Competencies in Clinical Informatics for Informaticians and Healthcare Professionals

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Learning objectives

- Describe the competencies required in clinical informatics for those who work professionally as clinical informaticians
- Describe the competencies required in clinical informatics for healthcare professionals
- Discuss the educational programs and activities required for clinical informaticians and healthcare professionals to achieve competence in clinical informatics

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Outline

- Background
- Competencies for clinical informaticians
- Competencies in clinical informatics for healthcare professionals
- Educational activities and programs to achieve competence

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Many problems in healthcare have information-related solutions

- Quality – not as good as it could be (McGlynn, 2003; Schoen, 2009; NCQA, 2010)
- Safety – errors cause morbidity and mortality; many preventable (Kohn, 2000; Classen, 2011; van den Bos, 2011; Smith 2012)
- Cost – rising costs not sustainable; US spends more but gets less (Angrisano, 2007; Brill, 2013)
- Inaccessible information – missing information frequent in primary care (Smith, 2005)

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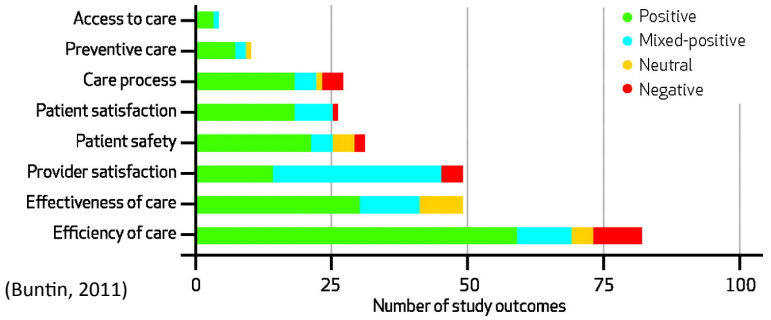
Growing evidence that information interventions are part of solution

- Systematic reviews (Chaudhry, 2006; Goldzweig, 2009; Buntin, 2011; Jones, 2014) have identified benefits in a variety of areas, although
  - Quality of many studies could be better
  - Large number of early studies came from a small number of "health IT leader" institutions



(Buntin, 2011)

These problems and solutions led to the HITECH Act and "meaningful use"

"To improve the quality of our health care while lowering its cost, we will make the immediate investments necessary to ensure that within five years, all of America's medical records are computerized … It just won't save billions of dollars and thousands of jobs – it will save lives by reducing the deadly but preventable medical errors that pervade our health care system."

January 5, 2009

Health Information Technology for Economic and Clinical Health (HITECH) Act of the American Recovery and Reinvestment Act (ARRA) (Blumenthal, 2011)

- Incentives for electronic health record (EHR) adoption by physicians and hospitals (up to $27B)
- Direct grants administered by federal agencies ($2B, including $118M for workforce development)

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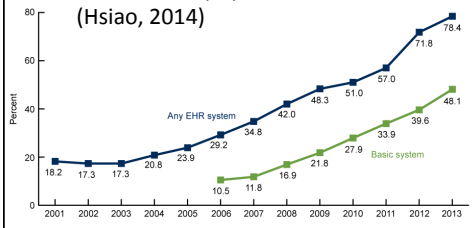
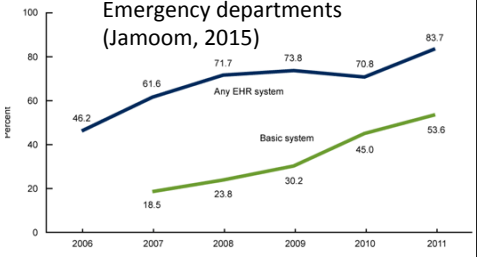
Which has led to significant EHR adoption in the US

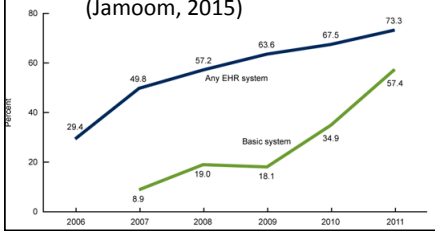
Office-based physicians (Hsiao, 2014)



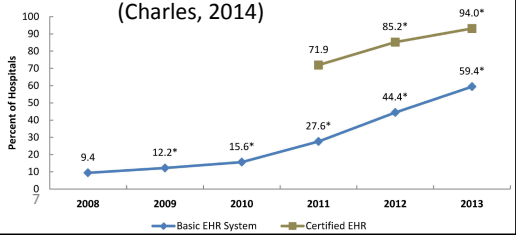
Emergency departments (Jamoom, 2015)



Outpatient departments (Jamoom, 2015)



Non-federal hospitals (Charles, 2014)



But there are still major challenges (Hersh, 2004)

Health Care Information Technology
Progress and Barriers

William Hersh, MD

IN THE 3 DECADES SINCE THE TERM "MEDICAL INFORMATICS" was first used, individuals working at the intersection of information technology (IT) and medicine have developed and evaluated computer applications aiming to improve health and health care. The need to ...

in this issue of JAMA, Slack demonstrates the value that patient-physician e-mail can have in improving patient care, and also catalogs the incomplete but encouraging underlying evidence.[11] As with many applications of IT, the technology can improve the existing situation but also empower clinicians and patients to think more fundamentally about how innovation can lead to changes in the way medicine is practiced ...

- Cost
- Technical challenges
- Interoperability
- Privacy and confidentiality
- Workforce

care IT.[8,9] It is no exaggeration to declare that the years ahead portend the "decade of health information technology."[10]

Informatics is poised to have a major impact in patient-clinician communication. In the Clinical Crossroads article ...

ment. The rest goes to those who typically do not pay for ...

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See also p 2255.

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Biomedical and health informatics underlies the solutions

- *Biomedical and health informatics* (BMHI) is the science of using data and information, often aided by technology, to improve individual health, health care, public health, and biomedical research (Hersh, 2009)
  - It is about information, not technology
  - http://www.billhersh.info/whatis
- Practitioners are BMHI are usually called *informaticians* (sometimes *informaticists*)
- Overview textbooks: Shortliffe, 2014; Hoyt, 2014

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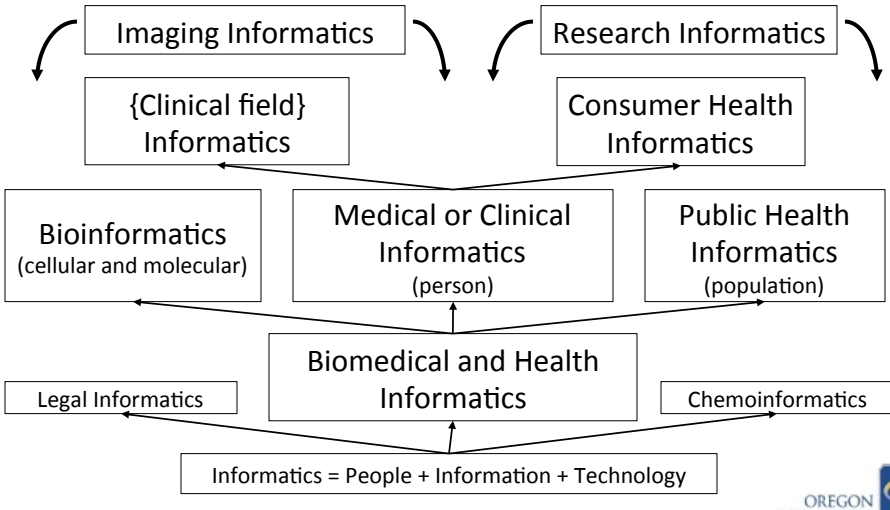
Informatics has many sub-areas



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Growth of field has led to increased job opportunities and shortages

- Opportunities
  - Estimated need for 41,000 additional HIT professionals as we moved to more advanced clinical systems (Hersh, 2008)
  - Actual numbers hired were even higher (Furukawa, 2012; Schwartz, 2013)
- Shortages
  - 71% of healthcare CIOs said IT staff shortages could jeopardize an enterprise IT project, while 58% said they would affect meeting meaningful use (CHIME, 2012)
  - More recent surveys paint continued picture of healthcare organizations and vendors having challenges recruiting and maintaining staff (HIMSS, 2014)

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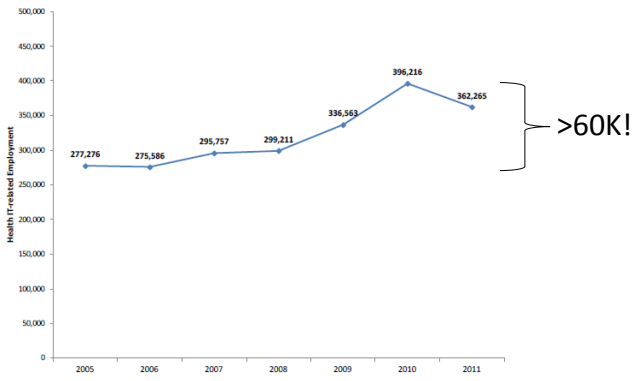
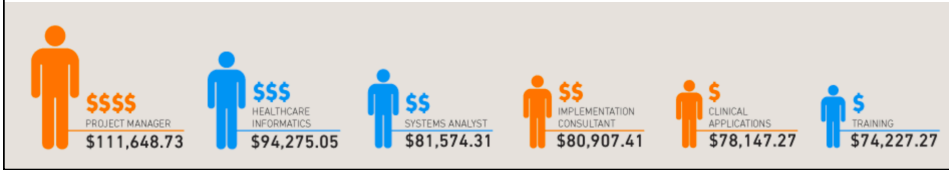
Job growth and salaries are high

Employment in health IT-related occupations in the health delivery system: 2005-2011 (Furukawa, 2012)





Including the new clinical informatics subspecialty for physicians

- History
  - 2009 – American Medical Informatics Association (AMIA) develops and publishes plans for curriculum and training requirements
  - 2011 – American Board of Medical Specialties (ABMS) approves; American Board of Preventive Medicine (ABPM) becomes administrative home
    - Subspecialty open to physicians of all primary specialties but not those without a specialty or whose specialty certification has lapsed
  - 2013 – First certification exam offered by ABPM
    - 455 physicians pass (91%)
  - 2014 – ACGME fellowship accreditation rules released
    - OHSU program third to be accredited nationwide

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Definition of clinical informatics (ACGME)

- Clinical informatics is the subspecialty of all medical specialties that transforms health care by analyzing, designing, implementing, and evaluating information and communication systems to improve patient care, enhance access to care, advance individual and population health outcomes, and strengthen the clinician-patient relationship

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A skilled workforce requires "competence"

- Competency-based education (Frank, 2010)
  - "An approach to preparing physicians for practice that is fundamentally oriented to graduate outcome abilities and organized around competencies derived from an analysis of societal and patient needs. It de-emphasizes time-based training."
- Growing adoption in medical education (Holmboe, 2014)
  - Growing discussion in medical education: if you achieve competence to enter graduate medical education, can/ should you graduate medical school in less than four years?
- Also being adopted in informatics education

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Inventory of competencies for various groups (Hersh, 2010)

- Competencies differ by group
  - Informaticians
    - Developing, implementing, and evaluating systems
    - Making optimal use of information
    - Recent elucidation of core competencies by AMIA (Kulikowski, 2012)
  - Clinicians
    - Applying informatics in delivery of care
    - Recent publication of competencies for medical students (Hersh, 2014)
  - Patients
    - Health information literacy

Table 2 Inventory of competencies in biomedical and health informatics.

Organization or Journal [Reference]	Year	Discipline	Title
Association for Computing Machinery [49]	1978	Computer science	Health Computing: Curriculum for an Emerging Profession
[50]	1992	Informatics	Recommendations of the German Association for Medical Informatics, Biometry and Epidemiology
Association of American Medical Colleges [51]	1999	Medical students	Medical School Objectives Project: Medical Informatics
International Medical Informatics Association [52]	2000	Informatics	Recommendations of the International Medical Informatics Association (IMIA) on education in health and medical informatics (updated in 2010)
UK National Health Service [53]	2001	Informatics	Health Informatics Competency Profiles for the NHS
American Nurses Association [54]	2001	Nursing	A Delphi Study to Determine Informatics Competencies for Nurses at Four Levels of Practice
...			
Nursing Clinics of North America [68]	2008	Nursing	Technology and informatics competencies
AMIA-OHSU 10x10 Course [69]	2009	Informatics	AMIA-OHSU 10x10 Program - Detailed Curriculum, Learning Objectives
AMIA Core Content for Clinical Informatics [35]	2009	Informatics	Core content for certification of physicians (with others to follow later)
TIGER Nursing Informatics [70]	2009	Nursing Informatics	TIGER Informatics Competencies Collaborative (TICC) Final Report
Office of the National Coordinator for Health IT [71]	2009	Electronic health record adoption	HIT Workforce Competencies by Role
Centers for Disease Control and Prevention, [72]	2009	Informatics	Public Health Informatics Competencies
International Medical Informatics Association [73]	2010	Informatics	Recommendations of the International Medical Informatics Association (IMIA) on education in biomedical and health informatics

Competencies of clinical informaticians (Safran, 2009)

- Search and appraise the literature relevant to clinical informatics
- Demonstrate fundamental programming, database design, and user interface design skills
- Develop and evaluate evidence-based clinical guidelines and represent them in an actionable way
- Identify changes needed in organizational processes and clinician practices to optimize health system operational effectiveness
- Analyze patient care workflow and processes to identify information system features that would support improved quality, efficiency, effectiveness, and safety of clinical services
- Assess user needs for a clinical information or telecommunication system or application and produce a requirements specification document
- Design or develop a clinical or telecommunication application or system
- Evaluate vendor proposals from the perspectives of meeting clinical needs and the costs of the proposed information solutions
- Develop an implementation plan that addresses the sociotechnical components of system adoption for a clinical or telecommunication system or application
- Evaluate the impact of information system implementation and use on patient care and users
- Develop, analyze, and report effectively (verbally and in writing) about key informatics processes

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Core content for clinical informatics (Gardner, 2009)

1. Fundamentals
1.1. Clinical Informatics
1.1.1. The discipline of informatics
1.1.2. Key informatics concepts, models, theories
1.1.3. Clinical informatics literature
1.1.4. International clinical informatics practices
1.1.5. Ethics and professionalism
1.1.6. Legal and regulatory issues
1.2. The Health System
1.2.1. Determinants of individual and population health
1.2.2. Primary domains, organizational structures, cultures, and processes
1.2.3. The flow of data, information, and knowledge within the health system
1.2.4. Policy & regulatory framework
1.2.5. Health economics and financing
1.2.6. Forces shaping health care delivery
1.2.7. Institute of Medicine quality components

2. Clinical Decision Making and Care Process Improvement
2.1. Clinical Decision Support
2.1.1. The nature and cognitive aspects of human decision making
2.1.2. Decision science
2.1.3. Application of clinical decision support
2.1.4. Transformation of knowledge into clinical decision support tools
2.1.5. Legal, ethical, and regulatory issues
2.1.6. Quality and safety issues
2.1.7. Supporting decisions for populations of patients
2.2. Evidence-based Patient Care
2.2.1. Evidence sources
2.2.2. Evidence grading
2.2.3. Clinical guidelines
2.2.4. Implementation of guidelines as clinical algorithms
2.2.5. Information retrieval and analysis
2.3. Clinical Workflow Analysis, Process Redesign, and Quality Improvement
2.3.1. Methods of workflow analysis
2.3.2. Principles of workflow re-engineering
2.3.3. Quality improvement principles and practices

3. Health Information Systems
3.1. Information Technology Systems
3.1.1. Computer Systems
3.1.2. Architecture
3.1.3. Networks
3.1.4. Security
3.1.5. Data
3.1.6. Technical approaches that enable sharing data
3.2. Human Factors Engineering
3.2.1. Models, theories, and practices of human-computer (machine) interaction (HCI)
3.2.2. HCI Evaluation, usability testing, study design and methods
3.2.3. Interface design standards and design principles
3.2.4. Usability engineering
3.3. Health Information Systems and Applications
3.3.1. Types of functions offered by systems
3.3.2. Types of settings where systems are used
3.3.3. Electronic health/medical records systems as the foundational tool
3.3.4. Telemedicine
3.4. Clinical Data Standards
3.4.1. Standards development history and current process
3.4.2. Data standards and data sharing
3.4.3. Transaction standards
3.4.4. Messaging standards
3.4.5. Nomenclatures, vocabularies, and terminologies
3.4.6. Ontologies and taxonomies
3.4.7. Interoperability standards
3.5. Information System Lifecycle
3.5.1. Institutional governance of clinical information systems
3.5.2. Clinical information needs analysis and system selection
3.5.3. Clinical information system implementation
3.5.4. Clinical information system testing, before, during and after implementation
3.5.5. Clinical information system maintenance
3.5.6. Clinical information system evaluation

4. Leading and Managing Change
4.1. Leadership Models, Processes, and Practices
4.1.1. Dimensions of effective leadership
4.1.2. Governance
4.1.3. Negotiation
4.1.4. Conflict management
4.1.5. Collaboration
4.1.6. Motivation
4.1.7. Decision making
4.2. Effective Interdisciplinary Teams
4.2.1. Human resources management
4.2.2. Team productivity and effectiveness
4.2.3. Group management processes
4.2.4. Managing meetings
4.2.5. Managing group deliberations
4.3. Effective Communications
4.3.1. Effective presentations to groups
4.3.2. Effective one-on-one communication
4.3.3. Writing effectively for various audiences and goals
4.3.4. Developing effective communications program to support system implementation
4.4. Project Management
4.4.1. Basic principles
4.4.2. Identifying resources
4.4.3. Resource allocation
4.4.4. Project management tools (non-software specific)
4.4.5. Informatics project challenges
4.5. Strategic and Financial Planning for Clinical Information Systems
4.5.1. Establishing mission and objectives
4.5.2. Environmental scanning
4.5.3. Strategy formulation
4.5.4. Action planning and strategy implementation
4.5.5. Capital and operating budgeting
4.5.6. Principles of managerial accounting
4.5.7. Evaluation of planning process
4.6. Change Management
4.6.1. Assessment of organizational culture and behavior
4.6.2. Change theories
4.6.3. Change management strategies
4.6.4. Strategies for promoting adoption and effective use of clinical information systems

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Informatics competence is also fundamental to clinician practice

- 21st century physicians and other clinicians must have competence in clinical informatics
- OHSU medical school curriculum being revised
  - Provides opportunity to introduce more informatics into curriculum
  - Process also aided by AMA Accelerating Change in Medical Education grant
- Driven by competencies focused on uses for informatics and not just technology itself

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PERSPECTIVES

Beyond information retrieval and electronic health record use: competencies in clinical informatics for medical education

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Abstract: Physicians in the 21st century will increasingly interact in diverse ways with information systems, requiring competence in many aspects of clinical informatics. In recent years, many medical school curricula have added content in information retrieval (search) and basic use of the electronic health record. However, this omits the growing number of other ways that physicians are interacting with information that includes activities such as clinical decision support, quality measurement and improvement, personal health records, telemedicine, and personalized medicine. We describe a process whereby six faculty members representing different perspectives came together to define competencies in clinical informatics for a curriculum transformation process occurring at Oregon Health & Science University. From the broad competencies, we also developed specific learning objectives and milestones, an implementation schedule, and mapping to general competency domains. We present our work to encourage debate and refinement as well as facilitate evaluation in this area.

In reality, applicable to all healthcare professional students.

Table 1 Competencies in clinical informatics and specific learning objective/milestone within each

Competency	Learning objectives/milestones
Find, search, and apply knowledge-based information to patient care and other clinical tasks	Information retrieval/search: choose correct source for specific task, search using advanced features, apply results Evaluate information resources (literature, databases, etc) for their quality, funding sources, biases Identify tools to assess patient safety (eg, medication interactions) Utilize knowledge-based tools to answer clinical questions at the point of care (eg, textbooks, calculators, etc) Formulate an answerable clinical question Determine the costs/charges of medications and tests Identify deviations from normal (laboratory tests/X-ray/results) and develop a list of causes of the deviation
Effectively read and write from the electronic health record for patient care and other clinical activities	Graph, display, and trend vital signs and laboratory values over time Adopt a uniform method of reviewing a patient record Create and maintain an accurate problem list Recognize medical safety issues related to poor chart maintenance Identify a normal range of results for a specific patient Access and compare radiographs over time Identify inaccuracies in the problem list/history/medication list/allergies Create useable notes Write orders and prescriptions List common errors with data entry (drop down lists, copy and paste, etc)
Use and guide implementation of CDS	Recognize different types of CDS Be able to use different types of CDS Work with clinical and informatics colleagues to guide CDS use in clinical settings
Provide care using population health management approaches	Utilize patient record (data collection and data entry) to assist with disease management Create reports for populations in different health care delivery systems Use and apply data in accountable care, care coordination, and the primary care medical home settings
Protect patient privacy and security	Use security features of information systems Adhere to HIPAA privacy and security regulation Describe and manage ethical issues in privacy and security
Use information technology to improve patient safety	Perform a root-cause analysis to uncover patient safety problems Familiarity with safety issues Use resources to solve safety issues
Engage in quality measurement selection and improvement	Recognize the types and limitations of different types of quality measures Determine the pros and cons of a quality measure, how to measure it, and how to use it to change care
Use HIE to identify and access patient information across clinical settings	Recognize issues of dispersed patient information across clinical locations Participate in the use of HIE to improve clinical care
Engage patients to improve their health and care delivery though personal health records and patient portals	Instruct patients in proper use of a personal health record Write an e-message to a patient using a patient portal Demonstrate appropriate written communication with all members of the health care team Integrate technology into patient education (eg, decision making tools, diagrams, patient education) Educate patients to discern quality of online medical resources (Web sites, applications, patient support groups, social media, etc) Maintain patient engagement while using an electronic health record (eye contact, body language, etc)
Maintain professionalism through use of information technology tools	Describe and manage ethics of media use (cloud storage issues, texting, cell phones, social media professionalism)
Provide clinical care via telemedicine, and refer those for whom it is necessary	Be able to function clinically in telemedicine/telehealth environments
Apply personalized/precision medicine	Recognize growing role of genomics and personalized medicine in care Identify resources enabling access to actionable information related to precision medicine
Participate in practice-based clinical and translational research	Use electronic health record alerts and other tools to identify patients and populations for offering clinical trial participation Participate in practice-based research to advance medical knowledge

Educational programs for achieving competence

- Informaticians
- Clinicians

Academic programs for informaticians

- An ever-growing number of programs – list of US informatics programs on AMIA Web site
  - http://www.amia.org/education/programs-and-courses
- Programs come in many flavors: medical, clinical, biomedical, health, bio-, nursing, etc.
- Funding available for research programs from National Library of Medicine (NLM), which funds fellowships to train future researchers at doctoral and postdoctoral levels at 14 universities
  - http://www.nlm.nih.gov/ep/GrantTrainInstitute.html
  - Also others from Veteran's Administration, Kaiser-Permanente, and other institutes of the National Institutes of Health (NIH)
- New fellowships forthcoming for clinical informatics subspecialists under Accreditation Council for Graduate Medical Education (ACGME) model

OHSU Biomedical Informatics Graduate Program

- Aims to train future professionals, leaders, and researchers
- Graduate level programs
  - Graduate Certificate
  - Master's – research, professional
  - PhD
- Graduate Certificate and Master's available online
- Innovations in online learning, including AMIA 10x10 Program

Graduates	CI	BCB	HIM	Total
GC	321	0	37	358
MBI	146	6	2	154
MS	68	9	0	77
PhD	10	6	0	16
Total	545	21	39	605

http://www.ohsu.edu/informatics

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How have OHSU students and graduates done?

- Now have nearly 20 years of experience…
- General observation: What people do when they graduate is partially dependent on what they did when they entered, e.g.,
  - Physicians, nurses, public health, etc. draw on their clinical/professional background
  - Information technology professionals draw on their unique background and experience
- Graduates have obtained jobs in a variety of settings, e.g., clinical, academic, and industry
- Some have obtained jobs before finishing the program; a few before starting

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Clinical informatics subspecialty

- Following usual path of five years of "grandfathering" training requirements to take certification exam before formal fellowships required
- Two paths to eligibility for exam in first five years
  - Practice pathway – practicing 25% time for at least three years within last five years (education counts at half time of practice)
  - Non-traditional fellowships – qualifying educational or training experience, e.g., NLM, VA, or other fellowship or educational program (e.g., master's degree)

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Clinical training model presents some challenges

- Fragmentation and funding challenges (Detmer, 2014)
- Clinical fellowship model has some aspects of "fitting square pegs into round holes" (Hersh, 2014)
- Requirement of two-year, full-time fellowship for board certification may limit career paths
  - Many clinicians pursue informatics in mid-career
- Many concerned about sustainability of funding
  - Fellows may practice but CMS rules do not allow them to bill
- Informatics is not only for physicians – AMIA exploring certification for others in informatics
  - http://www.amia.org/advanced-interprofessional-informatics-certification

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After 2018, there will only be clinical (ACGME) fellowships

- One of 9 specialties must serve as administrative home
  - Accreditation tied to specialty RRC
- Fellow must stay clinically active in their primary specialty
- Currently 7 programs have achieved accreditation, including OHSU and University of Arizona Phoenix

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What about informatics education for clinicians?

- Our competencies a starting point (Hersh, 2014)
- Working with other AMA grantee institutions to build
  - Milestones
  - Entrustable professional activities (EPAs)
  - Assessments
  - Addition to board exams, e.g., USMLE

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Conclusions

- Some problems in healthcare have informatics solutions
- Competence in clinical informatics is essential for 21st century healthcare professionals
- Many opportunities for clinical informatics professionals who will lead the way

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For more information

- Bill Hersh
  - http://www.billhersh.info
- Informatics Professor blog
  - http://informaticsprofessor.blogspot.com
- OHSU Department of Medical Informatics & Clinical Epidemiology (DMICE)
  - http://www.ohsu.edu/informatics
  - http://www.youtube.com/watch?v=T-74duDDvwU
  - http://oninformatics.com
- What is Biomedical and Health Informatics?
  - http://www.billhersh.info/whatis
- Office of the National Coordinator for Health IT (ONC)
  - http://healthit.hhs.gov
- American Medical Informatics Association (AMIA)
  - http://www.amia.org
- National Library of Medicine (NLM)
  - http://www.nlm.nih.gov

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