Introduction to Biomedical Informatics

Topic: Overview of BMI

Funded by NIH Grant XYZ
Outline

• Introduction to the class

• Motivating example: health records

• Origins of BMI

• Relationship of BMI to other disciplines

• Data acquisition, storage, and use

• Electronic Medical Records

• Conclusions and discussion

• Recommended reading
Why take this class...

• This class will NOT
  – teach you to be a programmer
  – teach you to fix broken computers
  – tell you about every important biomedical computing system or application

• This class WILL
  – introduce you to concepts underlying biomedical informatics
  – encourage you to read additional related material
  – help you connect broad concepts in biomedical informatics to your current and future work

• The practice of medicine is inexplicably entwined with the management of information (Shortliffe & Cimino, 3rd ed.)
Motivating example: health records

- Modern paper-based records grew out of the concept of “lab notebooks” for physicians

- What are some current challenges?
What are all the things that go into a medical record?
What are all of the ways in which the medical record is used?
Challenges to implementing electronic medical records:

- Impossible to fully automate record-keeping processes

- Limited standards for clinical terminology, billing and diagnostic codes, and interoperability among systems (both within one medical center and beyond to many)

- Data privacy, confidentiality, and security (importantly three different but related issues)
Some terms

• medical computer science
• information science
• information theory
• biomedical computing or biocomputation
• medical informatics
• bioinformatics
• biomedical informatics
History of Biomedical Informatics

• 1890: Hollerith used punch-card data processing in the US census; led to epidemiological surveillance via punch cards

• Late 1950s: Started to see applications of digital computers in medicine in engineering publications

• 1960s: Computer Science as a discipline formed; mainframes the norm

• 1970s and 1980s: emergence of the personal computer (PC) or microcomputer
The term *Informatics*

- 1968: A.I. Mikhailov, along with others coined the term Informatika during the development of the field of Information Science in Russia
- 1976: Nauchnye Kummunikatsii Informatika *Informatics: the scientific discipline that studies “the structure and general properties of scientific information and the laws of all processes of scientific communication.”*
- Late 1960’s: University departments in France, Holland, and Belgium established with the title “informatique medicale”
- 1974: “Medical Informatics” became the term of art at Kings College Hospital in London - “inform” from d’informatique, “atics” from d’automatique.
Formal Definitions and Standards Bodies

• 1985: American Standards for Testing Materials (ASTM, develops voluntary standards) established Subcommittee on Medical Informatics

• 1986: AAMC - defined medical informatics formally as “a developing body of knowledge and set of techniques concerning the organization and management of information in support of medical research, education and patient care.”

• For the purposes of this course, Biomedical informatics is a scientific field that deals with biomedical information, data, and knowledge – their storage, retrieval and optimal use for problem solving and decision making.
Biomedical Informatics Application Domains

• Biomedical Informatics has major application domains (sub-disciplines) including:
  – **Bioinformatics** – directed at the level of molecular and cellular processes
  – **Clinical Informatics** (a.k.a. healthcare informatics) - directed at the level of individuals (includes medical informatics, nursing informatics, dental, etc.)
  – **Public Health informatics** – directed at populations and society
  – **Social Informatics** – social impacts of information technology in healthcare field.
  – **Imaging informatics** – directed at the level of tissues and organs, e.g., pathology informatics, radiology informatics
How do you think Biomedical Informatics relates to other disciplines?
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Medical practice is all about gathering, reviewing and interpreting data

– Data are central to all medical care
– Data are central to the process of decision making

What are medical data?
An individual medical data point (datum) is a single observation about a patient

- The patient in question
- The parameter being observed
- The value of the parameter in question
- The time of the observation
Medical data are uncertain.

- Absence of standard medical vocabularies based on clear definitions makes all medical observations fuzzy.

- Common findings may mask rare ones.

- Symptoms and diagnoses can co-occur even when not related.

- Context helps remedy this issue to a degree.
Return to our example: the medical record

- Legal document

- Growing tendency to structure data

- Often reviewed intensely
Who (What) collects medical data?

• Physicians
• Nurses
• Radiologists
• Laboratory
• Office staffs admission personnel
• Technological devices
Potential Uses for Medical Information

• Historical Record

• Communication

• Diagnosis and Monitoring

• Legal Records

• Clinical and/or Epidemiological Research

• Perhaps custom treatments/personalized medicine
Pros and Cons of Paper Records

+ Flexibility
+ Relative robustness
+ Accessibility (paper is everywhere)
+ Familiarity

- Logistical issues
  - Unable to share with multiple users
  - The incomplete of the records
  - Legibility
  - Disorganization of the paper records
- Redundancy and inefficiency
- Influence on Clinical Research
- Accessibility (once the record is entered, it's hard to access by paper alone)
- Illegibility of provider handwriting
Goals of Computerized Records

• Facilitate patient care by serving as organized “external memory” for practitioners
• Enhance communications between providers and specialists
• Ensure continuity of care during inpatient stays and across outpatient visits
• Legal and financial purposes
• Research support
Pros and Cons of Electronic Records

+ Accessibility - remotely and simultaneously
+ Legibility
+ Automatic decision making - asking for missing information, alerts, reminders
+ Enhanced scope (have all inpatient and outpatient data and test results available even if a patient is outside local area)

- Initial investment
- Continuing costs (training, maintenance of confidentiality, etc.)
- Subtle failures (e.g., transcription errors of handwritten notes by data entry person)
- Catastrophic failures
- Data glut difficulties (physicians often use a great deal of data of low “decision value” to make small decisions. Capture is difficult and expensive.)
Factors Influencing Benefits of EHR/EMR Use

• Comprehensiveness of information

• Duration of use and retention of data

• Degree of structure of data

• Ubiquity of access
Automated Data Capture

- Recording data in the moment can take a person out of that moment (e.g., notes in class, records during patient visit)
- Comprehensive capture of all data is impractical – need priorities
- Relying on self-report alone can lead to missing information
- Insufficient detail ("tests were normal") avoided when test results automatically gathered from original source
- Chance to track data provenance in detail

But when data cannot be gathered automatically...

- Emphasis on personnel investment needed

- Avoidance of free text since interpretation by input personnel introduces errors

- Careful coding - emphasis on training

- Work on areas to increase accuracy of data input (e.g., structured data entry, voice recognition)
Medical care is informational

Physician encounters are information-rich

What are some examples from your experiences?
Where did the idea of storing all these data digitally originate?

- As in other domains, complexity and quantity of information requires digital database solutions (to a degree)
- 1950’s: Split between clinical and research information repositories
- 1960s: advent of computer-based hospital information systems (HIS)
- 1969: Lawrence Weed introduced problem-oriented medical record (POMR)
EMR

• The source-oriented information of a medical chart plus a “demand-oriented front end.” (Stead, 1987)

• Lindberg - ideal EMR concepts:
  – Careful measurements over patient’s conditions should be made, recorded and monitored;
  – Lifelong record must be complete and machine-readable;
  – Linkages should be included to sources of medical knowledge.
Functional Components of EMR

• Integrated view of patient data

• Clinical decision support

• Clinician order entry

• Access to knowledge resources

• Integrated communication and reporting support
What is the difference between an EMR and an EHR?
What is so complicated about EHR?

• Lots of types of data to store...

• Lots of people to make happy...
What does the EMR in particular have to do?
Desirable Features

• Modular

• Open Source (means different things to different people);

• Patient-centric

• Usable in research context (if the clinical setting using the EMR does research)
Issues, Barriers, Bottlenecks

- Privacy
- Interoperability
- Standards
- Usability
- Workflow
One example:

• Demo from Quest System
Translating Medical Data into Knowledge

- Data: single, uninterrupted observation point (e.g., one BP reading)
- Information: elements of data arranged to convey meaning
- Knowledge: generalized “truths” formed from analysis of information

Discuss: What is the difference between a database and a knowledge base? Why does it matter?
Discussion

• What do you think is the long-term relationship between health workers and computers?
• For the practitioners in the class, how have things changed for you in your profession over the years?
• Will clinicians be viewed as outmoded if they do not turn to computational tools for assistance?
Recommended Reading

• Heath and Luff – Documents and professional practice: ‘bad’ organisational reasons for ‘good’ medical records
• Marc Berg – The multiple bodies of the medical record
• Altman – Informatics in the care of patients: Ten notable challenges
• Institute of Medicine – Crossing the Quality Chasm: A New Health Systems for the 21st Century
• Collen 1995 – a history of medical informatics in the United States
• Weed 1969 – Medical Records, Medical Evaluation, and Patient Care: The Problem-Oriented Record as a Basic Tool.

• Chapters 1, 2, and 12 in blue book