The UAB Informatics Institute and Why It Isn't Just a Division of Computer Science

James J. Cimino, MD
Director, UAB Informatics Institute
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.
Biomedical Informatics is...

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

1950’s - Ledley RS, Lusted LB. Reasoning foundations of medical diagnosis; symbolic logic, probability, and value theory aid our understanding of how physicians reason. *Science*. 1959 Jul 3;130(3366):9-21

1960’s - Laboratory systems

1970’s – Expert systems

1980’s – Type I electronic medical records (EHRs)

1990’s – World Wide Web; Type II EHRs

2000’s – Social networking; Type III EHRs

2010’s – Meaningful use of EHRs; big data; learning health system
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’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
- Controlled terminologies and other standards
- Signal processing
- Natural language processing
- Mathematical modeling
- Decision analysis
- Expert systems
- User interface design
- Knowledge resources
Application Areas

- Biomolecular modeling
- Digital imaging systems (PACS)
- Electronic health records (documentation, order entry)
- Telemedicine
- Public health information systems
- Consumer informatics
- Disaster informatics
- Research informatics (translational and clinical)
- Education informatics
The Elephant and the Visually Impaired People
Biomedical Informatics is...
Issues and Technologies Pushing Informatics to the Fore

- Health care costs
- Medical errors and decision support
- Functional genomics
- Explosive growth of the literature
- Personal health records
- Mobile computing
- Sensor technology
- Privacy
- Translational research
- Public health disasters
- Social networking
- “Big data”
- “Meaningful use”
Case Presentation

The patient is a 50 year old, Native American female veteran who presents to the emergency room (ER) with the chief complaint of lip numbness, nausea and chest pain.

The patient was generally well until about one half hour prior to arrival in the ER, while eating dinner at a seafood restaurant in Rock Harbor, MA. She was finishing a dinner of New England clam chowder, lobster, steamed clams, and corn on the cob when she noted onset of symptoms. Others in her party ate fish and chips, although two other people ate the clam chowder; none at the steamers.

She gives a history of hypertension and states that she was getting a "capsule, half green, half blue-green" from her private doctor. She also reports that she was treated in the past for tuberculosis while she was pregnant, but doesn't remember what she was treated with or for how long. She reports that she was at another hospital on the other side of town, where she had a liver biopsy. She reports that he thinks the diagnosis was "hemachromatosis". The patient reports an allergy to Bufferin.

Physical examination revealed a well-developed, well-nourished diaphoretic female in moderate respiratory distress. Vital signs showed a pulse of 110, a respiratory rate of 8, an oral temperature of 100.3, and a blood pressure of 150/100. Examination revealed rales over both lower lung fields. Abdominal exam revealed a tender, palpable liver edge. Neurologic exam reveals dysarthria, diffuse muscle weakness, and hyperreflexia.

Chem7 (serum): Glucose 100 (70-105)  Chem7 (plasma): Glucose 150 (75-110)
CBC: Hgb 15 (12.0-15.8), Hct 45 (42.4-48.0), WBC 11,000 (3,540-9,060), Platelets 145K (165-415K)
A fingerstick blood sugar was 80
Urinalysis showed protein of 1+ and glucose of 0
A blood culture was positive for methicillin-resistant Staphylococcus aureus (MRSA)
ECG - Sinus Rhythm, 74BPM, Axis -30 degrees, ST segment 2mm elevated and T-waves down in leads I, L, V5 and V6
Chest X-ray Left upper lobe infiltrate, left ventricular hypertrophy

The patient's nurse reported that the patient seemed more worried about who would care for her elderly father if anything happened to her.

A medical student reviewing the case wonders whether paralytic shellfish poisoning could cause a myocardial infarction; she decides to do a literature search.
Issues in Cognitive, Information Processing, Communication, Practice, Education and Research

• How do we find out what medication the patient is on?
• How do we get her records from another institution?
• How do we get the *right* records?
• How do we keep the clinicians from getting overwhelmed?
• How do we recognize her potential allergy?
• How do we facilitate retrieval of relevant evidence?
• How do facilitate application of expert systems?
• How do we assess the patient’s genetic predispositions?
• What do we have to report for public health, and *how*?
• How do we exploit patient information to gain new knowledge?
• Why is this all hard to do?
Need for Standard EHRs: Nothing New Under the Sun

“A general purpose [health] record system would serve to improve the quality, planning and administration of health services, to help in the evaluation of comparative therapies, and to forward research on epidemiology and human genetics, and problems of diagnosis and especially on the natural history of disease.”

“We recommend the establishment of a special standing committee...to guide the development of a general purpose health record system...”

- President’s Science Advisory Committee
Life Sciences Panel, 1963
Meaningful Use of Electronic Health Records

- Leverage health IT to increase health care quality, lower health care costs and increase population health
- Focus on supporting health broadly, including but not limited to health care delivery
- Build incrementally over time from current technology – multiple methods of exchange required
- Maintain focus on and empower individuals
Big data is a broad term for data sets so large or complex that traditional data processing applications are inadequate. Challenges include analysis, capture, curation, search, sharing, storage, transfer, visualization, and information privacy.

- Wikipedia

In informatics, we have EHRs, images, genomics, healthcare transactions, biomedical literature, research data sets, social media...
Personalized Medicine

• A medical model that proposes the customization of healthcare - with medical decisions, practices, and/or products being tailored to the individual patient

• Commonly used to mean “genetics-driven” medicine

• Also known as “precision medicine”
The Learning Health System

The alignment of science, informatics, incentives, and culture for continuous improvement and innovation, with best practices seamlessly embedded in the delivery process and new knowledge captured as an integral by-product of the delivery experience.

- Institute of Medicine, 2007

Using observational data from EHRs to understand the implications of test results and impact of therapeutic choices.
UAB Initiatives

- Center for Genomic Medicine
- Personalized Medicine Institute
- Informatics Institute
The Agenda of the UAB Informatics Institute

- **Center for Genomic Medicine**
  - Relating Biobanks to Research Needs; Delivering Knowledge to the Point of Care

- **Personalized Medicine Institute**
  - Informatics Research to Address Research Information Needs; Improve Workflow

- **Center for Clinical and Translational Science**
  - Incorporation of New Data into Record; Integration of New Decision Support Tools

- **UAB Health System Electronic Health Record (Cerner)**
  - Helping Patients Understand their Health; Helping them Contribute to their Record
  - Teaching Clinical Trainees How to Use and Contribute to the ERH
  - Teaching Basic Informatics to Clinical Trainees; Training the Next Generation of Informaticians
  - Delivering Next Generation Decision Support to All Stakeholders

- **Informatics Institute**
  - Research
    - Improving Access to and Re-Use of Clinical Data to Support the Learning Health System
  - Operations
    - Patient Care
  - Clinical Education
    - Informatics Education

- **Coordinating Genomics Research with Clinical Research Activities**
Tactics versus Strategy
The Secret Agenda of the UAB Informatics Institute

1st Generation EHR – Home-grown by academic informatics groups
2nd Generation EHR – Early commercial efforts to recreate paper record
3rd Generation EHR - Mature commercial efforts to recreate paper record plus decision support
4th Generation EHR – Creation of an intelligent assistant for the twenty-first century

Current Electronic Health Record

Data Extracts → New Data Capture Technology

New Data Capture Technology → "Meaningful Use" Requirement

"Meaningful Use" Requirement → Knowledge-Based, Comprehensive Representation of Patient Information

Knowledge-Based, Comprehensive Representation of Patient Information → EHRs Can Do this Now, Even if They Doesn’t Understand the "Blob" of Data

EHRs Can Do this Now, Even if They Doesn’t Understand the "Blob" of Data → New Decision Support Technology

New Decision Support Technology → Can Be Stand-Alone Apps or Integrated with EHR for "Look and Feel"

Can Be Stand-Alone Apps or Integrated with EHR for "Look and Feel" → Clinicians and Patients

Clinicians and Patients → Education Research Needed to Learn How to Teach Proper Use

Education Research Needed to Learn How to Teach Proper Use → Informatics Research Needed to Define this

Informatics Research Needed to Define this → Everyone Wins if Record is Comprehensive and Computable

Everyone Wins if Record is Comprehensive and Computable → Research Operations

Research Operations → Research
Where Does Computer Science Fit In?

• Can we develop user interfaces that will capture the clinicians’ strategies?
• Can we represent the patient as a finite-state automaton?
• Can we build intelligent assistants that bring best evidence to bear?
• Can we develop heuristics for:
  • Modeling genomic and proteomic data?
  • Leaping from genetic sequence data to clinical decision-making?
  • Monitoring social media data for epidemiologic trends?
• Collaboration on research, teaching and mentoring
Conclusions

• Biomedical informatics is not just domain-specific applied computer science
• We have been ready for the promise of better EHRs for years
• Viewing the EHR as something other than a diary is a fundamental challenge
• The Center for Human Genomics will provide the genetic knowledge
• The Personalized Medicine Institute will deliver it
• The Informatics Institute will provide the data and tools to succeed
• Computer Science can show us new techniques for all of these tasks