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**Toward a Roadmap  
for an Effective  
Information Technology-  
Enabled  
Health System**

Robert A. Greenes, MD, PhD  
Department of Biomedical Informatics  
Biomedicine @ ASU

Sedona, AZ  
July 21, 2009

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**Several key words in this title :**

*Toward a **Roadmap** for an **Effective Information Technology-Enabled Health System***

- Roadmap
  - There is a huge gap. How do we get from where we are to where we need to be?
- Effective
  - What are goals? What are criteria for effectiveness? What is “meaningful use”?
- IT-enabled
  - What specific functionality?
- Health
  - Not just health care, also health maintenance, disease prevention
  - Needs to include behavioral health/health care, needs to be patient-centered
- System
  - Do we actually have a “system”? Will we have one at the end of the process? What is the role of IT in fixing a broken health care/health system?

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**Foci of this talk**

- Some desiderata for a rational health “system”
- Where IT can help
  - What are the gaps? A focus on the grand challenges facing health IT
- The role of biomedical informatics as a field
- A recommended agenda for biomedical informatics to facilitate health system transformation

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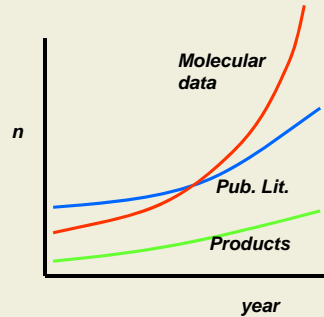
**Some desiderata for an effective health system**

- **Informed**, high quality, safe, cost-effective clinical decision making and **care**
  - Best available care
- **Accelerated translation** of discovery to use
  - Vibrant research enterprise
- Systematic and ongoing **evaluation** of outcomes and benefits as a basis for the system
  - Continued improvement process

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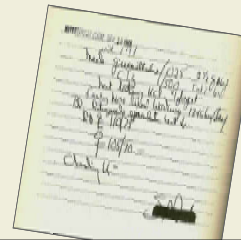
### Informatics challenges of the health care system

- Handling the growth of molecular and genomics data
  - outstripping publication growth and product creation



### Informatics challenges of the health care system

- Handling the growth of molecular and genomic data
  - outstripping publication growth
- Improving quality and depth of clinical data – the phenotype
  - Fragmented, incompatible, non-communicating, lack of system
  - Dictation, voice recognition enables capture
  - Data not readily extracted
  - Progress in NLP, structured data entry methods
  - Limited adoption of standards



### Informatics challenges in clinical and translational medicine

- Handling the growth of molecular and genomic data
  - outstripping publication growth
- Improving quality and depth of clinical data – the phenotype
  - Fragmented, incompatible, non-communicating, lack of system
  - Data not readily extracted
- Accelerating the translation process
  - From bench to bedside
  - From bedside to adoption

### Converting research to care



Balas EA, Boren SA. Managing clinical knowledge for health care improvement. Yrbk of Med Informatics 2000; 65-70

## Informatics challenges of the health care system

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  - From bench to bedside
  - From bedside to adoption
- Improving the care process
  - Reduce errors, unevenness of quality, disparities, lack of continuity

## Errors, disparities, quality deficiencies

- Landmark IOM reports

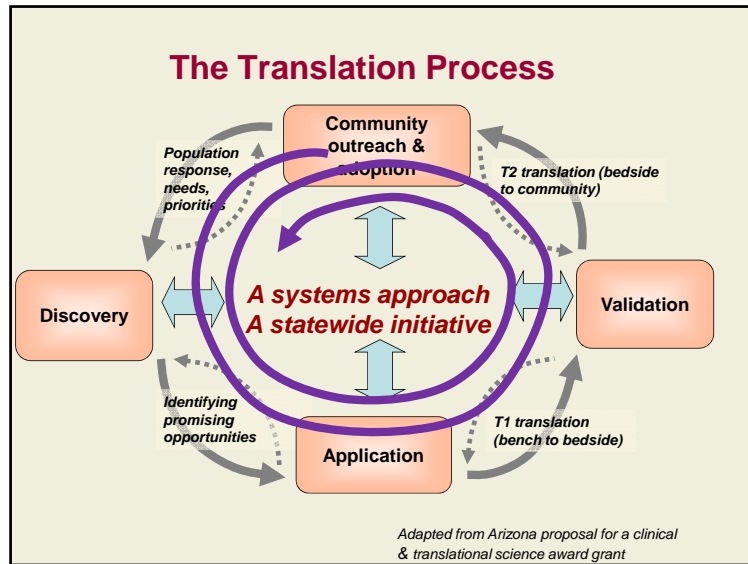


## Informatics challenges of the health care system

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  - From bench to bedside
  - From bedside to adoption
- Improving the care process
  - Reduce errors, unevenness of quality, disparities, lack of continuity
- Assemble, manage and disseminate knowledge of best practices
  - EPCs, CER studies, CDS repositories
  - Incorporating new knowledge on a regular basis

## The Dawn of the Age of Personalized Medicine?

- 8/16/2007, US Food and Drug Administration (FDA) : labeling for the widely prescribed anticoagulant Warfarin was updated to explain how individuals' genetics may impact their response to the drug.
- Coumadin (Bristol-Myer's Squibb) new label states:
  - "It is recommended that Coumadin therapy be initiated with a dose of 2 to 5 mg per day with dosage adjustments based on the results of [prothrombin time/international normalized ratio] determinations. **The lower initiation doses should be considered for patients with certain genetic variations in CYP2C9 and VKORC1 enzymes** as well as for elderly and/or debilitated patients and patients with potential to exhibit greater than expected PT/INR responses to Coumadin."



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## How IT can help

- Widespread use of EHRs, CPOE, CDS
- Patient data and knowledge access, PHRs, CDS
- Interoperability and HIE
- Aggregation of data at population level
- Systematic approach to privacy and confidentiality
- A societal framework in which to do the above
  - in a coordinated way
  - that supports trust
  - that is dynamic and evolving
  - that is sustainable

*The problem is that the above represent both the potential benefits and the grand challenges*

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## The role of Biomedical Informatics

- Developing and evaluating health IT solutions
- As the interface between biomedical/ health domain experts and information technology
- Preparing people for work in health IT

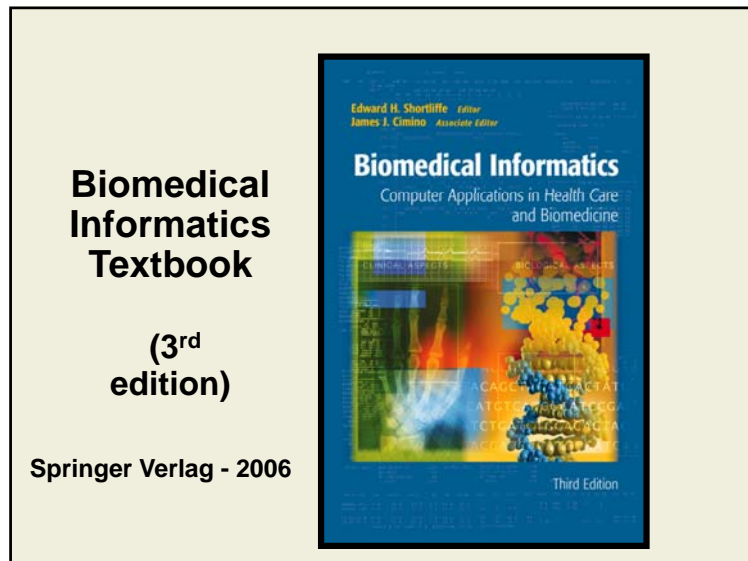
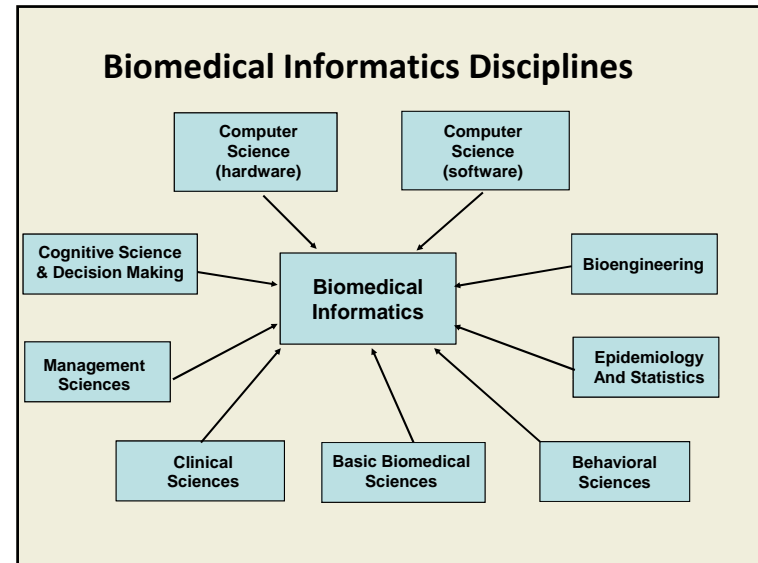
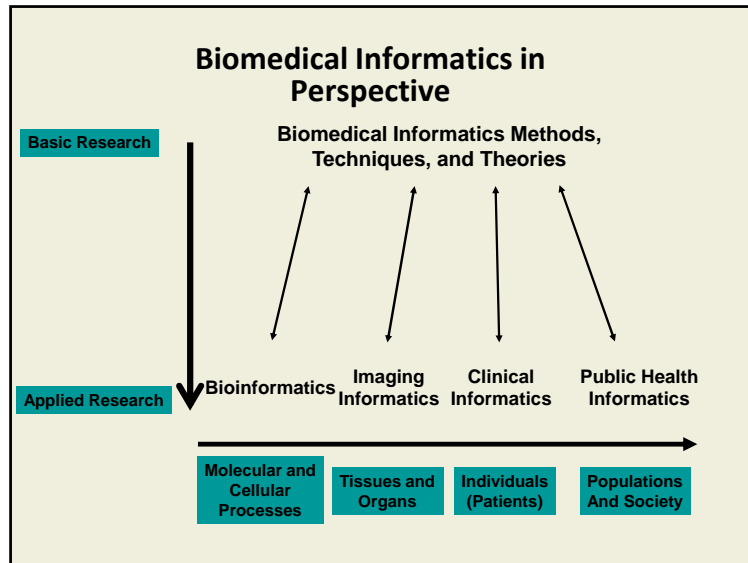
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## What is “biomedical informatics”?

- The field concerned with
  - designing methods for *acquiring, representing, organizing, and analyzing* data
  - about *biomedical phenomena and health systems and processes*
  - to create *knowledge* and support problem solving and decision making
- Both a *basic* and an *applied* field

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## The need for BMI expertise

- **Data and knowledge explosion**
  - very large and complex databases
  - need for new methods for organization, search, data mining and prediction
    - in genomics, proteomics, imaging, clinical research and practice, and public health spheres
  - derivation, validation, and application of knowledge
- **Growth of "team science" and "team projects"**
  - increased reliance on multidisciplinary teams for all kinds of projects
  - large programs and initiatives that require informatics to support them
- **Importance as an economic strategy**
  - Investment in large scale integration, interoperability, communication based on informatics
  - HITECH initiatives
- **Growing demand for skilled informaticians**
  - in academia, health care organizations, research institutes, industry

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## BMI as a field

- Relatively new, usually arising in medical centers, medical schools
- Typically in the form of programs, divisions, centers
  - Now have 14-15 academic departments in US
- ASU BMI as an example
  - One of the newest US departments of BMI
    - Formed in 2007 in downtown Phoenix
    - As a unique partnership with UA College of Medicine

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- See: [http://bmi.asu.edu/downloads/IMIA\\_Yearbook08\\_preprint.pdf](http://bmi.asu.edu/downloads/IMIA_Yearbook08_preprint.pdf)

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### Phoenix Biomedical Campus

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### BMI Research Foci

Bioinformatics	Imaging Informatics	Clinical Informatics	Public Health Informatics
	Cognition and Decision Making		
	Data Mining/Predictive Modeling		
	NLP/AI/Structured Knowledge Representation		
	Embedded Systems		
	Collaboration Technologies & Methods		

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### Faculty

	<b>Robert A. Greenes, M.D., Ph.D.</b> Ira A. Fulton Chair Member, Inst of Med, Nat Acad Sci (from Harvard University)		<b>Douglas Fridsma, M.D., Ph.D.</b> Associate Professor (from Univ. of Pittsburgh and joint with Mayo)
	<b>Vimla Patel, Ph.D., D.Sc.</b> Vice Chair Member, Nat Acad Soc Sci (Canada) (from Columbia University and joint with UA)		<b>William G. Johnson, Ph.D.</b> Assistant Professor (from Yale University)
	<b>William G. Johnson, Ph.D.</b> Director, Center for Health Information and Research (from ASU)		<b>Edward H. Shortliffe, M.D., Ph.D.</b> Assistant Professor (from Columbia University)
	<b>Edward H. Shortliffe, M.D., Ph.D.</b> Professor Member, Inst of Med, Nat Acad Sci (from Columbia University)		<b>Trevor Cohen, M.D., Ph.D.</b> Assistant Professor (from ASU and joint with Banner Health)
	<b>Diana Petitti, M.D., M.P.H.</b> Professor (from Kaiser Southern California)		<b>Kanav Kahol, Ph.D.</b> Assistant Professor (from ASU and joint with Banner Health)
	<b>Jianming Liang, Ph.D. (arriving)</b> Associate Professor (from Siemens Corp.)		<b>Graciela Gonzalez, Ph.D.</b> Assistant Professor (from ASU, pending, now Asst Res. Prof)

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### Clinical and Research Faculty

	<b>Howard Silverman, M.D., M.S.</b> The University of Arizona College of Medicine – Phoenix (joint with ASU)		<b>Jose Piovchetti-Perez, M.D.</b> Associate Research Professor (from Universidad Central del Caribe, P.R.)
	<b>Wade Bannister, Ph.D.</b> Assistant Research Professor (from ASU)		<b>Craig Parker, M.D., M.S.</b> Associate Research Professor (from Intermountain Healthcare in Utah)

### Affiliate and Adjunct Faculty

- 10 Collaborating faculty in SCI
- 11 Affiliate Faculty from various other disciplines at ASU
- 12 Adjunct Faculty from diverse organizations around valley

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### Growth of the Department

- 5 year target (through 2013)
  - Establish expertise in all 4 key foci
    - Initially through high profile recruits
  - Core faculty 25 FTE (30-35 people)
  - Clinical & research faculty 10-15 FTE
  - Adjuncts/affiliates ~ 20 FTE
  - Total 60-70

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## Education and Training Programs

2007

- 13 students admitted into the first MS BMI class
  - From diverse disciplines
    - Medicine, Computer Science, Bioengineering, Psychology, Nursing, Biology, and Mathematics
- Medical school informatics curriculum co-taught physicians and basic medical scientists



2008

- 7 students admitted into the first PhD BMI class
- 7 students admitted into the second MS BMI class in Fall 2008

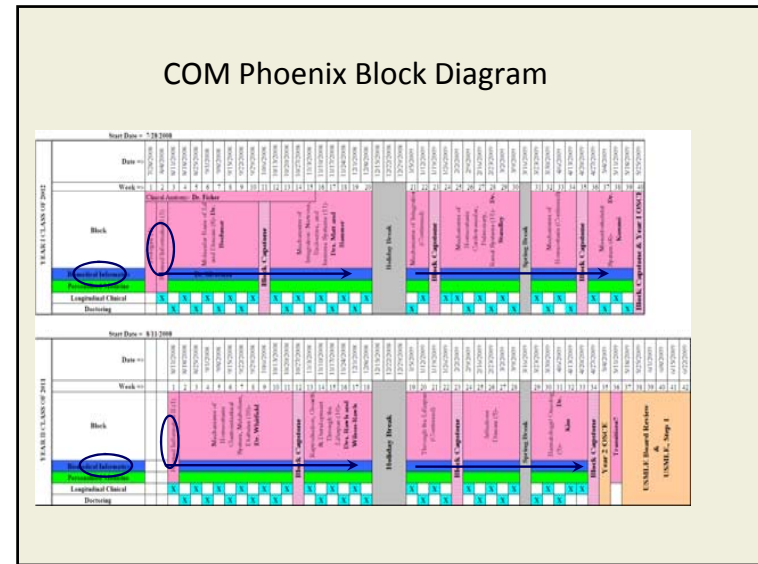
2009

- BS degree program designed and approved, to begin Fall 2010
- Starting a postdoctoral training program

2010 and beyond

- Short courses, certifications, online programs

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## Health IT-oriented R&D foci

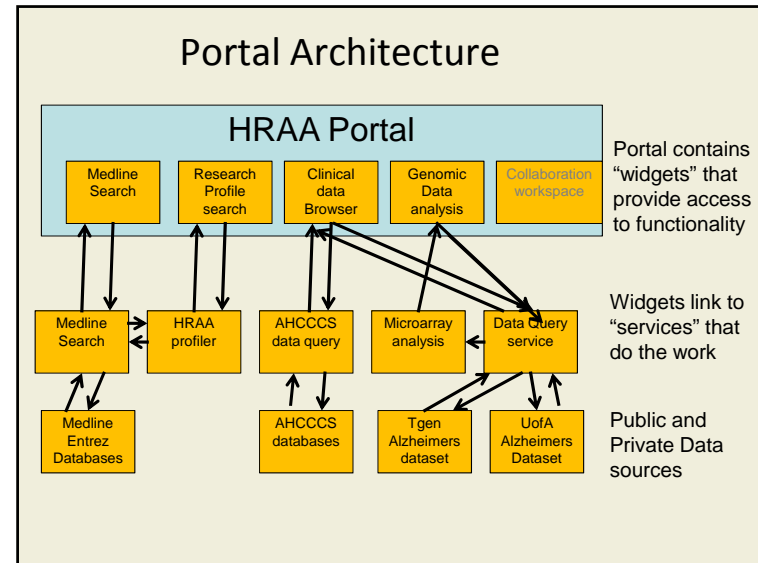
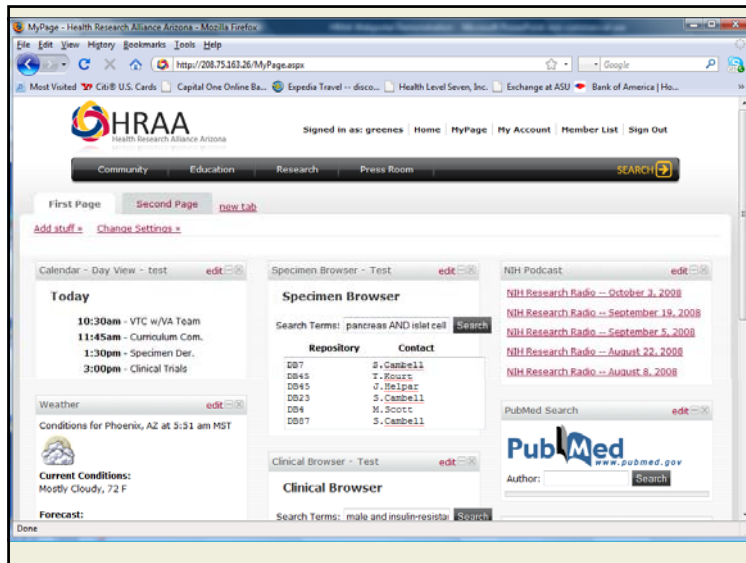
- An emphasis on statewide, regional and community platforms
  - BioCore– Collaboration portal
    - Development for a proposed Arizona statewide CTSA (HRAA)
    - New technologies for collaboration
  - HIE – Health Information Exchange
    - Working with Arizona Health Care Cost Containment System (AHCCCS) – state Medicaid agency
    - Aso with Arizona Health-e Connection (AzHeC) – consortium for EHR, ERx, HIE interoperability
  - Morningside Initiative
    - Consortium to develop clinical decision support repository, methods, and organizational framework for sharing
  - CHIR – Center for Health Information and Research
    - Health services research unit with statewide claims database – Arizona HealthQuery
  - CARE-IT- Clinical Application, Research, and Education Interoperability Testbed
    - A platform and approach for working with vendors, product and service developers to move toward interoperability

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## BioCore Web Portal

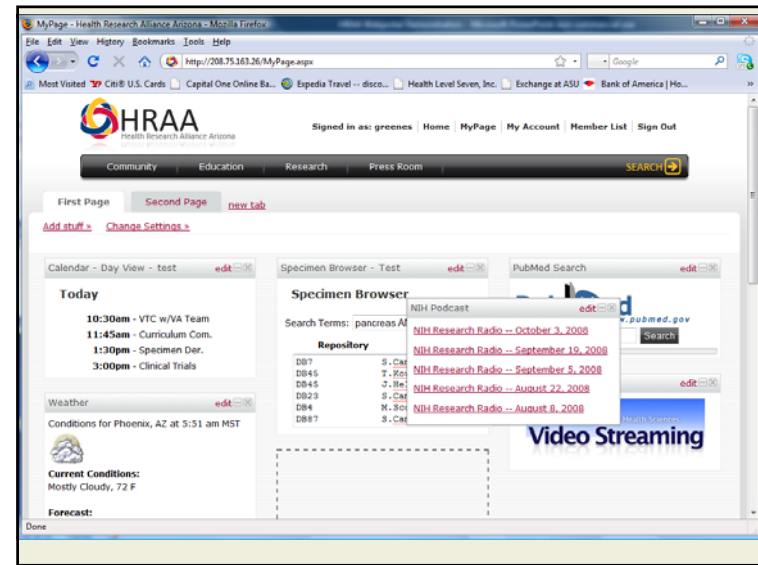
*D. Fridsma, R. Greenes*

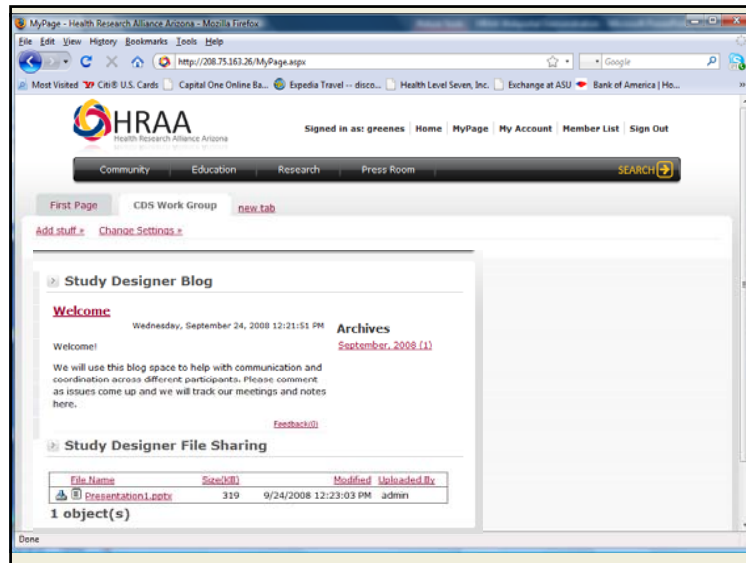
- Present and organize information and resources to user
  - Access across institutional boundaries
  - Web services that do the work behind the scenes
  - Common standards for data and development to exchange information between applications and services
  - Capabilities easily added over time
  - Ability to incorporate external services
- Customizable interface
  - Personal pages, with choice and layout of components
  - Web 2.0 collaborative tools
- Enterprise (inter-enterprise) integration
  - Support for workflow



## Collaborative Web 2.0 Functionality

- User-defined layout to "my pages" and "my projects"
  - Add specific widgets
  - Lay out widgets
  - Calendars, blogs, shared file spaces
- Create "my groups"
  - Group-specific workspaces
  - Resources needed by group





## A virtual “marketplace”

- Web 2.0 tools for user comments, feedback, blogs, ratings for all resources and services
  - e.g., competing microarray analysis facilities, image processing cores, high performance computing, biostatistics consulting services
- Usage data for evaluation and feedback

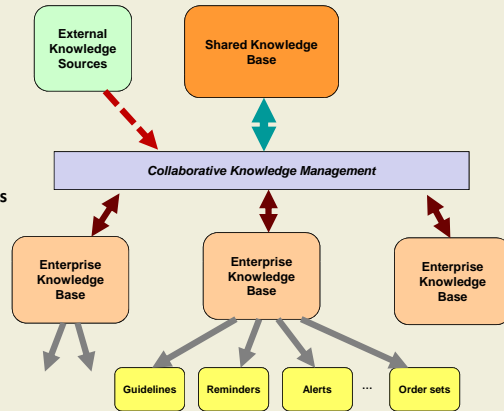
## Extensible addition of functionality

- Discovery tools
  - investigators, students, resources
- Collaboration tools
- Scientific resources
  - Biospecimen repositories
  - Databases
  - Clinical trials
  - Knowledge bases, info resources
  - Statistical, analytical, visualization tools, grid computing
- Wizards, templates, consultation services
  - e.g., design a trial, fill out an IRB application
- Education resources
- Personal management
  - Calendar, to dos, documents, bibliography, profile, etc.
- Workflow, pipelining, composition of services

## The Morningside Initiative

R. Greenes, D. Fridsma

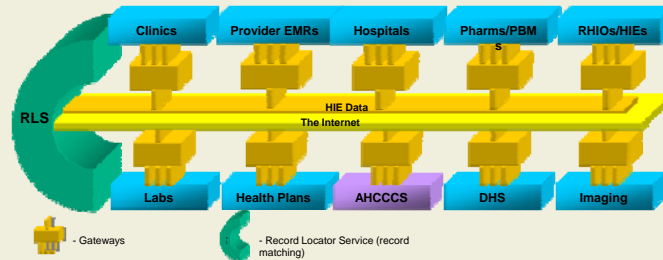
- A consortium of DOD, VA, Kaiser, Partners, Henry Ford Hospital, Intermountain Health, coordinated by ASU
- For knowledge sharing for clinical decision support (CDS)
- Initial focus on diabetes
- Startup support from TATRC
- Goal of scaling up as national-level public-private initiative



## Interoperable health records and CDS

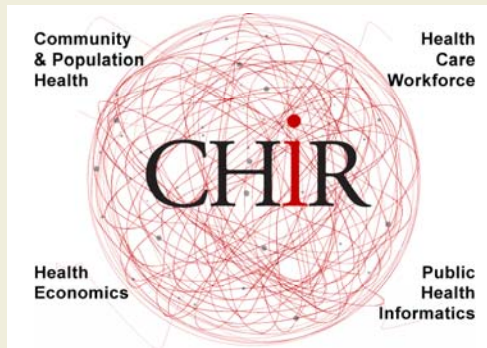
C. Parker, R. Greenes

- Interagency Service Agreement with AHCCCS (state Medicaid agency)
- for joint activities in [EHR and health information exchange \(HIE\)](#) development
- application of CDS



## Center for Health Information & Research

W. Johnson, D. Petitti



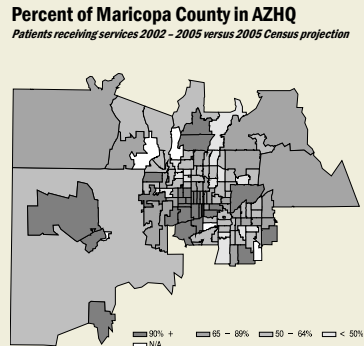
Operates Arizona HealthQuery – a unique statewide database for health services research

## Arizona HealthQuery (AZHQ)

- A Research Patient Data Repository (RPDR)
- Statewide community health data system
  - Sponsored by Arizona State University
- Community resource for assessing health status and health care needs in Arizona
- Obtains routinely collected administrative data from employers, insurers, providers and health related organizations
- Links data sources to create integrated health information for each person
- Demographic, clinical, geographic, and health care financial information

## Organizing Principles

- Participation is voluntary
- HIPAA-compliant data contracts
- Data partners retain ownership
- Data partners never identified in research without their prior permission
- Patients never identified in research output
- Strict physical and electronic security



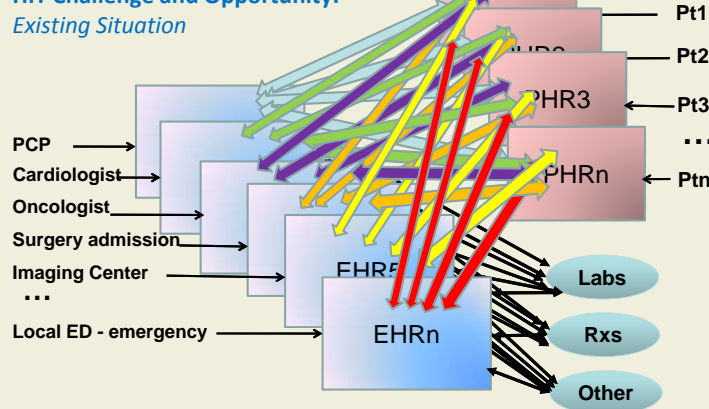
## CARE-IT: Clinical Application, Research, and Education Interoperability Testbed

*D. Fridsma, H. Silverman*

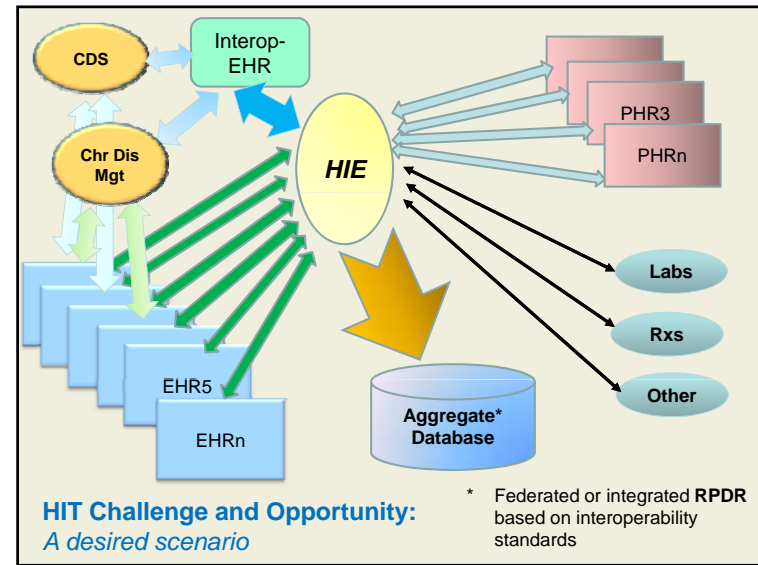
CARE-IT

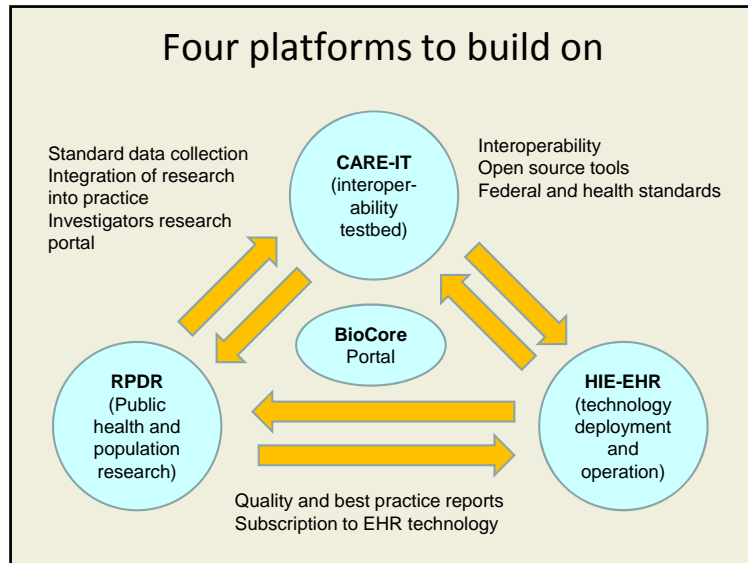
- Mission
  - promote research into open-source, interoperable and standards based solutions for health care information technology
  - provide an innovative educational infrastructure for education of healthcare and technology profession.
- Key features
  - Interoperability
  - Open source tools
  - Federal and health standards
  - Role in education
- Consortium model with vendor and health system participation
  - Federal partners (Navy, DoD)
  - Open Source and commercial partners (Medsphere, CareFX)
  - Universities (UA, ASU)
- Research/development /evaluation environment
  - for system HIE-EHR, RPDR platforms
  - for SOA functions, quality reporting, education

### HIT Challenge and Opportunity: Existing Situation



- All incompatible, non-standard, proprietary





- ### A possible HIT roadmap for AZ: An example of the approaches that can be taken
- A combination of four key platforms for:
    - Development and interoperability testing of health information systems and components (**CARE-IT**)
    - Integrated **HIE-EHR** model for patient-centered health care delivery
      - Support for interoperable advanced features: decision support, disease management, etc.
    - Data aggregation for research, quality and performance reporting, evaluation, and health policy development: **RPDR**
    - Collaboration and teaming workgroup activities: **BioCore portal**
  - Education and training programs
    - Degree programs, inservice, online, short courses, and certification programs

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## Agenda for Biomedical Informatics to facilitate health system improvement

- Role in enabling and fostering social change
  - Provide technical underpinnings, infrastructure, standards
  - Bring stakeholders together because of new capabilities not otherwise available
  - Work with stakeholders to develop solutions that are scalable, interoperable, and sustainable
  - Develop the new workforce

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### BMI's "social engineering" role – adaptation of technology to needs and driving change through technology

- BMI vs. HIT vs. CS
- New primacy because of CTSAs, personalized medicine era, HITECH

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Commentary: **Informatics in Biomedicine and Health Care**  
Robert A. Greenes, MD, PhD, and Edward H. Shortliffe, MD, PhD

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**Abstract**

During the last two decades, biomedical informatics (BMI) has become a critical component in biomedical research and health care delivery, as evidenced by two recent phenomena. One, as discussed in the article by Bernstam and colleagues in this issue, has been the introduction of Clinical and Translational Science Awards. Perhaps even more important has been the recent, arguably long overdue, emphasis on deployment of health information technology (IT) nationally. BMI utilizes IT and computer science as tools and methods for improving data acquisition, data management, data analysis, and knowledge generation, but it is driven by a focus on applications based in deep understanding of the science and practice, problems, interactions, culture, and milieu of biomedicine and health. Building from Bernstam and colleagues' distinction between BMI and other IT disciplines, the authors discuss the evolving role of BMI professionals as individuals uniquely positioned to work within the human and organizational context and culture in which the IT is being applied. The focus is not on the IT but on the combination—the interactions of IT systems, human beings, and organizations aimed at achieving a particular purpose. There has never been a time when the need for individuals well trained in BMI—those who understand the complexities of the human, social, and organizational milieu of biomedicine and health—has been more critical than it is now, as the nation seeks to develop a national infrastructure for biomedicine and health care, and as these fields seek to broadly deploy IT wisely and appropriately.

Acad Med. 2009; 84:000-000.

Academic Medicine, Vol. 84, No. 7 / July 2009

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## An agenda for BMI

- Develop and promote infrastructure, technology, standards
  - HIEs
  - Interoperability testbeds
  - Collaboration resources
    - Shared knowledge bases
    - Tools libraries
    - Aggregated data
- Bring stakeholders together
  - Use new capabilities as the “draw” or incentive
    - Databases, collaboration technologies, new tools– e.g., interoperable CDS
  - Facilitate effective teaming
- Large scale projects and demonstrations
  - Focus on solutions that are scalable, interoperable, and sustainable
- Develop the workforce
  - Multiple levels
    - Professional, graduate, undergraduate, certificates
    - Online and short course options

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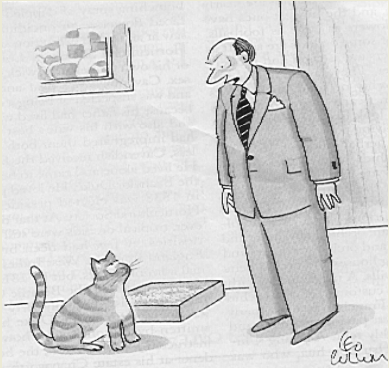
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## Behavioral health

- Special issues of confidentiality and privacy
  - Can they be accommodated under role-based access?
- Structured data capture
  - What are best tools, terminology systems?
- What are primary opportunities for decision support?
- How do we go from accepted best practice to actual practice?
  - Dissemination and adoption

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Questions, comments?

**Never, ever think outside of the box!!!**

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