Biomedical and Healthcare Informatics: Opportunities and Challenges for MIS Researchers

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Agenda

- BHI community
  - Health Informatics
  - Biomedical Informatics
- BHI Areas of Interest
- Strengths of MIS Community
- Experience of working with Health Community
- Major Conferences and Outlets
Biomedical Informatics Definition

- Biomedical informatics (BMI) is the interdisciplinary field
- Focuses on the effective uses of biomedical data, information, and knowledge for scientific inquiry, problem solving and decision making, motivated by efforts to improve human health.
Interdisciplinary Nature of BMI

Biomedical & Health Informatics

- Computer Science (hardware)
- Computer Science (software)
- Cognitive Science and Decision Making
- Management Science
- Clinical Sciences
- Basic Biomedical Sciences
- Bioengineering
- Epidemiology and Statistics
- Computer Science (hardware)
- Computer Science (software)
Biomedical Informatics ≠ Health Informatics

Basic Research

Biomedical Informatics Methods, Techniques, and Theories

Biomedical Informatics ≠ Health Informatics

Health Informatics

Clinical Informatics

Public Health Informatics

Bioinformatics

Imaging Informatics

Molecular and Cellular Processes

Tissues and Organs

Individuals (Patients)

Populations And Society

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Major Areas: Clinical Care

- **Electronic health record (EHR) systems**
  - Document the practice of medicine, nursing, and ancillary services

- **Practice management (PM) systems**
  - Facilitate patient registration, scheduling, and billing.
Major Areas: Clinical Research

- Clinical data warehouses and electronic data capture
- Federated System
- Tools to enable reuse of EHR data and prospective data collection
- Electronic institutional review board (eIRB)
- Clinical research management systems (CRMSs), also known as clinical trial management systems (CTMSs),
Strengths of MIS Community

- MIS community with last 40 years of experience and expertise has lot to contribute
- It is important for MIS community to get involved now
- Specific Areas of Interest
  - System Analysis, Design and Implementation
Strengths of MIS Community (cont--)

- Decision Support System
  - Multi-criteria decision making
  - Group decision support
  - Decision making under uncertainty
  - Design and implementation of decision support systems
Strengths of MIS Community (cont--)

- Technology Adoption and Diffusion
  - Major issue with implementation and adoption of various technologies
  - Has implications for design

- Standardization and Inter-organizational systems
  - Technical Issues
  - Organizational Issues
Strengths of MIS Community (cont--)

- Data and Information Integration
  - Federated Model
  - Health Exchanges
  - Patient Portal
  - Integration of Patient non health related data with health data
  - Interoperable system
  - Standardization of User Interface
  - Human Computer Interface
Strengths of MIS Community (cont--)

- Virtual Teams and virtual organizations
- Media Richness & Media Naturalness
- Use of Virtual Reality Technology to provide care
- Telemedicine
Strengths of MIS Community (cont--)

- Natural Language Processing & Text Mining
  - Ontologies
- Predictive Analytics
- Big Data
- Imaging Data
Some Example Research Projects

Innovation in Virtual Worlds: System Development and Delivery of Health Care Services in Second Life®

Nitin P. Walia
Mariam Zahedi
Hemant Jain
Focus

- Investigate Unique aspects of building systems and developing processes in VWs
- How this new platform can be creatively used to effectively deliver healthcare services
Develops

• The Theory of Organic Emergence of Systems for Building in Virtual Worlds
  • What is the process of developing a system (presence) in VWs (with focus on SL as the exemplar)?
  • What if any, are the unique aspects of developing a presence in such environments?

• Multiple Case Studies: Austria, Germany, Korea, Italy, US, and UK
  • Interview inside SL at Interviewees location Open ended semi-structured
Investigates

- Group Medical Visit in Virtual Worlds for Healthcare Service Delivery
- The potential of this new platform to deliver healthcare services more effectively.
- Address critical global issue of our time: Access to quality healthcare
Second Life Based Medical Facility

- Arrival Point
- Reception Office
- Physician Office
- Training Area
- Auditorium
Second Life Based Medical Facility
Some Example Research Projects

A PRACTICAL APPROACH TO BREAST CANCER KNOWLEDGE MANAGEMENT: A TUMOR BOARD PERSPECTIVE®

Carmelo Gaudioso
Hemant Jain
Research Motivation

- Breast cancer is the most frequently diagnosed cancer in women
- Lifetime risk in the United States is estimated at 12.7%
- Knowledge gap
- Improve dissemination and uptake of evidence-based knowledge
Breast Cancer Case Discussion: Knowledge Sharing Model
Research Focus

Aligning Knowledge to Practice: A Medical Informatics Integrative Perspective on Medical Knowledge Management Systems Design ®
Organizational Alignment with Knowledge Management
(Extended from Henderson & Venkatraman, 1993)
Second Focus

A Question-Based Case-Based Reasoning KMS: Bridging the Gap between Practice and Knowledge®
Study

Weather Medical Knowledge Management Systems Improve the Uptake of Evidence-Based Knowledge in Medical Decision Making: A Breast Cancer Multidisciplinary Cancer Care Committee’s Experience. ®
Some Example Research Projects

Patient-Oriented Evidence-Based Treatment Decision Support System (TreatQuest®) for Lung Cancer

Danqing Hu
Hemant Jain
Patient-Oriented Evidence-based Decision Support

- Patient-Centered Medicine
  - Focus on patient participation
  - Accommodate patient’s needs
- Evidence-Based Medicine
  - Focus on use of evidence
  - Aim to use population-based research
- TreatQuest ®
  - Integrate the two paradigms in a seamless manner
Data/Information Organization

External Static Data Sources
- TIBER-Bioinformatics
- GEC Data
- CNIC/NCI Data
- NCI Data
- Other Data Source

Internal Data Repository
- Literature Research Data/Information
- Guidelines Domain Knowledge
- TreatQuest Data

TreatQuest Internal Data/Information/Knowledge Processing Engine

TreatQuest Hybrid Dynamic Data/Information/Knowledge Sources

TreatQuest External Data/Information/Knowledge Processing Engine

External Data Repository
- Google Custom Search Service
- NCNI National Cancer Institute Website
- NCI/NCI Website
- WebMD Website
- PubMed Website
- MedlinePlus Website
- Other Data/Information/Knowledge Sources
- Other Website
- Other Information
- Other Domain Knowledge Service

Other Data/Information/Knowledge Links/Service

Biomedical and Health Informatics Research Institute
Integrating Big Data

- SEER Data: Surveillance, Epidemiology, and End Results (SEER) program
- Cover 26% of U.S population
- 124 data items
Some Example Research Projects

After Cancer Education and Self-Management Operations (ACESO): An Intelligent-Personal Health Information System (I-PHIS) Approach

Akshat Kapoor
Derek Nazareth
Hemant Jain
Gap in Research

- Most existing tools and resources are available for either detection (pre-diagnosis) or during the course of treatment.
- Not many patient-driven and managed care plans exist.
- Existing breast cancer survivorship plans exist in the form of a paper document, which is passive in nature.
- Interactive care plans must be more dynamic and customized to account for unique individual characteristics.
Follow-Up Care | Providers to Contact
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**Medical history and physical examination** | • First 5 years  
• Year 6+
**Posttreatment mammography** | • First 5 years  
• Year 6+
**Breast self-examination** | • N/A
**Pelvic examination** | Ob/gyn

**Coordination of care** | • First 5 years  
• Year 6+

**Genetic counseling** | If indicated, based on risk factors

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**Follow-Up Visit Frequency**

**Visit Frequency for HI/P Years 1-3:**  
- 3 months  
- 6 months  
- 12 months  

**Visit Frequency for Mammography:**  
- 6 months  
- 12 months  

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**Notes:**
- Risk: You should continue to follow-up with your physician because the risk of breast cancer recurrence continues for more than 15 years after treatment.
- Symptoms of Recurrence: Report these symptoms to your doctor: new lump, bone pain, chest pain, shortness of breath or difficulty breathing, abdominal pain, or persistent headaches.
- Not Recommended: The following tests are not recommended for routine breast cancer follow-up: breast MRI, FDG/PET scans, complete blood cell counts, automated chemistry profile, chest x-rays, bone scans, liver ultrasound, and tumor markers (CA 15-3, CA 27-29, CEA). Talk with your doctor about reliable testing options.

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Some Example Research Projects

Matching Patients to Clinical Trials

Euisung Jung
Atish Sinha
Hemant Jain
Carmelo Gaudioso
Motivation for research

- High cost
  - Average cost is $12 million
- Time consuming
  - 3 to 5 years
- Subject recruitment
  - 80% of clinical trials don’t meet patient recruitment timelines
Method

1. Collect Data (ClinicalTrial.gov)
2. Remove all XML tags and Extract subjects’ eligibility section
3. Tokenization, Lemmatization
4. Stop Word Removal
5. Matching with Custom dictionary
6. Expand with UMLS
7. Evaluation

Tools:
- NLTK, Ruby
- Stanford NLP
- Lucene
- JAVA program with MySQL DB
Major Conferences

- AMIA Annual Symposium
  - November, Washington DC
  - Leading Biomedical and Health Informatics

- Joint Summits on Translational Science
  - April, San Francisco
  - Translational Bioinformatics
  - Clinical Research Informatics
AMIA Annual Symposium

- Translational bioinformatics
- Clinical research informatics
- Clinical informatics
- Consumer health informatics
- Public health informatics
Joint Summits on Translational Science

- Pharmacogenomics and adverse events
- Tools to enhance understanding and analysis of omic data
- Using omic data for predication and prioritization
- Machine learning omics for cancer
Joint Summits on Translational Science

- Machine learning and phenotypes
- Biology to phenotype prediction and biobanks
- HER phenotypes and methods
- Natural language processing
- Data sharing and data repositories
Public Health Informatics and Global Health Informatics

- Rapidly expanding
- Center for Disease Control and Prevention
- Health ministry
- World Health Organization
- Need for information systems in healthcare delivery around the globe
Categories and Trends

- Meaningful Use Surveillance, Immunization, and Other Registries
- Methods to Improve Geospatial Data
- Natural Language Processing, Methods
- Data Quality for PH
- Decision Support
- Internet Usage and Consumer Online Behaviors
Challenges and opportunities

- Patient Protection and Affordable Care Act
- Patient safety in an information technology-laden environment
- Need for health information and communication by researchers, practitioners, and the public
Translational Research Paradigm

- The conduct of basic science, clinical, and translational research is extremely complex, involving a variety of actors, processes, resources, and information types that ideally are integrated at a systems level.
- Focus on bi-directional flow of data, information, and knowledge between the basic sciences, clinical research, and clinical/public health practice.
- Is predicated on an integrative approach to hypothesis generation, testing, and evidence dissemination. (Zerhouni, 2005)
A New Paradigm in Scientific Inquiring

- Complete human genome
- Genetic underpinnings of disease
- Clinical phenotype
- New generation of therapies
Conclusion

- This is an exciting Field
- MIS has lot to contribute

- QUESTIONS???