Biomedical Informatics and Health IT: Opportunities and Challenges

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Biomedicine @ ASU

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The basic patient-care process

- Make decisions
- Order tests & Rxs
- Obtain patient data
- Evaluate data
Why the basic tasks are getting harder

- **Make decisions**
- **Evaluate data**
- **Order tests & Rxs**
- **Obtain patient data**

**More knowledge**
- Genes, proteins, cellular processes, pathways
- Clinical trials, meta-analyses
- Products, interactions, side-effects

**More pressures**
- Safety and quality initiatives
- Cost-effectiveness foci
- Liability concerns
- Patient information, demands
- Compliance
- Decreased time
- Increased documentation

**More data**
- More sources, e.g., Gene analyses, assays, imaging, image processing, ...

**More data volume**

**More specialization**
- Only see part of picture

**More test & treatment options**
- E.g., gene sequencing, biomarkers, imaging procedures, new drugs, minimally invasive surgery
Augmenting the patient-care process model

1. Obtain patient data
2. Aggregate data
3. Evaluate data
4. Make decisions
5. Apply decision support
6. Order tests & Rxs
7. Generate/Revise knowledge
8. Knowledge base

Data warehouse
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
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
  - Data not readily extracted
  - Dictation, voice recognition enables capture
  - 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

Original research

Negative results

18% Dickersin, 1987

Submission

variable

17 years to apply 14% of research knowledge to patient care!

Negative results

Lack of numbers

Inconsistent indexing

35% Balas, 1995

50% Poynard, 1985

Bibliographic databases

6.0 - 13.0 years Antman, 1992

Reviews, guidelines, textbook

9.3 years

Patient 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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- Improving quality and depth of clinical data – the phenotype
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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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- Accelerating the translation process
  - 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
"I'll explain it one more time. Each of these beeps is a heartbeat, not an incoming e-mail."
The Knowledge Explosion

The Information Barn

“Everything you want to know at rock-bottom prices”

- Day-old information: 2 lbs. for $5
- End-of-the-season information clearance: 294 pieces
- Slightly irregular information
- Army surplus info: 50¢ each
- Info overstock: Any three items for $9.99
- $2 bag
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."
The Translation Process

Community outreach & adoption

T2 translation (bedside to community)

T1 translation (bench to bedside)

Application

A systems approach
A statewide initiative

Population response, needs, priorities

Discover

Validation

Adapted from Arizona proposal for a clinical & translational science award grant
How informatics can help

- Widespread use of EHRs, CPOE, CDS
- Patient data and knowledge access, PHRs, decision support
- 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
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
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
Biomedical Informatics in Perspective

Basic Research

Biomedical Informatics Methods, Techniques, and Theories

Applied Research

Molecular and Cellular Processes

Bioinformatics

Imaging Informatics

Tissues and Organs

Clinical Informatics

Individuals (Patients)

Public Health Informatics

Populations And Society
Biomedical Informatics Disciplines

- Computer Science (hardware)
- Computer Science (software)
- Cognitive Science & Decision Making
- Management Sciences
- Clinical Sciences
- Basic Biomedical Sciences
- Bioengineering
- Epidemiology And Statistics
- Behavioral Sciences
Biomedical Informatics Textbook

(3rd edition)

Springer Verlag - 2006
The need for BMI expertise

• Data and knowledge explosion
  – 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 (Health Information Technology for Economic and Clinical Health Act) initiatives - $23-48B stimulus

• Growing demand for skilled informaticians
  – in academia, health care organizations, research institutes, industry
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

• BMI in Arizona as a pacesetter in this expanding field
  – One of the newest US departments of BMI
    • Formed in 2007 in downtown Phoenix
    • As a key part of the partnership of ASU with UA College of Medicine
Unique aspects of Arizona BMI

• Organization structure
  – ASU Dept on COM-P campus

• Seeking to combine aspects of both leading research BMI departments and community embeddedness
  – AZ as a testbed, model for biomed and health care change and impact of health IT

• Extent of collaborations
Biomedical Informatics in the Desert - A New and Unique Program at Arizona State University

J. A. Greene, S. Pankratz, K. Patel, H. Silverman, E. W. Simpson
Department of Biomedical Informatics, Arizona State University and University of Arizona College of Medicine, Phoenix, in conjunction with Arizona State University

1. Introduction

The Arizona State University (ASU) Department of Biomedical Informatics (BMI) is one of the newest departments of BMI in the world — one of the last in the country to be established. It is in the best tradition of being innovative in its conception, a multidisciplinary framework in which it is positioned as a constituency, and which is based on the Arizona State University model. The Department has received funding in recent years on national and state level development, research and external funding. The Department has been the primary contributor to the growth and development of the ASU Department of Biomedical Informatics. Within the framework of the National Institutes of Health (NIH) and the Department of Biomedical Informatics, the Department of Biomedical Informatics has made considerable investments in the past five years in the research infrastructure, an university system, and in public-private partnerships aimed at building a strong research base and stimulating the development of the technology industry. With strong emphasis on the transdisciplinary, there is a single focus on integration and implementation, in order to make significant advances quickly as a result of which the Department of Biomedical Informatics is one of the leading programs in the nation. The Department of Biomedical Informatics is one of the most innovative departments of BMI in the world — one of the last in the country to be established. It is consistent with the Arizona State University model. The Department has received funding in recent years on national and state level development, research and external funding. 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CAVITARY MASS

Finding:
Mass ID: 1
Margins: spiculated
Length: 2.3cm
Width: 1.2cm
Cavitary: Y
Calcified: N
Spatial relationships: Abuts pleural surface; invades aorta

Capture data once, use it many times

Embedded Systems

Simulation and Modeling

Data Mining/Knowledge Generation

NLP/AI/Structured Knowledge Representation

Collaboration Technologies & Methods

Public Health Informatics
Robert A. Greenes, M.D., Ph.D.
Ira A. Fulton Chair
Member, Inst of Med, Nat Acad Sci
(from Harvard University)

William G. Johnson, Ph.D.
Director, Center for Health Information and Research
(from ASU)

Diana Petitti, M.D., M.P.H.
Professor
(from Kaiser Southern California)

Jianming Liang, Ph.D. (arriving)
Associate Professor
(from Siemens Corp.)

Douglas Fridsma, M.D., Ph.D.
Associate Professor
(from Univ. of Pittsburgh and joint with Mayo)

Valentin Dinu, Ph.D.
Assistant Professor
(from Yale University)

Kanav Kahol, Ph.D.
Assistant Professor
(from ASU and joint with Banner Health)

Graciela Gonzalez, Ph.D.
Assistant Professor
(from ASU, pending, now Asst Res. Prof)
Clinical and Research Faculty

Howard Silverman, M.D., M.S.
The University of Arizona
College of Medicine – Phoenix
(joint with ASU)

Craig Parker, M.D., M.S.
Associate Research Professor
(from Intermountain Healthcare in Utah)

Jose Piovanetti-Perez, M.D.
Associate Research Professor
(from Universidad Central del Caribe, P.R.)

Affiliate and Adjunct Faculty

21 Affiliate Faculty from various other disciplines at ASU
12 Adjunct Faculty from diverse organizations around valley
Growth of the Department

• 5 year target (through 2013)
  – Establish expertise in all 4 key foci
  – Core faculty 25 FTE (30-35 people)
  – Clinical & research faculty 10-15 FTE
  – Adjuncts/affiliates ~ 20 FTE
  – Total 60-70
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
R&D Themes

• Facilitating multiparty collaboration
  – networked trials, access to resources, analytic methods, etc.

• Developing infrastructure for health care transformation
  – data access, interoperability, quality, error prevention, decision support

• Fostering public health
  – health services research, health policy
BioCore– Collaboration portal

D. Frdisma, R. Greenes

- Genesis to provide underpinning for a proposed Arizona statewide CTSA (HRAA)
- New technologies for collaboration
- Working with UA, TGen, NAU, AHCCCS, multiple hospitals and community health centers
BioCore Web Portal

• 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
Testbed for IBM “Blue Spruce” collaboration platform
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. Frdisma

• 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
- Collaboration with Arizona Health-e Connection
- application of CDS

RLS - Record Locator Service (record matching)
CARE-IT: Clinical Application, Research, and Education Interoperability Testbed

D. Fridsma, H. Silverman

- **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), clinical partners

- **Research/development /evaluation environment**
  - for system HIE-EHR, RPDR platforms
  - for SOA functions, quality reporting, education
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
- 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
  - Over 40 data partners
- Links data sources to create integrated health information for each person
- Demographic, clinical, geographic, and health care financial information
Health IT Challenge and Opportunity: 
*Existing Situation*

- All incompatible, non-standard, proprietary
HIT Challenge and Opportunity: A desired scenario

* Federated or integrated RPDR based on interoperability standards
Four platforms to build on

- Standard data collection
- Integration of research into practice
- Investigators research portal

CARE-IT
(interoperability testbed)

- Interoperability
- Open source tools
- Federal and health standards

BioCore
Portal

- RPDR
(Public health and population research)
- HIE-EHR
(technology deployment and operation)

Quality and best practice reports
Subscription to EHR technology
A proposed 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
Simulation and training

**K. Kahol**

- Study of surgical errors and fatigue
  - Best paper award, Amer. Coll. of Surg. annual meeting
- Use of Wii as warmup for surgery
  - Best paper award, MMVR, news coverage channel 5, BBC, Wall St J blog
- Extensive collaboration with Banner Health
• Knowledge-guided genome data analyses
  *V. Dinu, G. Gonzalez*
  – Guiding GWAS studies, with TGen
  – Selection of therapeutic targets, with TGen

• Next-generation sequencing
  *V. Dinu*
  – Work with TGen

• Computer-aided detection and diagnosis in imaging
  *J. Liang*
  – Work with Banner, St. Joseph’s

• Data management and data modeling
  *G. Gonzalez*
  – Alzheimer Consortium

• Clinical information systems & clinical research
  *Doug Fridsma*
  – With Mayo Clinic
An agenda for BMI

- Develop and promote infrastructure, technology, standards
  - Health Information exchange – become national model
  - Interoperability testbed – provide extensible approach to nation
  - Collaboration resources – serve as a model for fostering team science
    - Shared knowledge bases
    - Tools libraries
    - Aggregated data
- Bring stakeholders together – catalyze social change
  - 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
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
Questions, comments?

Never, ever think outside of the box!!!