



Duke University School of Medicine

Library Space Planning Committee

Appendix K

**AAMC and ACGME
Informatics Objectives and Competencies**



Medical School Objectives Project: Medical Informatics Objectives

I. Introduction

The Medical Informatics Advisory Panel was charged to provide guidance on learning objectives related to medical informatics. To this end, the panel has developed recommendations to help ensure that medical school graduates have a foundation in medical informatics that will support them, as physicians in the 21st century, to efficiently utilize increasingly complex information for problem solving and decision making. The recommendations consist of a set of learning objectives expressing the competencies medical schools should help their students attain, as well as a set of implementation strategies outlining ways schools can develop educational programs that address these learning objectives.

A. Definition and Scope of Medical Informatics

Medical informatics is the rapidly developing scientific field that deals with resources, devices and formalized methods for optimizing the storage, retrieval and management of biomedical information for problem solving and decision making.¹

The emergence of medical informatics as a discipline is due in large part to advances in computing and communications technology, to an increasing awareness that biomedical knowledge and clinical information about patients are essentially unmanageable by traditional paper-based methods, and to a growing conviction that the processes of knowledge retrieval and expert decision making are as important to modern biomedicine as the fact base on which clinical decisions or research plans are made.

Medical informatics is an interdisciplinary field based on computer science, information science, the cognitive and decision sciences, epidemiology, telecommunications, and other fields. Researchers in medical informatics discover new methods and techniques to enhance health care, biomedical research, and education through information technology. These advances are applicable to all basic and clinical domains of biomedicine.

¹ Edward Shortliffe, M.D., Ph.D. What is medical informatics? <<http://camis.stanford.edu/whatisinformatics.htm>>. accessed 1/5/98. Stanford University, 1995.

B. Educational Premise

The argument that medical informatics should be a central feature of the medical curriculum rests on the following premise:

To support health care, life-long learning, education, research and management, medical students should be able, at the time of graduation, to utilize biomedical information for: formulating problems; arriving at strategies for solutions; collecting, critiquing and analyzing information; taking action based on findings; and communicating and documenting these processes and the results.

C. Organization of the Objectives

The Medical Informatics Advisory Panel identified five major roles played by physicians-- Life-long Learner, Clinician, Educator/Communicator, Researcher, and Manager-- as those in which medical informatics plays a vital part.

The learning objectives are framed within the context of these five roles. The panel recognizes that these roles are intertwined in daily practice. For instance, a physician addressing a challenging case is primarily in his/her clinician role but may also be: a learner, discovering what the biomedical literature has to say about a potential treatment plan; a researcher, comparing this particular patient's circumstances with others previously treated at the institution; an educator, helping the patient understand the treatment options; and a manager, making arrangements to ensure that the treatment plan can actually be implemented. The categorization of objectives according to roles is therefore somewhat artificial, and, as a result, occasional overlaps will be seen in the objectives that follow. Nonetheless, this categorization may help schools develop their educational programs and track their progress along the way.

By organizing these objectives according to physician roles, the panel also sought to emphasize connections with other elements of the curriculum. Schools may find that they currently address some of these objectives through offerings in related fields such as clinical epidemiology, evidence-based medicine, or medical decision making. Medical school curricula operate at the limit of what can be achieved in four years. Adding entirely new components, no matter how important they are, is a daunting task. Because medical informatics draws from and affects so much of what is already taught, the panel believes that the most practical and sustainable approach to achieve these objectives is one of infiltration: enhancement of existing curricular elements as opposed to creation of entirely new ones. The Implementation Strategies address these considerations explicitly.

D. Scope and Specificity of the Objectives

The methods, tools and resources developed through medical informatics often help physicians accomplish tasks that they were already doing, enabling them do so more efficiently or in entirely new ways. Other applications of information technology allow

physicians to accomplish tasks that were not previously possible. Each objective is included below only if, by its attainment, a physician's ability to fulfill the specified role has been significantly informed, transformed, or enabled by medical informatics.

The panel elected to express these objectives in terms of *what students should be able to do with information technology and what knowledge and attitudes about information technology they require for these purposes*--in service of the five physician roles. The panel did not specify "how", in terms of hardware and software implementation, each of these tasks should be carried out. Addressing the latter would have made this document rapidly obsolete as the technology itself is changing so rapidly. In this and many other ways, these objectives are intended as a guide. Individual institutions will necessarily add detail to these objectives, modifying them to suit local emphases, priorities, and available resources.

The panel also distinguished these objectives from those traditionally seen as "computer literacy". While basic literacy is essential for appropriate use of information technology and resources, the panel assumed that increasing numbers of students are bringing these competencies to medical school. The Appendix provides examples of what the panel sees as computer literacy competencies. All medical schools should identify, at a very early stage of the curriculum, medical students who have not mastered these literacy objectives and should provide appropriate experiences to assist them.

The panel acknowledges that the objectives listed below are ambitious. The panel members deliberately elected to articulate a high standard, to suggest and make explicit what may be possible with time, rather than limiting their scope to more immediately attainable goals. As specified in the Implementation Strategies, the panel advocates a graduated approach to developing educational programs that address these objectives. The objectives are offered without explicit or implicit priorities. It is necessary for each school to set local priorities as directed by its own values and resources. These priorities in turn direct which objectives are addressed sooner and/or in greater depth.

II. Objectives

A. Role of Life-long Learner

Medical education is a life- (or at least career-) long process beginning with medical school, extending into residency, and continuing through years of medical practice. Support of life-long learning with information technology requires more than computer literacy. Other requirements include cognizance of the broad range of medical information resources available and their relative value for particular needs, the know-how to use them, and the motivation to use them routinely. To provide a foundation for life-long learning, the successful medical school graduate should be able to do the following:

1. Demonstrate knowledge of the information resources and tools available to support life-long learning. Knowledge includes awareness of these resources, their content, and the information needs they can address. Relevant resources include MEDLINE and other relevant bibliographic databases, textbooks and reference sources, diagnostic expert systems, and medical Internet resources.
2. Retrieve information, demonstrating the ability to:
 - a. Perform database searches using logical (Boolean) operators, in a manner that reflects understanding of medical language, terminology and the relationships among medical terms and concepts..
 - b. Refine search strategies to improve relevance and completeness of retrieved items.
 - c. Use a standard bibliographic application to download citations from a search and organize them into a personal database.
 - d. Identify and acquire full-text electronic documents available from the World Wide Web or a local "virtual" library.
3. Filter, evaluate, and reconcile information, demonstrating the following:
 - a. Knowledge of the factors that influence the accuracy and validity of information in general.
 - b. The ability to discriminate between types of information sources in terms of their currency, format (for example a review vs. an original article), authority, relevance, and availability.
 - c. The ability to weigh conflicting information from several sources and reconcile the differences.
 - d. The ability to critically review a published research report.
 - e. Knowledge of copyright and intellectual property issues, especially with regard to materials that are retrieved electronically.
4. Exhibit good "information habits." These reflect attitudes that support the effective use of information technology, and include:
 - a. Using multiple information sources for problem solving.
 - b. Maintaining a healthy skepticism about the quality and validity of all information. (This includes recognition that technology which provides new capabilities also has the potential to introduce new sources of error.)
 - c. Making decisions based on evidence, when such is available, rather than opinion.
 - d. An awareness of the many ways information becomes lost or corrupted and the need to take appropriate preventative action (for example, routinely employing backup procedures for personal and institutional data).
 - e. Effectively using security procedures (for example, choosing "good" passwords, not sharing them, and changing them often).
 - f. Protecting confidentiality of private information obtained from patients, colleagues, and others.

B. Role of Clinician

The clinician must acquire information about the patient, make clinical decisions based on available information, and document and relay findings. To lay the foundation for supporting the full range of clinical activities with information technology, the successful medical school graduate should be able to do the following:

1. Retrieve patient-specific information from a clinical information system, demonstrating the ability to display selected subsets of the information available about a given patient.
2. Interpret laboratory tests, demonstrating the following:
 - a. Knowledge of the limitations of standard laboratory measurements.
 - b. The ability to integrate clinical and laboratory findings
3. Incorporate uncertainty explicitly into clinical decision making, demonstrating the ability to:
 - a. Quantify and communicate the degree of certainty associated with specific items of scientific and clinical information.
 - b. Identify and locate, when possible, the crucial pieces of missing clinical information, and determine when it is appropriate to act on incomplete information.
 - c. Integrate verbal and statistical sources of medical knowledge with the facts of a specific clinical case.
4. Make critical use of decision support, demonstrating knowledge of the available sources of decision support which range from textbooks to diagnostic expert systems to advisories issued from a computer-based patient record.
5. Formulate a treatment plan, demonstrating the ability to do the following:
 - a. Express the relative certainties of a differential diagnosis.
 - b. Express the relative risks and benefits of outcomes and treatment options.
 - c. Take action by balancing them.
6. Document and share patient-specific information, demonstrating the ability to record in information systems specific findings about a patient and orders directing the further care of the patient.
7. Respect patient (and physician) confidentiality, demonstrating the following:
 - a. Knowledge of the legal, ethical, and medical issues surrounding patient documentation, including confidentiality and data security.
 - b. The ability to use security-directed features of an information system.

C. Role of Educator/Communicator

Physicians play significant roles as teachers in various contexts: with peers and students, with their patients, and with the public at large. In all contexts they must also

communicate effectively. To provide a foundation through which information technology can effectively support the physician as educator, the successful medical school graduate should be able to do the following:

1. Select and utilize information resources for professional and patient education, demonstrating:
 - a. Practical knowledge of instructional technologies and resources available via the Internet, CD-ROM, video teleconferencing, and other media.
 - b. The ability to effectively utilize various computer-based instructional tools, including electronic tutorials and patient simulations.
 - c. The ability to effectively utilize a variety of computer-based self assessment tools.

2. Effectively employ written, electronic and oral communication, demonstrating the following:
 - a. The ability to use software to create visual materials that effectively support oral presentations.
 - b. The ability to create a handout that includes simple graphics and tables for use in teaching or patient education.
 - c. The ability to collaborate across multiple sites using electronic mail, discussion lists, news groups, teleconferencing, and related communication technologies.
 - d. Knowledge of institutional electronic communications policies.

D. Role of Researcher

"Research" includes traditional biomedical research performed primarily in the laboratory as well as clinical research exploring outcomes of medical interventions. These activities are performed by a relatively small proportion of physicians. However, the use of research tools and techniques is not restricted to formal studies. In addition, the relative ease of access to aggregate data in electronic form means that many clinical questions of the physician who is not a full-time researcher may be easily addressed through "ad hoc" research. Therefore, as we extend the tasks of a physician to include the examination of primary data across patients or other units, we see proper use of appropriate research tools as central to every physician's work. Examples include determination of a practice's case mix, determination of the incidences of diagnoses in a practice, testing the efficacy of a new treatment, and assuring quality of care.

Physician-researchers must understand sources for data and employ methods of decision theory to help formulate testable hypotheses; and they must collect, organize, analyze and interpret the data. They should also have an appreciation for the roles that medical informatics and computational biology have played in the conduct of modern biomedical research. To establish the foundation for information technology to support physicians in the roles as researchers, the successful medical school graduate should be able to do the following:

1. Determine what data exist relative to a clinical question or formal hypothesis, demonstrating the following:
 - a. The ability to use information technology to locate existing data sources.
 - b. Knowledge of data sources (including medical records, claims and reimbursement information and online data) at one's own institution by identifying how these might be used to address a specific clinical question posed as research.
 - c. The ability to identify and locate existing data sets not maintained at one's own institution (e.g., national registry data) that might be used to address a specific clinical question posed as research.

2. Execute a plan for data collection and organize data for analysis, demonstrating the ability to:
 - a. Select an appropriate computer database tool for collecting and organizing data.
 - b. Properly represent data from a study in a form that is useful and supports computer-based analysis.

3. Analyze, interpret and report findings, demonstrating the ability to:
 - a. Select the appropriate computer software tool for analysis of data.
 - b. Use software to perform simple statistical analysis and portray the results graphically.
 - c. Interpret the reports of statistical software analysis.

4. Appreciate information technology's impact on basic biomedical research, demonstrating an understanding of ways in which information technology supports:
 - a. Gene sequencing and genetic data banks.
 - b. Automation of laboratory experiments.
 - c. Bibliographic retrieval and management of the biomedical literature

E. Role of Manager

Physicians must understand and manage costs, manage and work effectively in groups, and effectively manage themselves. They also must understand their roles within the context of the overall health care system. To establish a foundation for information technology to support physicians in their managerial roles, the successful medical school graduate should be able to do the following:

1. Appreciate the role of information technology in relation to managing the cost of medical care and its impact on individuals and society, demonstrating knowledge of the following:
 - a. On-line sources of health care financing information.
 - b. Continuous quality improvement and process management.
 - c. How information technology can be used to develop, implement, and monitor compliance with clinical pathways and other forms of patient care protocols.
 - d. How clinical information in the aggregate is used to determine health care service planning for populations.

2. Formulate and make decisions for individuals and groups, demonstrating the following:
 - a. Knowledge of cost/benefit issues in health care.
 - b. The ability to use a decision-analysis package.
 - c. The ability to use software assessing patient utilities.
 - d. The ability to incorporate economic and cost perspectives.
3. Work effectively as an individual, in interprofessional groups, and as a member of a complex health care system, demonstrating the following:
 - a. The ability to use electronic personal and clinical scheduling systems.
 - b. The ability to archive and organize digital information of personal and clinical import.
 - c. Knowledge of online resources for legislation, political advocacy, and local health care policy setting.

III. Implementation Strategies

The panel identified ways in which schools might implement educational programs addressing the learning objectives listed above. These strategies, as a group, envision the ultimate embedding of experiences relating to informatics as opposed to exclusive reliance on a categorical informatics course to achieve some or all of the above objectives.

The strategies are expressed in two tables. Table 1 addresses a set of curricular issues and suggests:

- what might be an “initial strategy” pursued by a school at an early stage of addressing medical informatics in the curriculum,
- an “ideal state” which expresses the panel’s view of the best curricular approach to addressing medical informatics,
- some “strategic advice” provided as illustrative steps schools can take to move from an initial strategy to the ideal state.

Table 2 has a similar organization but addresses instructional issues and approaches. The panel recognizes that each institution will ultimately invent its own ideal state and that attainment of the ideal state will require a process extending over several years.

Table 1. Curricular Issues

Issue	Initial Strategy	Ideal State	Strategic Advice
When to teach	Once in basic science years	Throughout all four years	Include informatics as a theme in the school's next curriculum revision
Structure	Categorical course in medical informatics	Informatics embedded in all courses	Work with and focus on strengths already at the institution
Who teaches	Informatics specialists	All faculty	<p>Create formal opportunities for "rank and file" faculty to learn to participate in teaching this material</p> <p>Informatics specialists should seek opportunities to integrate their material into the overall curriculum</p>
Breadth of coverage	All students; selected objectives	All students; all objectives	Customize the objectives to your institution
Assessments	Tests are specific to informatics objectives	Assessment is built into overall evaluation schema	<p>Build questions addressing informatics objectives into course examinations</p> <p>Develop "open computer" (analogous to "open book") examinations</p>
Sequence	None; everything is taught together	Cumulative, with increasing sophistication of tasks	Use information technology to enable collaborative projects between students

Table 2: Instructional Issues

Issue	Initial Strategy		Ideal State	Strategic Advice
Where	Central Computer Lab	Multiple Satellite Labs	Point of Service	<p>The health sciences library is a major resource</p> <p>Information technology supplied for students can also bring important resources to preceptors/community doctors</p>
Pacing	Lockstep: All students are exposed to a given topic at the same time		Self-paced: Students learn on an as-needed basis with appropriate support	The clinical years of the curriculum provide a natural setting for self-paced learning, as do problem-based learning settings.
Approach	Reception learning; didactic sessions with closed-ended tasks	Discovery learning; open-ended tasks		<p>Use students (especially those with advanced computer skills) in a teaching role</p> <p>Faculty will require recognition for the contributions to developing new educational materials</p>

Additional implementation strategies emerge from the widespread investment in information technology, primarily to support health care and its management, that is occurring in virtually all academic medical centers. These investments are creating a technology infrastructure, in the form of desktop computers that are placed throughout the environment, other computing devices, and networks to interconnect them. It is important for applications of information technology that originate within the medical curriculum to take advantage of this infrastructure, to utilize these networks and computers, and adopt whatever standards the institution as a whole is adopting. There should not be, within academic medical centers, a separate information technology architecture to support the educational mission of the institution. Systems to support all aspects of the institutional mission should be as integrated as possible.

To realize this integration, representatives of the educational mission should participate in the processes determining information technology strategy for the institution as a whole. Deans and other institutional leaders should take steps to ensure that representatives of the educational mission are “at the table” when strategic decisions regarding the deployment of information technology are made. This approach is in full accord with the Integrated Advanced Information Management Systems (IAIMS) program of the National Library of

Medicine. (See <http://www.nlm.nih.gov/pubs/factsheets/iaims.html> for more information on IAIMS)

Another key component of an overall implementation strategy is to involve students. Because many students are technologically sophisticated, they can be important and influential forces for change. The more experienced students can be opinion leaders among their colleagues, to shape and legitimate the curricular approach that is followed. Students can contribute to development of software that may be needed to address informatics objectives, and other applications of technology to education, through summer jobs and internship experiences. Students can also play an important role as teachers of their peers in formal curricular experiences that address the informatics objectives.

The AAMC can contribute to this effort in important ways, helping member institutions address these objectives. The AAMC Curriculum Management & Information Tool (CurrMIT) can track the more specific objectives established by individual schools, opening these to inspection and sharing across institutions. Workshops, programs at meetings, and other AAMC-sponsored activities can assist curriculum leaders and faculty members develop strategies to effect change. Initiatives of the AAMC that support information resources in general can and should, as part of their overall mission, embrace these objectives and support the efforts of individual institutions to attain them.

Appendix

Computer Literacy Issues

Students must have certain basic skills before they can develop higher level informatics competencies. Many students will acquire them during their premedical education. The skills should be assessed at the start of medical school and deficiencies should be addressed early in the first year. Upon entry into medical school, students should be able to demonstrate basic computer literacy, including the following abilities:

- a. To launch a computer application.
- b. To save work to a computer file.
- c. To print a file.
- d. To copy a file for use on another computer.
- e. To use a standard word processing program to create and edit a formatted document using tables and graphics.
- f. To use electronic mail effectively, including proper etiquette.
- g. To access and use the World Wide Web.

Medical Informatics Advisory Panel

Chair: Charles P. Friedman, Ph.D.; Director, Center for Biomedical Informatics; Professor of Medicine;

University of Pittsburgh

Milton Corn, M.D.; Acting Associate Director, National Library of Medicine Extra Mural Programs

Mark Frisse, M.D.; Chief Information Officer; Washington University School of Medicine

Joseph W. Hales, Ph.D.; Assistant Research Professor, Division of Medical Informatics; Duke University Medical Center

Helene Hoffman, Ph.D.; Assistant Dean for Curriculum and Educational Computing; University of California - San Diego School of Medicine

Harold Lehmann, M.D., Ph.D.; Assistant Professor for School of Medicine; Director of Medical Informatics Education; The Johns Hopkins University

Richard Rathe, M.D.; Associate Professor & Director of Medical Informatics; University of Florida College of Medicine

AAMC Staff to the Advisory Panel:

Albert A. Salas; Staff Associate, Division of Medical Education; email aasalas@aamc.org

ACGME

General Competencies

At its February 1999 meeting, the ACGME endorsed general competencies for residents in the areas of:

- ▶ patient care,
- ▶ medical knowledge,
- ▶ practice-based learning and improvement, and
- ▶ interpersonal and communication skills,
- ▶ professionalism,
- ▶ systems-based practice.

Identification of general competencies is the first step in a long-term effort designed to emphasize educational outcome assessment in residency programs and in the accreditation process. During the next several years, the ACGME's Residency Review and Institutional Review Committees will incorporate the general competencies into their Requirements. The following statements will be used as a basis for future Requirements language. If you have any questions, comments and other requests for assistance, please address them to outcomes@acgme.org.

ACGME GENERAL COMPETENCIES Vers. 1.3 (9.28.99)

The residency program must require its residents to develop the competencies in the 6 areas below to the level expected of a new practitioner. Toward this end, programs must define the specific knowledge, skills, and attitudes required and provide educational experiences as needed in order for their residents to demonstrate the competencies.

PATIENT CARE

Residents must be able to provide patient care that is compassionate, appropriate, and effective for the treatment of health problems and the promotion of health. Residents are expected to:

- communicate effectively and demonstrate caring and respectful behaviors when interacting with patients and their families
- gather essential and accurate information about their patients
- make informed decisions about diagnostic and therapeutic interventions based on patient information and preferences, up-to-date scientific evidence, and clinical judgment
- develop and carry out patient management plans
- counsel and educate patients and their families
- use information technology to support patient care decisions and patient education
- perform competently all medical and invasive procedures considered essential for the area of practice
- provide health care services aimed at preventing health problems or maintaining health

- work with health care professionals, including those from other disciplines, to provide patient-focused care

MEDICAL KNOWLEDGE

Residents must demonstrate knowledge about established and evolving biomedical, clinical, and cognate (e.g. epidemiological and social-behavioral) sciences and the application of this knowledge to patient care. Residents are expected to:

- demonstrate an investigatory and analytic thinking approach to clinical situations
- know and apply the basic and clinically supportive sciences which are appropriate to their discipline

PRACTICE-BASED LEARNING AND IMPROVEMENT

Residents must be able to investigate and evaluate their patient care practices, appraise and assimilate scientific evidence, and improve their patient care practices. Residents are expected to:

- analyze practice experience and perform practice-based improvement activities using a systematic methodology
- locate, appraise, and assimilate evidence from scientific studies related to their patients' health problems
- obtain and use information about their own population of patients and the larger population from which their patients are drawn
- apply knowledge of study designs and statistical methods to the appraisal of clinical studies and other information on diagnostic and therapeutic effectiveness
- use information technology to manage information, access on-line medical information; and support their own education
- facilitate the learning of students and other health care professionals

INTERPERSONAL AND COMMUNICATION SKILLS

Residents must be able to demonstrate interpersonal and communication skills that result in effective information exchange and teaming with patients, their patients families, and professional associates. Residents are expected to:

- create and sustain a therapeutic and ethically sound relationship with patients
- use effective listening skills and elicit and provide information using effective nonverbal, explanatory, questioning, and writing skills
- work effectively with others as a member or leader of a health care team or other professional group

PROFESSIONALISM

Residents must demonstrate a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to a diverse patient population. Residents are expected to:

- demonstrate respect, compassion, and integrity; a responsiveness to the needs of patients and society that supercedes self-interest; accountability to patients, society, and the profession; and a commitment to excellence and on-going professional development

- demonstrate a commitment to ethical principles pertaining to provision or withholding of clinical care, confidentiality of patient information, informed consent, and business practices
- demonstrate sensitivity and responsiveness to patients' culture, age, gender, and disabilities

SYSTEMS-BASED PRACTICE

Residents must demonstrate an awareness of and responsiveness to the larger context and system of health care and the ability to effectively call on system resources to provide care that is of optimal value. Residents are expected to:

- understand how their patient care and other professional practices affect other health care professionals, the health care organization, and the larger society and how these elements of the system affect their own practice
- know how types of medical practice and delivery systems differ from one another, including methods of controlling health care costs and allocating resources
- practice cost-effective health care and resource allocation that does not compromise quality of care
- advocate for quality patient care and assist patients in dealing with system complexities
- know how to partner with health care managers and health care providers to assess, coordinate, and improve health care and know how these activities can affect system performance