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1 Introductions

This course introduces students to the concepts and practices of health informatics. Topics include: (1) introduction to the health informatics discipline; (2) major applications and commercial vendors; (3) decision support methods and technologies; (4) information systems design and engineering; and (5) new opportunities and emerging trends. A semester-long group project will provide students hands-on experience in planning and building healthcare information systems; associated ethical and legal concerns, software engineering and human-computer interaction issues, and user acceptance and outcomes evaluation methods will also be discussed.

1.1 Prerequisites

Graduate status. Prior technology/programming backgrounds preferred, but not required.

1.2 Definition of medical/health informatics

[Def. n.] Medical/Health Informatics (MI, HI) is an evolving scientific discipline that deals with the collection, storage, retrieval, communication and optimal use of health related data, information and knowledge. The discipline utilizes the methods and technologies of the information, social and technology sciences for the purposes of problem solving and decision-making thus assuring quality healthcare in all basic and applied areas of medical, biomedical and health sciences.¹

- HI is concerned primarily with the processing of data, information and knowledge in all aspects of healthcare;
- HI aims to study the principles and provide solutions;
- HI domains are—research, academia, operations and commercial;
- HI as a discipline is used by—clinicians, operational health practitioners, managers, academics, researchers, educators, scientists, technologists, and political leaders.

1.3 Basic tenets and intended audience

To Err Is Human: Building a Safer Health System, a landmark report published by the Institute of Medicine (IOM) in 2000, estimated that 44,000 to 98,000 people die each year from medical errors [2]. Within this report were a number of IOM recommendations on how to create safer systems in health care organizations, including (1) a recommendation for computer-based patient records; and (2) a call for health care organizations to make a commitment to using information

¹ What is Medical / Health Informatics?, Medinfo 2007 Program Brochure.
technology to manage their knowledge databases and processes of care. *Crossing the Quality Chasm*, another landmark IOM report published in 2001, further articulated that a health IT (HIT) infrastructure is a critical component of delivering safer care, and electronic health records (EHR) is a major component of a successful HIT infrastructure [3].

While the implementation of HIT has seen steady progress, EHR adoption rate remains low in the United States. In 2007, less than 13% of outpatient physician practices have adopted the technology; if only ‘complete’ implementation is considered—including the functionalities of electronic prescribing and clinical decision support—this rate drops to 4% [1]. Similarly, in 2008, only 1.5% of U.S. hospitals have full-fledged EHRs [4]. The quality impact of use of EHRs also remains unclear. While there is increasing evidence that EHR use is associated with improved quality and reduced errors, it is often shown that poorly designed HIT systems and/or implementation processes are responsible for unintended, negative consequences, resulting in decreased time efficiency, escalated threat to patient safety, and jeopardized quality of care.

The current climate for healthcare reform, combined with the explosive advances in information technology, has created the need for skilled individuals who are able to design, manage, and integrate clinical and administrative information, technologies, and systems in healthcare organizations. This course is accordingly designed for graduate students and healthcare practitioners who wish to develop a comprehensive understanding of the design, use, and evaluation issues and methodologies of health informatics applications.

### 1.4 Learning objectives

Upon completing this course, students will or will be able to:

1. Understand the role of health informatics in revolutionizing healthcare delivery, administration, education, and research;
2. Distinguish the various types of healthcare information, including data, knowledge, sources, and standards;
3. Develop (very) basic health IT product procurement skills;
4. Learn decision analysis methods commonly used in medicine;
5. Analyze obstacles and success factors for implementing and integrating information and decision technologies in healthcare;
6. Discuss the management and policy implications of introducing informatics applications into healthcare for process efficiency and quality improvement;
7. Develop teamwork skills to mediate the communication between healthcare professionals and IT personnel;
8. Acquire hands-on experience in analyzing practical problems and solving problems using appropriate health informatics approaches.

1.5 Instructor

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1.6 Related Health IT courses on campus

Students interested in health informatics or topics on general health IT are encouraged to consider:

1. (F) BIOINF 555/HMP 696/SI 696—Concepts in Health Informatics (a research seminar course offered at both masters and doctoral levels)

2. (W) HMP 648—Empirical Methods for Health informatics (examining health informatics as an empirical science; focusing on formal studies of applications of information technology applied to health care, population health, and personal health)

3. (W) HMP 647—Thinking ‘Informatically’ about Health (a seminar to establish for the participants a conceptual basis through which to understand informatics as a distinctive field)

4. (F) HMP 669—Database Systems and Internet Applications in Health Care (covering the technical aspect of designing and implementing the database components underlying most modern healthcare information systems)

5. (F) SI 654—Critical Policy Issues in Health IT (discussions on key policies and policy issues related to the use of information technologies in healthcare)

6. (W) HMP 655—Decision Making Models in Health Care (introduction to decision science and applications of computational models for decision making in healthcare, foundational components underlying many clinical decision-support systems)
7. (F) SI 653—Evidence-Based Health Information Practice (designed for information professionals whose job responsibility involves integrating health sciences research into clinical decision making)

8. More, see http://healthinformatics.umich.edu/.

2 Structure, Requirements, and Grades

2.1 Lectures

The class will be taught in a discussion format via lectures, software demonstrations, case analyses, and student presentations. Lectures are organized under the following five segments, with approximately 6–8 guest speeches to be arranged:

1. **Introduction to the Discipline** (Week 1–2)
   This section introduces basic concepts in health informatics and its history, definition, subdisciplines, and professional organizations and activities.

2. **Major Applications and Commercial Vendors** (Week 3–6)
   This section introduces major health informatics applications including electronic medical records (EHR) and computerized prescriber order entry (CPOE). Data interoperability issues will also be discussed, with a particular focus on medical controlled vocabularies and electronic data interchange standards. Several commercial, homegrown, and open-source applications will be demonstrated in class.

3. **Decision Support Methods and Technologies** (Week 7–8)
   This section introduces decision support methods and technologies in healthcare, primarily focusing on clinical decision support systems (CDSS) that use evidence-based medicine principles to improve the effectiveness of clinical decision-making. Decision analysis methods commonly in medicine will also be discussed.

4. **Information Systems Design and Engineering** (Week 9–11)
   This section discusses the planning and implementing issues of healthcare information systems. Also covered in this section are software engineering principles, human factors and human-computer interaction issues, and evaluation methods of end user acceptance and outcomes.

5. **New Opportunities and Emerging Trends** (Week 12)
   The last section discusses new opportunities and emerging technology trends of information technologies in healthcare; examples include wireless and handheld devices, social computing paradigms, and eHealth applications.
2.2 System project

Actively engaging in the system project will help students develop hands-on skills in the analysis, design, implementation, and evaluation of healthcare information systems. Each group, composed of up to 5 students, will (1) identify and analyze a practical problem; (2) propose a solution using appropriate health informatics approaches; and (3) specify system requirements for prototype implementation. Deliverables of the system project include: project proposal; project presentation; and final project report. The project proposal should:

1. Describe clearly the problem and the context;
2. Identify at least one off-the-shelf commercial product that could be used to (partially) address the problem;
3. Propose your own solution using appropriate health informatics approaches;
4. Analyze use of standards in your proposed solution;
5. Discuss potential privacy and confidentiality implications.

The final project report should, in addition, present design requirements, a mock-up prototype, and discuss how you plan to:

1. Evaluate and improve the usability of your proposed solution;
2. Encourage end-user adoption and acceptance;
3. Assess system effectiveness.

The final project will be evaluated based on the following criteria: innovativeness, practical value, potential impact, prototype demonstrability, structure and clarity of presentation, and quality of reports.

2.3 Grades

Final grades will be determined according to the following formula:

1. **Class participation: 25%**
   (a) Participation in class discussions
   (b) Reading assignments (2–3 papers each week on average)
   (c) A in-class quiz based on one of the reading assignments (10%)

2. **Homework assignments: 15%×2 (individual effort)**
   (a) Concepts in health informatics (due February 20 before class)
3. **System project: 45% (group effort)**

(a) Project proposal: 10% (due March 26 before class)
(b) Classroom presentation: 10% (April 16)
(c) Final project report: 15% (due April 23 midnight)
(d) Peer evaluation: 10%

2.4 **Classroom rules**

Use of laptop computers or other mobile electronic devices is prohibited in class.

3 **Materials**

3.1 **Course website**

https://ctools.umich.edu/portal/site/898e9feb-8699-4363-9ea0-d178ff53c8dd

3.2 **Textbook**


3.3 **Reading assignments**

To supplement the lectures, additional articles and cases will be handed out in class; expect 2–3 reading assignments each week.

3.4 **Cases**

Three HI applications will be demonstrated and discussed in class:

1. **The Clinical Reminder System (CRS)**

   Jointly developed at Carnegie Mellon University and the West Penn Allegheny Health System, the Clinical Reminder System is a web-based, “lite” electronic medical record system that uses evidence-based clinical guidelines to generate physician, clinic staff, and patient directed reminders at the point of care.
2. UMHS CareWeb System

CareWeb is a Clinical Data Repository (CDR) system developed and used at UMHS, with over 14,000 active users generating approximately 20 million clinical documents each year. We will also learn about the services, facilities, and strategic plans of the UMHS Medical Center Information Technology (MCIT), the unit responsible for CareWeb maintenance and continued development.

3. GE Centricity Practice Solution

Deployed in several inpatient units at UMHS, Centricity Practice Solution is an integrated clinical and financial management solution provided by GE Healthcare. Discussion of GE Centricity Practice Solution will focus on its software user interface design and the support of clinical workflow management.

4 Schedule

WEEK 1–2 Section 1: Introduction to the Discipline

Course overview and introduction

1. Course overview
2. Basic concepts in health informatics
3. Outstanding issues

Course overview and introduction—continued

1. Acquisition, storage and use of biomedical data
2. Basics of computers, computer networks, and telecommunication
3. Ethics and healthcare informatics
4. Student self-introduction

WEEK 3–6 Section 2: Major Applications and Commercial Vendors

Electronic health records (EHR)

1. Core functionalities of EHR
2. Essential data elements
3. Clinical workflow integration
4. Case studies

Electronic health records—continued
1. Personal health records
2. Clinical documents and natural language processing (NLP)
3. Interfacing with medical devices
4. Case studies

Computerized prescriber order entry (CPOE)
1. Introduction to CPOE
2. Known issues in CPOE implementations
3. Case studies

Data interoperability
1. Medical controlled vocabularies and classification systems
2. Electronic data interchange standards in healthcare

**WEEK 7–8**  
**Section 3: Decision Support Methods and Technologies**

Clinical decision support system (CDSS)
1. Evidence-based medicine and knowledge-based expert systems
2. Representation, execution, and sharing of medical knowledge
3. Success factors for implementing CDSS

Decision analysis in medicine
1. Decision making under uncertainties
2. Non knowledge-based decision support systems
3. Data warehousing and data mining technologies

**WEEK 9–11**  
**Section 4: Information Systems Design and Engineering**

Information systems analysis and design
1. Requirements analyses
2. Relational database design
3. Design patterns

Information systems development
1. Working with relational database management systems
2. Essential programming skills for building web-enabled applications
3. Basics of software engineering

Evaluation of healthcare information systems
1. Human-computer interaction issues and usability testing
2. End user adoption and acceptance
3. Outcomes evaluation

WEEK 12 Section 5: New Opportunities and Emerging Trends

New Opportunities and Emerging Trends
1. Advances in computing hardware (mobile and smart devices)
2. Public health surveillance systems
3. eHealth applications and consumer informatics
4. Social computing paradigms
5. Service-oriented architecture and HealthGrid

WEEK 13 Prototype System Implementation

WEEK 14 Project Presentation (April 16)

5 Resources

5.1 Online resources
1. AHRQ National Resource Center for Health IT
   http://healthit.ahrq.gov/
2. The Office of the National Coordinator for Health Information Technology
   http://healthit.hhs.gov/
3. Health IT Stimulus News
   http://www.ihealthbeat.org/
4. OpenClinical
   http://www.openclinical.org/
5. CPOE.org
   http://www.cpoe.org/
6. Certification Commission for Health Information Technology (CCHIT)
   http://www.cchit.org/
5.2 Major professional organizations

1. American Medical Informatics Association (AMIA)
   http://www.amia.org/

2. Health Information and Management System Society (HIMSS)
   http://www.himss.org/

3. International Medical Informatics Association (IMIA)
   http://www.imia.org/

4. Certification Commission for Healthcare Information Technology (CCHIT)
   http://www.cchit.org/

5. Health Level 7 (HL7)
   http://www.hl7.org/

5.3 Major professional conferences

1. AMIA Annual Symposium

2. Triennial World Congress on Health (Medical) Informatics (also known as Medinfo)
   http://www.medinfo2013.dk/

3. Annual HIMSS Conference and Exhibition
   http://www.himssconference.org/

5.4 Major academic journals

1. Journal of the American Medical Informatics Association (JAMIA)
   http://jamia.bmj.com/

2. Journal of Biomedical Informatics (JBI)
   http://www.journals.elsevier.com/journal-of-biomedical-informatics/

3. International Journal of Medical Informatics (IJMI)
   http://www.ijmijournal.com/

4. Journal of Medical Internet Research (JMIR)
   http://www.jmir.org/
6 Academic Integrity

The faculty of the School of Public Health believes that the conduct of a student registered or taking courses in the School should be consistent with that of a professional person. Courtesy, honesty and respect should be shown by students toward faculty members, guest lecturers, administrative support staff and fellow students. Similarly, students should expect faculty to treat them fairly, showing respect for their ideas and opinions and striving to help them achieve maximum benefits from their experience in the School. Student academic misconduct refers to behavior that may include plagiarism, cheating, fabrication, falsification of records or official documents, intentional misuse of equipment or materials (including library materials), and aiding and abetting the perpetration of such acts. The preparation of reports, papers, and examinations, assigned on an individual basis, must represent each student’s own effort. Reference sources should be indicated clearly. The use of assistance from other students or aids of any kind during a written examination, except when the use of aids such as electronic devices, books or notes has been approved by an instructor, is a violation of the standard of academic conduct.

References


