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# MEDICAL INFORMATICS

A Course for Health Professionals



## Educational Objectives and Outlines

### What is Medical Informatics?

#### Faculty

James Cimino

#### Educational Objectives

The class will develop its own definition of Medical Informatics and discuss the personal qualities and skills needed for success.

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### Current issues in medical informatics

#### Faculty

[Donald A.B. Lindberg, M.D.](#)

#### Educational Objectives

This lecture will summarize the federal interagency High Performance Computing and Communications program accomplishments in non-medical and health related aspects and will enumerate some past, current, and future research funding sources.

At the completion of the session, participants will:

- Understand the "interagency model" and the government-industry-university approach to the HPCC work.
- Understand the initial opportunities in biomedical applications of the NII.
- Have a beginning set of funding contacts.

#### Session Outline

1. High Performance Computing and Communications federal program
  - Background and Legislation
  - Objectives and Organization
  - Phase 1
    - Accomplishments - Grand Challenges
    - Progress on Grand Challenge Problems
  - Phase 2
    - National Information Infrastructure
    - National Challenge Applications
      - Non-medical
      - Medical
2. NLM Role in the NII
  - Intramural Research
    - UMLS
    - Visible Human
  - Extramural Research
    - NII medical testbed
    - Telemedicine
    - Computer-based patient record
  - Public Policy Issues
    - Medical Data Privacy
    - National Security

- Intellectual Property Rights
  - Traditional Copyright Demands
  - Today's Revolution in Electronic Publishing
- Federal Research Funding Sources for Medical Informatics
  - NLM Programs
  - Other HHS Programs
  - Other federal agency support

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## Academic Informatics: Columbia as a Case Study

### Faculty

Ted Shortliffe

### Educational Objectives

This lecture will provide one perspective on the academic discipline of medical informatics and explain how it is shaping the evolution of the department at Columbia University. Emphasis will be placed on the interplay between research and education programs and the development of operational clinical systems in a large academic medical center.

At the completion of the session, participants will:

- Understand the scope and depth of the field of medical informatics and the differences between its basic and applied components
- Be familiar with one academic program, including issues in curriculum design and the education of future professionals for research, industrial, government, and healthcare delivery careers
- Understand how clinical service responsibilities can enhance both the educational and research environments for such an academic program

#### Session Outline

1. The Scientific Basis for the Discipline of Medical Informatics
  - What is Medical Informatics?
  - Biomedical Informatics in Perspective
  - Biomedical Informatics Research Areas
  - Sample Career Paths for Biomedical Informatics Professionals
2. Implications for the Design of an Academic Department in the Field
  - Training Future Biomedical Informatics Professionals
  - Challenges For Academic Informatics
3. The Columbia Program as a Case Study
  - Departmental organization and scope
  - ? Departmental size
  - ? Summary of activities and relationships
  - Educational programs
  - ? Biomedical Informatics Disciplines
  - ? Biomedical Informatics Curriculum
  - ? Training Philosophy
  - ? Program Characteristics
  - ? What Do Our Informatics Graduates Do?
  - ? Trends
  - Research programs
  - ? Some Research Projects from Columbia's Department of Medical Informatics
  - ? Center for Computational Biology and Bioinformatics (CCBB)
    - Interaction with development and service activities
  - ? Center for Advanced Technology (CAT)
    - ? Clinical systems development and management responsibilities
  - ? WebCIS
    - (a) Clinical Data Repository
    - (b) Architecture - Function
    - (c) Architecture - Platform
    - (d) Views of Data in WebCIS
    - (e) Vocabulary (MED)
    - (f) Security
    - (g) WebCIS Adoption
4. Lessons and conclusions

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## **The Internet: Reflections on What's Coming**

### **Faculty**

Lawrence C. Kingsland, III, Ph.D.

### **Educational Objectives**

This lecture has two independent segments. The first segment introduces the Unified Medical Language System (UMLS) project initiated by the National Library of Medicine in 1986. The second segment discusses several aspects of upcoming technologies that are having and will have an impact on the way we view and use the Internet. At the completion of the session, participants will:

- Have received an introduction to the history of the Unified Medical Language System
- Be introduced to the content of the UMLS Knowledge Sources: the Metathesaurus, the Semantic Network and the SPECIALIST lexicon
- Have viewed a demonstration of the UMLS Knowledge Source Server
- Have viewed a demonstration of the UMLS Metathesaurus browser application in the Internet Grateful Med program, including the introduction of related concepts and co-terms
- Have received an introduction to technologies that are shaping the further development of the Internet and the ways we use it.

### **Session Outline**

- Unified Medical Language System
  - History
  - The UMLS Metathesaurus
  - The UMLS Semantic Network
  - The SPECIALIST lexicon
  - The UMLS Knowledge Source Server
  - The Internet Grateful Med Metathesaurus browser as an example of a UMLS application, with emphasis on related concepts and co-terms
- Internet Futures
  - Context
  - Internet Protocol (IP)
  - IPv6
  - Quality of Service (QOS)
  - Optical switching
  - Virtual Private Networks (VPNs)
  - Digital Spread Spectrum
  - Bluetooth
  - Wireless Access Protocol (WAP)
  - Ubiquity (wearable computing)
  - Dynamic content
  - Standards/open source

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## **PubMed and the NLM Gateway**

### **Faculty**

[Annette Nahin](#)

### **Educational Objectives**

This lecture and lab session will look at the National Library of Medicine's PubMed interface for searching MEDLINE. Searching techniques will be presented as well as a review of recent enhancements. There will also be a demonstration of the NLM Gateway - an interface for searching multiple NLM products. During the hands-on lab time, students can choose from various projects including creating Cubby stored searches in PubMed, creating a link to PubMed search results for a personal web site, and searching the Gateway and emailing the search results to someone

### **Session Outline**

1. PubMed Overview
2. Automatic Term Mapping
  - Search Refinement
  - Feature's Bar (Limits, Preview/Index, History and Clipboard)
3. Related Articles
4. Cubby - stored searches & LinkOut
5. NLM's Gateway Overview
6. Searching Multiple Databases
7. Searching OLDMEDLINE for journal citations, 1958 - 1965
8. Define Your Own Display Format
9. Hands on lab time

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## **Class of 2003 Personal Web pages workshop**

### **Faculty**

Chris Dematos

### **Educational Objectives**

This hands on laboratory will introduce participants to WYSIWYG HTML editing, basic digital image editing and compositing, and publishing web pages to a server.

At the completion of the session, participants will:

- Have created a personal web page with one or more images, and hyperlinks using free HTML editor (Netscape Composer)
- Have a basic understanding of digital image editing software (Photoshop).
- Have created a class resource that enables participants to know one another better

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## **Digital Library Research**

### **Faculty**

[Alexa T. McCray, Ph.D.](#)

### **Educational objectives**

This lecture presents the basic principles and practices involved in designing and implementing a digital library, as well as the research issues that need to be addressed. Two case studies, ClinicalTrials.gov and Profiles in Science are introduced, and participants are given an opportunity to do a short exercise.

By the end of the session students will:

- Understand the basic principles that underlie the design, implementation, and maintenance of a successful digital library.
- Have an understanding of digital library research issues.
- Have pointers to useful resources in digital library research.

### **Session Outline**

1. Informatics Research Agenda for Digital Libraries
2. Basic Principles in the Design and Implementation of a Digital Library
  - System Design Principles and Practices
    - Standards
    - Modularity
    - Extensibility
    - New technologies

- Content and Collection-based Principles and Practices
    - Data acquisition and selection
    - Metadata
    - Intellectual property
    - Permanence and persistence of digital objects
  - Human Factors Principles and Practices
    - Accessibility, usability
    - Automation of manual tasks
1. Case Studies
    - [ClinicalTrials.gov](http://ClinicalTrials.gov)
    - [Profiles in Science](#)
  2. Hands-on Exercise
    - Assigning metadata tags

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## **Principles of Web page design**

### **Faculty**

Chris Dematos

### **Educational Objectives**

At the completion of this session, participants will have an understanding of Hypertext Markup Language (HTML) and its application in the creation of World Wide Web pages.

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## **Introduction to Personal Databases**

### **Faculty**

David Remsen

### **Educational Objectives**

This hands on workshop will create sample databases and discuss the implications of different data models.

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## **Principles of Database Design**

### **Faculty**

James Cimino

### **Educational Objectives**

This lecture and lab session will introduce basic principles of organization of data in computerized systems. At the completion of the session, participants will:

- Understand the historical evolution of computerized data handling methods
- Know the relative strengths and weaknesses of hierarchical, relational, information network, and object-oriented database systems
- Understand the process of development of a set-theory-based relational data model, including entity-relationship definitions, principles of fully normalized relational models, state transitions and data flow diagrams.
- Understand the design principles involved in the transformation of a flat file record structure to a normalized relational structure (lab exercise).

### **Session Outline**

- Database definitions and paradigms

- What is a Database?
- Historical Evolution of data management techniques
- General benefits of Database Management Systems (DBMSs)
- DBMS types
  - Heirarchical
  - Information Network (linked lists and pointers)
  - Relational
  - Object-oriented
  - XML
- Principles of Relational database design
  - Representation of real world objects and their attributes
  - Relationships between objects
  - Table notation formalisms
  - Relationships: one-to-one, one-to-many, many-to-many
- System design and building methods
  - Entity-relationship diagrams
  - State Transition Models
  - Data Flow Diagram
- Transforming flat files to tables
- A sample problem in database design

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## Evaluation Methods in Medical Informatics

### Faculty

Charles P. Friedman, Ph.D.

### Session Outline

This section of the course examines medical informatics as an empirical science. As such, the section will focus on formal studies of applications of information technology in medicine. We refer to these applications generically as information resources. Studies can be conducted while information resources are under development as well as after they are in routine service. Studies typically address questions such as: Is the resource functioning as anticipated? How can it be improved? Does it make a difference? Are the differences it makes beneficial?

Within medical informatics, there is increasing interest in evaluation and empirical studies. From an administrative perspective, as institutions invest in new technology, it is critical for them to know how these systems can contribute to health care, education, and research so they can set develop plans and set priorities. From a more academic perspective, research projects in informatics, including doctoral dissertations and masters theses, now often include an evaluation or empirical study component. Much of the funded research in informatics is required to have such a component.

These sessions on evaluation will provide participants with an understanding of the range of evaluation methods that are used in informatics and will address how studies are designed as well as how data for these studies are collected, analyzed, and reported. We will address during the day many of the challenges that make evaluation difficult, emphasizing those challenges that are particular to medical informatics, and we will discuss methods that have been developed for addressing many of these challenges.

### Educational Objectives:

At the completion of the session, participants will be able to:

1. Describe the purposes of evaluation in medical informatics.
2. List several factors that can make it difficult to do evaluation in medical informatics effectively, as well as strategies that can be employed to address these difficulties.
3. Distinguish objectivist (quantitative) and subjectivist (qualitative) approaches, describe the assumptions that underlie them, and explain why both methods are used.
4. Identify the major steps in the process of conducting objectivist and subjectivist studies.
5. Identify the individuals or groups comprising the “audience” for an evaluation study.
6. Describe how the methods and purposes of a study can be matched the level of maturity of an information resource.
7. Frame many of the recurring difficulties of evaluation in medical informatics as problems of measurement.
8. Distinguish between measurement errors that are issues of reliability from those that are issues of validity. Distinguish between different types of validity.
9. Explain how “measurement studies” can be conducted to identify the sources of error in any measurement process, and to estimate the magnitude of these errors.

10. Explain what is meant by a “gold standard” in the framework of a measurement study.

Identify measurement methods and features of measurement instruments that can be employed to reduce measurement errors.

11. Identify some specific evaluation questions or issues that lend themselves particularly well to subjectivist approaches.
12. Explain how the questions and key issues of a study arise through the process of immersion.
13. Describe the major data collection strategies in subjectivist research, how these are used in a complementary way within a study, and how the data generated by each are analyzed.
14. Explain the steps a researcher can take to ensure the veracity of the findings of a subjectivist study.
15. Describe some of the barriers to combining objectivist and subjectivist methods within a single study.

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## Basics of Structuring and Exchanging Data

### Faculty

[Judy Ozbolt, R.N., Ph.D.](#)

This session identifies the characteristics and uses of health care data, discusses the role of standards in data exchange, and describes one process of standards development as a case example.

### Educational Objectives:

- Identify the types and uses of health care data.
- Describe problems with traditional patient records.
- Discuss the roles of controlled vocabularies, formal terminologies, and coding systems in capturing and using health care data.
- Identify major standards-developing organizations and describe the process of standards development.
- Using the reference terminology model for nursing as a case example, discuss challenges to standards development and ways to meet those challenges.

### Session Outline:

1. Health care data
  - Types of data
  - Methods of collecting data
2. Uses of health care data
  - Historical / legal record
  - Basis of planning care and tracking progress
  - Communication
  - Health services management and research
3. Weaknesses of the traditional record as a source of data
  - Difficulties of retrieval and interpretation
  - Redundancy and inefficiency
  - Unsuitability for research
4. Terminology standards for health care data
  - Need for "a terminology of terminologies" and ISO Standard 1087
  - Major terminology standards and standards-developing organizations
5. Progress toward a reference terminology for nursing (case example)
  - Status of nursing terminology in 1998
  - Process of Nursing Terminology Summit Conferences and intervening work
  - Achievements: working draft standard terminology model, collaboration with HL7, LOINC, CEN TC 251, ISO, IMIA, ICN
6. Summary of key points: terminology standards as the key to interpreting and exchanging health care data.

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## Clinical Care as an Integration of Process and Discipline—case example

### Faculty

[Judy Ozbolt, R.N., Ph.D.](#)

This session discusses the principles and methods of interdisciplinary collaboration and integration in goal-directed patient care, using as a case example Vanderbilt's collaborative care pathways supported by the PathworX system.

### **Educational Objectives:**

- Distinguish between integrated, collaborative interdisciplinary care and disparate multidisciplinary care.
- Describe how interdisciplinary collaboration occurs in a collaborative care pathway.
- Discuss the advantages of goal-oriented care for the individual patient and for the process of quality improvement.

### **Session Outline:**

1. Interdisciplinary care versus multidisciplinary care
2. Illustrative examples of collaborative interdisciplinary care in the pathway for minor ischemic stroke patients
3. Patient/family goals and system goals
4. Goal achievement and quality improvement

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Architecture basics: enterprise technology, information and security standards

### **Faculty**

[William W. Stead, M.D.](#)

### **Educational Objectives:**

This lecture will introduce basic principles of information technology architecture together with a sample of “best practices” for application, information, and security architectures.

At the completion of this session, attendees should:

- Understand the concept of information technology architecture
- Appreciate the role of layering and componentization for re-use and scale
- Understand the role of various informatics techniques in supporting information re-use and linkage

### **Session outline:**

1. A definition of architecture
2. Application architecture principles
  - n Layer Reference model
  - pragmatic compromises
  - phased approach for migration from legacy applications
3. Information architecture principles
  - Decoupling information content from IT tools
  - VUMC enterprise architecture as an example
  - Managing Application level Logical Unit of Work (LUW)
  - Informatics techniques that make content “understandable”
    - Re-useable data models
    - Standards that “homogenize” data
    - Relating separate information sources
4. Security architecture
  - Context – enterprise security objectives & practices
  - Use of layering and modularity to achieve reuse and scale

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Putting the pieces together

### **Faculty**

[William W. Stead, M.D.](#)

[Judy Ozbolt, R.N., Ph.D.](#)

Randolph A. Miller, M.D.

This session will include three problem-based blocks. In each block, the faculty will briefly pose a real-world problem and facilitate discussion as the students use the principles from the day’s lectures to develop a solution.

### **Educational Objectives:**

Applying the principles from today’s lectures

## **Session Outline:**

Case 1: Integrating a stand-alone system to support rehabilitation practice

Case 2: Creating a collaborative care pathway

In this session participants collaborate to sketch in the elements of a pathway for a patient type of the group's choosing. Participants identify the discipline-based roles they would play in an actual process of pathway development. They play out those roles to fill in some aspects of a pathway, then critique their individual and group performance.

### *Case Objectives*

- Identify distinct roles for different disciplines in pathway development.
- Experience and critique an exercise in interdisciplinary collaboration to begin to construct a pathway.

### *Case Outline*

- Select a patient type for pathway development.
- Identify the disciplines participating in pathway development and define the role of each.
- Role-play the process of pathway development.
- Critique the process for collaboration, disciplinary integration, and goal orientation.

Case 3: Developing a treatment advisor

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## **Building Web interfaces to databases**

### **Faculty**

David Remsen, MBL staff

### **Educational Objectives**

This workshop will give participants hands-on experience in serving databases to the web. In this session they will learn the different necessary components of a database web server. They will create their own interface to a database and learn how to conditionally format the results in HTML. They will get an understanding how HTML form elements translate to database calls, how an HTML form translates to a database query, and how a query is processed and the results are returned.

### **Session Outline**

1. Present an overview of a generic database web serving system. This overview will consist of identifying and defining the function of the the different elements that compose a database server.
2. A brief introduction to a few of the different database solutions to show how different vendors address the model described in 1.
3. Create an interactive web database using Filemaker Pro 4.0 with a sample database which will address the following: Querying the database using FORM and embedded URLS
4. Editing a Record via the web
5. Adding/Deleting Records
6. Processing results with format files.
7. Understanding how HTML and database meta tags can interact by:
  - a. Listing multiple records
  - b. Formatting a single record
  - c. Using conditionals to selectively format records
  - d. Using color and graphics with numeric content

Creating embedded links to Entrez, PubMed, others

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## **Aligning Enterprise & Information Technology Strategies**

### **Faculty**

This lecture explores how to align enterprise and information technology strategies, together with how to organize the information technology/informatics function for success.

**Educational Objectives:**

- Understand where IT/Informatics holds the greatest potential value to an enterprise
- Appreciate the role of scenario planning in imagining discontinuous change
- Understand the challenges that face the enterprise IT function and strategies for overcoming barriers to success
- Appreciate the importance of achieving fit between organization structures of the enterprise and the IT function

**Session Outline**

1. What is the purpose of IT/Informatics in an enterprise?
  - IT Value Proposition
  - IT trends and implications for the future
  - “Core competencies” of IT
  - Vignettes of possible changes in roles and learning
2. Strategies for a successful Enterprise IT Function
  - Scaling up to enterprise scope
  - Managing data as an enterprise asset
  - Providing core planning functions
  - Bridging the gap between academics and operations
    - The basic science of biomedical informatics
    - Linking research and training to operations
    - Linking Bioinformatics to Clinical Informatics
    - Linking informatics research to informatics support of research
    - Vanderbilt - a case of organization in evolution
3. Selecting a strategy for your enterprise
  - Stages of penetration of Integrated Information Management
  - Challenges for the enterprise

**Managing Technological Change**

**Faculty**

Ash

This session presents an overview of the issues that must be addressed to effectively manage technological change. It will include a case study.

**Educational Objectives:**

- To become aware of the non-technical issues connected with technological-informatics changes.
- To understand several of the reasons for system failure
- To review a case to determine what non-technical issues could have been addressed initially.
- To review what change agents need to do to facilitate organizational success

**Session Outline:**

1. "Systems" in broader context
  - A system is not just technology
  - Begins with a perception of the overall need for change
  - Developing a definition of the specific needs/requirements
  - Begin to prepare the staff for change
  - Development/selection—the technical system
  - Implementation preparation, includes training
  - Implementation
  - Support—of users and to repair deficiencies
2. Why Systems Often Fail
  - What Is Failure?
  - Failure Issues
    - Communication
    - Culture
    - Underestimation of complexity
    - Scope creep

- - Organizational
    - More organizational issues
    - Technology Training
    - Leadership issues
- 3. Case study—Case 12.1: LDS Hospital: Institution-Wide Antibiotic Management David C. Classen and Stanley L. Pestotnik from Transforming Health Care Through Information: Case Studies (NM Lorenzi, RT Riley, MJ Ball, JV Douglas) Springer-Verlag 1995.
- 4. Managing the Change
  - Gather benchmark data
  - Analyze the benefits from various perspectives
  - Assess the general organizational climate
  - Finding the tipping point
  - Find powerful champions
  - Develop general ownership
  - Strive for rapid implementation
  - Establish realistic expectations
  - Provide timely training
  - Provide extensive support
  - Ensure system stability
  - Protect professional egos
  - Plan some end-stage fun

## Negotiating the Political Minefields

### Faculty

Ash

### Educational Objectives:

- Understand the political side of information system/informatics system implementation
- To learn 12 strategies to assist you the change agent in more effectively managing the political process

### Session Outline:

1. Examples of Political Problems
2. Politics and Power
3. Sources of Power
  - Interpersonal power
  - Knowledge-expertise power
  - Knowledge-information power
  - Positional power
  - Derived power
  - Referent power
4. Twelve Key Strategies
  - be patient
  - maintain your sense of perspective
  - identify and work with the power people
  - maintain good communications
  - avoid isolation
  - know the “rules of the game,”
  - maintain high energy
  - be directly involved
  - manage your ego
  - maintain a sense of trust
  - maintain your sense of humor
  - use your silver bullets wisely.

## Telemedicine

### Faculty

Thomas S. Nesbitt, MD, MPH

### Educational Objectives

This lecture will review current telemedicine applications. Specific emphasis will be placed upon how these systems have been evaluated, what are the associated costs, what are the benefits, and what factors are associated with successful applications.

### **Session Outline**

- What is Telemedicine?
- Rationale for telemedicine and how it relates to medical informatics
- What are the various telemedicine technologies?
- What are locations in which telemedicine is being effectively used?
- Operational issues in starting and running a Telemedicine program
- Is telemedicine clinically effective and is it cost-effective?
- What are the barriers to the adoption of Telemedicine?
- What is the future of Telemedicine?

### **Designing a medical informatics curriculum**

#### **Faculty**

Faculty Panel

#### **Educational Objectives**

At the completion of this session, participants should have an understanding of issues attendant to the development and implementation of a medical informatics curriculum at the fellows' home institutions.

#### **Session Outline**

This session will be an interactive discussion among faculty and fellows. It will review the topics covered at the MBL course and promote discussion regarding future changes.

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