect of our lives
Medical Informatics comes of age

• Formalization of Medical Informatics discipline from 1974 through 1990’s into new millennium

• Medical Informatics became increasingly recognized as an important component of the overall practice of medicine

— (Collen, 1996).
Shortliffe and Perrault

• Defined Medical Informatics thus in 1990:

‘..the rapidly advancing scientific field that deals with the storage, retrieval, and optimal use of biomedical information, data, and knowledge for problem solving and decision making.’

– (Shortliffe and Perrault, 1990)
Shortliffe’s definition

• Shortliffe’s definition made no mention of computers or information technology.
• Focussed on subject matter – Information, rather than tool – Computer.
• Medical informatics is about information –
  – capture, use, and storage
  – rather than equipment that makes it possible
However, understanding relationships and properties of information is as important to medical computing as hardware / software necessary for its distribution.

This is vital to understanding the field of Medical Informatics and how it will impact medical computing in the future.
Medical Informatics – Revised concept

• Next slide shows Edward H. Shortliffe describing the inter-relationships between:
  – biomedical and clinical informatics
  – clinical practice and clinical informatics
  – computer science and biomedical informatics
  – (Amsterdam, 2007)
Biomedical Informatics in Perspective

Contribute to...

Biomedical Informatics Methods, Techniques, and Theories

Computer Science

Draw upon....

Contributes to....

Clinical Informatics

Clinical Practice

Draws upon....
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 by processing EMRs
- Information is outcome of analyzing data
- Knowledge is obtained from analyzing information and representing it in OBO Foundry ontologies
Medical Informatics

- Computerized Medical Records
- Computer-Aided Instruction
- Medical Software Security
- Veterinary Informatics
- Telemedicine
- Nursing Informatics
- Physician Order Entry Systems
- Medical Expert Systems
- Medical Software Engineering
- Clinical Information Systems
- Health Information Networks
- Policy Making
Why Medical Informatics

• Why is proper management of medical data important?
  • Patient health record
  • Administrative purposes
  • Research and knowledge discovery
  • Legal issues
  • And the list goes
Why Medical Informatics

• What is lacking in the current approach?

  • Organizational
  • Logistical
  • Research
  • Passive nature of EMRs
Medical Informatics Solutions

- Databases of EMRs
- Information Retrieval for Patient Cohort Identification
- Internet-based access
- Computer programs developed for processing clinical data
Why Medical Informatics

• What is lacking in the current paper-based approach?

Medication errors:

• Patient has allergic reactions
• Wrong medication given to patient
• Wrong dosage given to patient

Progress of Medical Informatics

- Many Medical Informatics research centres developed computerized medical record systems
- Incorporating Medical Informatics design principles.
- With the shift to clinician-driven designs…
- Many of these survived today and others are making a resurgence
HELP System

• HELP system is an example
• Developed by University of Utah
• Deployed in LDS Hospital in Salt Lake City.
Other Systems

• Other examples of Medical Informatics groups developing medical computing systems include:
  – **TMR** (The Medical Record) @ Duke University
  – **Regenstrief** Medical Record System @ University of Indiana.
Regenstrief System

• The Regenstrief system
  – Contains >1.5 million patient encounters in digital format
  – One of the most extensive repository of medical record information in the world
    – (MacDonald, 1997)
Modernization of NLM

• 1986 – Dr. Don Lindberg (pathologist) became director of NLM and ushered in a new era in Medical Informatics

• NLM began emerging as a staunch supporter of discipline of and research in Medical Informatics

• This period saw emergence of Medical Informatics in USA
Dr. Don Lindberg

- Led NLM through major changes
  - Development of **Unified Medical Language System (UMLS)** in 1986
  - Refinement of **MEDLINE**
  - Establishment of **Visible Human Project (Male / Female)**
- Secured funding of numerous Internet connections to rural hospitals
UMLS Meta-thesaurus

- It is a medical component of a large vocabulary system
- It addresses need for standardized medical vocabulary
- Such vocabulary necessary for categorizing biomedical information sources
- In order to enhance information retrieval
- UMLS also popular as a vocabulary for computerized medical systems.

—(NLM, 1997).
UMLS Meta-thesaurus

- Based on Roget’s original methodology
- Roget’s Thesaurus concept provided a scalable system that addressed differences in concept descriptions (synonymy) encountered in medicine
- UMLS Meta-thesaurus: Massive project
- Encompasses >500,000 terms / 252,000 concepts
Future of Medical Informatics

• Medical computing has contributed significantly to improvements in healthcare
• There are still tremendous challenges for future medical informaticians
• It is often assumed benefits of a paperless record will be immediately realized once all information available on paper is digitized.
• However…
Shortliffe’s study

- Shortliffe’s study – 168 consecutive visits to an Internal Medicine clinic
- Those with missing charts, reports were excluded from study
- Among the remainder, despite having complete medical chart, all laboratory, radiology reports etc…
- In 81% of physician visits, some important information was not available.
Shortliffe’s study

• The required information had not been captured in the process of generating the standard medical record

• This problem is unlikely to be solved by digitizing paper-based information resources already available to physicians.

• It is an information problem, not a computer problem.
Other studies

• Workgroup for Electronic Data Interchange (WEDI) study found 50% of paper-based medical records are missing or incomplete
  – WEDI, 1996.

• Institute of Medicine (IOM) reported 30% of treatment orders were not documented
Barriers

• These are problems of information acquisition

• They require intimate knowledge of:
  – Information content
  – Environment in which they are collected
  – Technology used to capture them

• These are essential tools of medical informatician
Summary

- Medical Informatics discipline is not new
- Yet appears to only be in its infancy in terms of enhancing medical practice
- Medical Informatics has the potential to benefit patient care as much as a newly discovered drug / therapy
- Yet direct benefits will not come in classic form – therapeutic interventions.
Summary

• Instead, they will be derived from enhancing our ability to care for patients
• Through improved delivery of medical knowledge and information.
• This is the promise of Medical Informatics
• It will be evident as medical practice forges ahead in the information age.
Summary

• Medical Informatics promises to
  – Reduce medical risks
  – Improve patient care
  – Cut costs of treatment
• Therefore, the term ‘Medical Informatics’ itself has undergone a transformation
• The generally accepted terminology now is Health(care) Informatics
• This includes (Bio)Medical-, Clinical-, Health-, Patient-, Nursing-, Public Health Informatics
Gunther Eysenbach’s diagram

1999
Eysenbach’s definition of Patient Informatics graphically represented
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