The Spectrum of Biomedical Informatics and the UAB Informatics Institute

Molecular and Cellular Pathology Seminar
September 22, 2015

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Overview

- Definitions

- A quick survey of biomedical informatics

- The UAB Informatics Institute
What is biomedical informatics?

“Computers in medicine”

“The field that concerns itself with the cognitive, information processing and communication tasks of medical practice, education and research, including the information science and the technology to support these tasks.” Greenes RA. Shortliffe EH. JAMA 1990 Feb 23; 263(8):1114-20.

The art and science of organizing knowledge of human health and disease, and making it useful for problem solving.
What is biomedical informatics?

- Genetics
- Molecular Biology
- Cell Biology
- Physiology and Pathophysiology
- Patient Care
- Clinical Informatics
- Clinical Research Informatics
- Translational Informatics
- Bioinformatics
- Population Health
- Population Informatics
Some questions that biomedical informatics can answer

- How do we find out what medication the patient is on?
- How do we get her records from another institution?
- How do we incorporate problem list into current thinking?
- How do we assess the patient’s genetic predispositions?
- What do we have to report for public health, and how?
- How do we facilitate retrieval of relevant evidence?
- How do facilitate application of expert systems?
- How do we keep the clinician from getting overwhelmed?
- How do we exploit patient information to gain knowledge?
Genetics: The branch of biology that deals with the transmission and variation of inherited characteristics, in particular chromosomes and DNA

Genomics: The study of the structure of the genome, examining the molecular mechanisms and the interplay of genetic and environmental factors in disease
OMIM® - Online Mendelian Inheritance in Man®

Welcome to OMIM®, Online Mendelian Inheritance in Man®. OMIM is a comprehensive, authoritative compendium of human genes and genetic phenotypes that is freely available and updated daily. The full-text, referenced overviews in OMIM contain information on all known mendelian disorders and over 15,000 genes. OMIM focuses on the relationship between phenotype and genotype. It is updated daily, and the entries contain copious links to other genetics resources.

This database was initiated in the early 1960s by Dr. Victor A. McKusick as a catalog of mendelian traits and disorders, entitled Mendelian Inheritance in Man (MIM). Twelve book editions of MIM were published between 1966 and 1998. The online version, OMIM, was created in 1985 by a collaboration between the National Library of Medicine and the William H. Welch Medical Library at Johns Hopkins. It was made generally available on the internet starting in 1987. In 1995, OMIM was developed for the World Wide Web by NCBI, the National Center for Biotechnology Information.

OMIM is authored and edited at the McKusick-Nathans Institute of Genetic Medicine, Johns Hopkins University School of Medicine, under the direction of Dr. Ada Hamosh.

NLM's Profiles in Science -- The McKusick Papers
Enter a study id, dbSNP id, MeSH/HPO phenotype term, keywords, author names, HGNC gene symbols, chromosomal regions or PUBMED identifier

(e.g. HGVS307, rs2317951, Pancreatic cancer, replication study, Todd JA, ADAM19, chr12:13234..4534534, 17554300)

About GWAS Central

GWAS Central provides a centralized compilation of summary level findings from genetic association studies, both large and small. We actively gather datasets from public domain projects, and encourage direct data submission from the community. See more.

Frequently asked questions

- How do I find phenotypes of interest?
- How do I find genes/regions of interest?
- How do I find markers of interest?
- How do I use the Browser to identify regions of interest?
- How do I submit my own data to GWAS Central?

News

27/03/2015  GWAS Central data release March 2015 Read more.

28/08/2014  GWAS Central study meta-data available for use in data citation research Read more.

17/08/2014  GWAS data release August 2014 Read more.

Custom tracks

Upload your own p-values as custom tracks to GWAS Central and view them alongside other Study data.
The database of Genotypes and Phenotypes (dbGaP) was developed to archive and distribute the results of studies that have investigated the interaction of genotype and phenotype.
Cost per Genome

Moore's Law

NIH National Human Genome Research Institute

genome.gov/sequencingcosts
Translational Bioinformatics: the development of storage, analytic, and interpretive methods to optimize the transformation of increasingly voluminous biomedical data, and genomic data, into proactive, predictive, preventive, and participatory health.

Personalized Medicine: a medical model that proposes the customization of healthcare - with medical decisions, practices, and/or products being tailored to the individual patient (lately, with genomic tailoring).

Pharmacogenomics: the study of how genes affect a person's response to drugs (together with pharmacokinetics).
Pharmacogenomics

- HER2-
  neu—trastuzumab
- bcr/abl—imatinib mesylate
- C-kit—imatinib mesylate
- EGFR—gefitinib
- TPMT—mercaptopurine and azathioprine
- UGT1A1—irinotecan
- CYP2C9/VKORC1—warfarin
- HLA-B*5701—abacavir
- HLA-B*1502—carbamazepine
- CYP2C19—clopidogrel
- CYP2D6—5-HT3 receptor antagonists, antidepressants, ADHD drugs, and codeine derivatives, tamoxifen
**TEST PERFORMED**

**Solid Tumor Gene Set** - Targeted next-generation sequencing was performed on this sample of metastatic adenocarcinoma consistent with pancreatic primary. See Test Details for more information.

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**CLINICALLY RELEVANT RESULTS SUMMARY**

Variants that are deemed clinically significant are listed here.

<table>
<thead>
<tr>
<th>Variants Detected</th>
<th>In patient tumor type: FDA approved therapies, prognostic information, or other course of action</th>
<th>In another tumor type: FDA approved therapies, prognostic information, or other course of action</th>
</tr>
</thead>
<tbody>
<tr>
<td>KRAS p.Q61H</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

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**CLINICALLY RELEVANT INTERPRETATIONS**

Interpretations of variants that are deemed clinically significant are listed here.

<table>
<thead>
<tr>
<th>Variants Detected</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>KRAS p.Q61H</td>
<td>A nonsynonymous <strong>KRAS p.Q61H</strong> variant was identified and occurs within exon 3, which encodes the nucleotide binding domain of the protein. The mutation leads to constitutional activation of small GTPase and downstream MAPK pathway as well as PI3K pathway and contributes to increased cellular proliferation and survival, and ultimately oncogenic transformation <em>in vitro</em> (Smith G, et al.; Br J Cancer 102; 693-703; 2010 Feb 16). KRAS mutations at codon 61 occur infrequently in patients with colorectal and lung cancer as well as exocrine pancreatic cancer (Prior IA, Lewis PD, Mattos C; Cancer Res 72; 2457-67; 2012 May 15), accounting for less than 1% of KRAS-mutated cancers. In patients with colon cancer, activating <strong>KRAS</strong> mutations including Q61H cause decreased sensitivity to anti-EGFR therapy (Douillard JY, et al.; N Engl J Med 369; 1023-34; 2013 Sep 12) (Loupakis F, et al.; Br J Cancer 101; 715-21; 2009 Aug 18). KRAS mutation at codon 12 or 13 had been shown to be an adverse prognostic marker in pancreatic ductal adenocarcinoma (Sinn BV, et al.; Pancreas 43; 578-83; 2014 May), but the prognostic implication of the Q61H variant in pancreatic ductal adenocarcinoma is unknown.</td>
</tr>
</tbody>
</table>
Clinical Trials Data Management Systems:
Organized capture of data for clinical trials, support workflow, study objectives, data analysis

Clinical Data Repositories:
Data from electronic health records organized for re-use in designing new studies (hypothesis testing), estimating available cohort size, assisting with recruitment, actual secondary analysis

Learning Health System:
Considers how health care is structured to develop and to apply evidence--from health profession training and infrastructure development to advances in research methodology, patient engagement, payment schemes, and measurement--and highlights opportunities for the creation of a sustainable learning health care system that gets the right care to people when they need it and then captures the results for improvement
REDCap is a mature, secure web application for building and managing online surveys and databases. While REDCap can be used to collect virtually any type of data, it is specifically geared to support data capture for research studies. The REDCap Consortium is composed of 1,607 active institutional partners in 92 countries who utilize and support REDCap in various ways.

The REDCap application allows users to build and manage online surveys and databases quickly and securely, and is currently in production use or development build-status for more than 196,000 projects with over 270,000 users spanning numerous research focus areas across the consortium. To find out if your institution is already running REDCap, you will find contact information on the Consortium Partners page. Learn more about REDCap by watching a brief summary video (4 min) or overview (14 min).

Map of REDCap Consortium Partners

Recent publications using REDCap:

- Geriatric Assessment-Guided Care Processes for Older Adults: A Delphi Consensus of Geriatric Oncology Experts J Natl Compr Canc Netw. 2015 Sep;13(9):1120-30.
- Critically Ill Children Have Low Vitamin D Binding Protein, Influencing Bioavailability of Vitamin D Ann Am Thorac Soc. 2015 Sep 10.
- Hospital Incidence and Outcomes of ARDS Using the Kigali Modification of the Berlin Definition Am J Respir Crit Care Med. 2015 Sep 9.

View all 1,761 articles
MISSION

i2b2 (Informatics for Integrating Biology and the Bedside) is an NIH-funded National Center for Biomedical Computing based at Partners HealthCare System. The i2b2 Center is developing a scalable informatics framework that will enable clinical researchers to use existing clinical data for discovery research and, when combined with IRB-approved genomic data, facilitate the design of targeted therapies for individual patients with diseases having genetic origins. This platform currently enjoys wide international adoption by the CTSA network, academic health centers, and industry. i2b2 is funded as a cooperative agreement with the National Institutes of Health.

DRIVING BIOLOGY PROJECTS

- Overview
- Current DBPs
  - Autoimmune/CV Diseases
  - Diabetes/CV Diseases
- Past DBPs
  - Airways Diseases
  - Hypertension
  - Type 2 Diabetes Mellitus
  - Huntington's Disease
  - Major Depressive Disorder
  - Rheumatoid Arthritis
  - Obesity

RESOURCES

- Overview
- Computational Tools
- Software
- NLP Research Data Sets
- NLP Shared Tasks
- Academic Users' Group
- Publication Data

SOFTWARE
The Learning Health System

Personal Health Record → Quality Measures → Clinical Decision Support

Electronic Health Record → Public Health → Public Health Policy

Health Information Exchange → Clinical Research → Clinical Guidelines

Natl & Intl Health Analytics
Electronic health records are on the ascendance thanks to the Affordable Care Act

- Advantages: Legible, available, support billing and compliance
- Other EHR features less useful: data entry, alerts, results review
Overriding Alerts

- Overriding of appropriate alerts without adverse drug events (alert suggesting monitoring serum levels). Overriding may be justified or unjustified.
- Overriding of appropriate alerts with adverse drug events (no alternative for appropriate treatment). Overriding may be justified or unjustified.
- Overriding of inappropriate alerts without adverse drug events. Overriding is justified because of inappropriateness.
- Overriding of inappropriate alerts with adverse drug events. Overriding is justified because of inappropriateness.

Adverse drug events without alert overrides.

Appropriate alerts

Useful alerts

Overridden alerts

Adverse drug events
Origins of the modern medical record

1960's - 1980's
- First generation: pioneers

1990's
- Second generation: first commercial attempts

Present
- Third generation: stable commercial products

Clinical Trials
- Dynamed
- Up to Date
- Harrison's
Personal Health Informatics

Search for health information

e-Patients exchange e-mail with family members/friends

e-Patients seek guidance from online patient-helpers

Participate in online support groups

Join other online self-helpers to research shared concerns

Use online medical guidance systems

Interact with volunteer online health professionals

Use the paid services of online medical advisors

Engage in electronic conversations with their local clinicians

Receive one-way electronic messages from their clinicians
Find out what your DNA says about you and your family.

- Learn what percent of your DNA is from populations around the world
- Contact your DNA relatives across continents or across the street
- Build your family tree and enhance your experience with relatives

(order now) $99
Public Health Informatics

- Epidemiology
- Outbreak Management
- Emergency Response
- Electronic Laboratory Reporting and other Information Exchanges
- Government Policy
- Public Health Surveillance
United States Flu Activity

Influenza estimate

Google Flu Trends estimate
United States data

United States: Influenza-like illness (ILI) data provided publicly by the U.S. Centers for Disease Control.
The Agenda of the UAB Informatics Institute

Center for Genomic Medicine
- Coordinating Genomics Research with Clinical Research Activities

Personalized Medicine Institute
- Relating Biobanks to Research Needs; Delivering Knowledge to the Point of Care

Center for Clinical and Translational Science
- Informatics Research to Address Researcher Information Needs and Improve Workflow
- Incorporation of New Data into Record; Integration of New Decision Support Tools

UAB Health System Electronic Health Record (Cerner)
- Helping Patients Understand their Health; Helping them Contribute to their Record

Informatics Institute
- Improving Access to and Re-Use of Clinical Data to Support the Learning Health System
- Improving Access to and Re-Use of Clinical Data to Support Institutional Decision-Making

Research

Operations

Patient Care
- Delivering Next Generation Decision Support to All Stakeholders

Informatics Education
- Teaching Basic Informatics to Clinical Trainees; Training the Next Generation of Informaticians

Clinical Education
- Teaching Clinical Trainees How to Use and Contribute to the ERH

Patient Education (Patient School)