

# Big Data in Medicine and Biology: An EMBS Perspective

**Andrew F. Laine, D.Sc.\***

Percy K. and Vida L. W. Hudson Professor of Biomedical Engineering  
and Professor of Radiology (Physics)

Chair, Department of Biomedical Engineering

Columbia University

New York, NY USA

\* President-Elect, IEEE Engineering in Biology and Medicine Society,  
Fellow IEEE, Fellow AIMBE

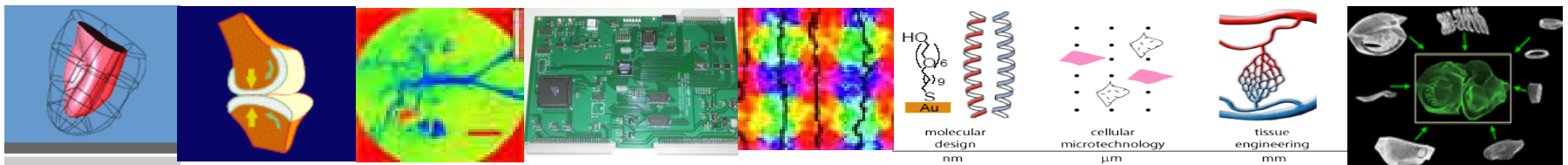
# EMBS – World's Largest and Oldest BME Organization

- Merger in 1963 of
  - AIEE Committee on Electrical Techniques in Medicine and Biology (1948)
  - IRE Professional Group on Medical Electronics (1952)
- 1968 IEEE Professional Group on Medical Electronics renamed Engineering in Medicine and Biology Society (EMBS)
- > 9,800 members
- > 1,900 student members
- Typically > 2,800 attendees at annual conference
- > 50% outside North America

# EMBS Mission:

## Advancing Health Care Through Technology

- Application of engineering sciences and technology to medicine and biology
- Promote the profession, career paths
- Provide global leadership
- To benefit its members and humanity
- Disseminating knowledge, fostering professional development, and recognizing excellence
- Medical Industrial Standards



# Outcome-Driven Healthcare

***Patient-Centric***  
***Evidence-Based***  
***Clinical and Health Decision***  
***Support***

```
graph TD; A["Patient-Centric  
Evidence-Based  
Clinical and Health Decision  
Support"] --> B["Genetic Disease  
Pediatric Sickle  
Cell Disease"]; A --> C["Acute Condition  
Intensive  
Care Unit"]; A --> D["Chronic Condition  
Predictive  
Health"];
```

***Genetic Disease***  
***Pediatric Sickle***  
***Cell Disease***

***Acute Condition***  
***Intensive***  
***Care Unit***

***Chronic Condition***  
***Predictive***  
***Health***

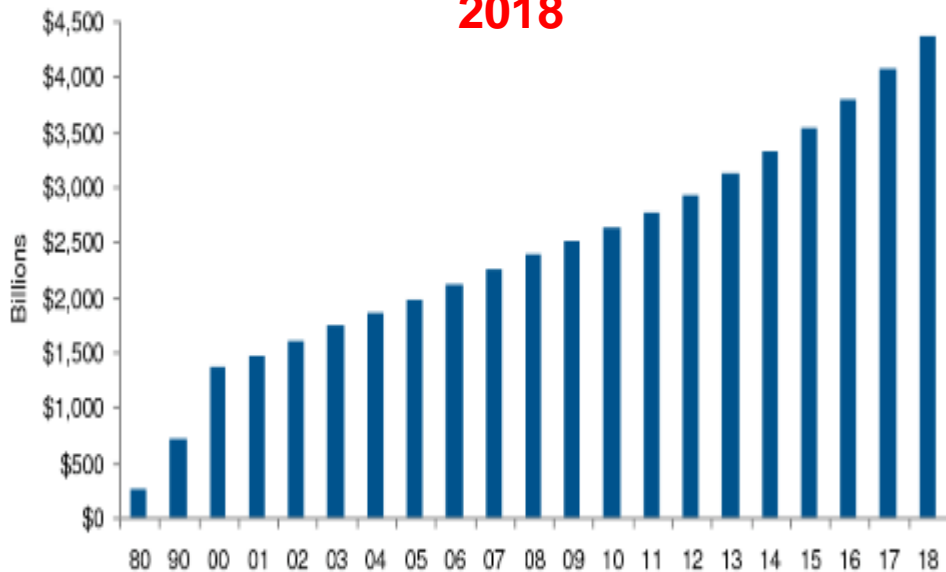


# US Healthcare **Cost: Highest!** Health **Outcome: 37!!**

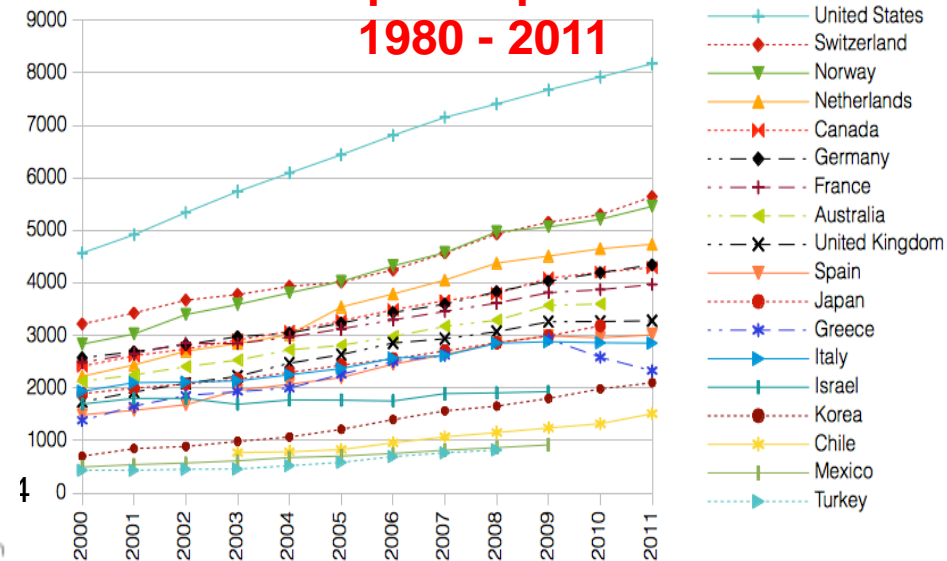
US Health Expenditures: \$3.1 trillion in 2014

- > 10 Times the Level of 1980<sup>1</sup>
- Highest per Capita (\$8,915) among ALL other nations<sup>2</sup>
- Grow Faster Than National Income during the Foreseeable Future<sup>3</sup>

**National Health  
Expenditures 1980 -  
2018**



**Average Health Care Spending  
per Capita  
1980 - 2011**



1. National Health Statistics Group.

2. WHO Department of Health Statistics and Informatics.

3. Ginsburg PB, 2008

4. Data from WHO, "Global Health Expenditure Database," ed: World Health Organization

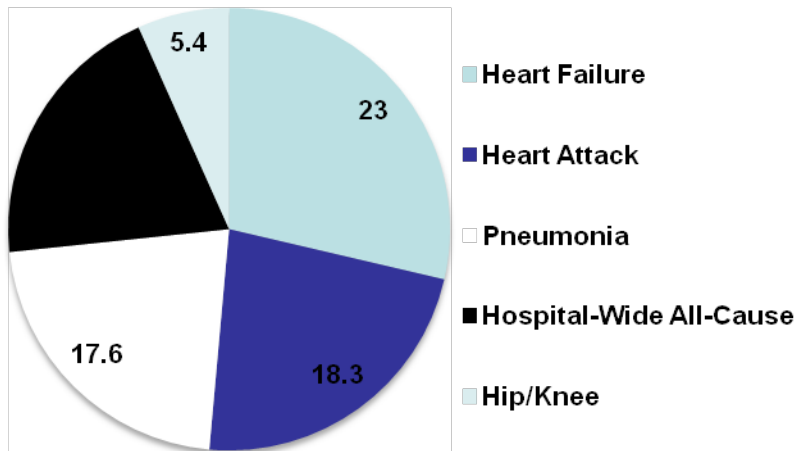
Link: <http://apps.who.int/nha/database/ResourcesPage.aspx>

# Critical Care

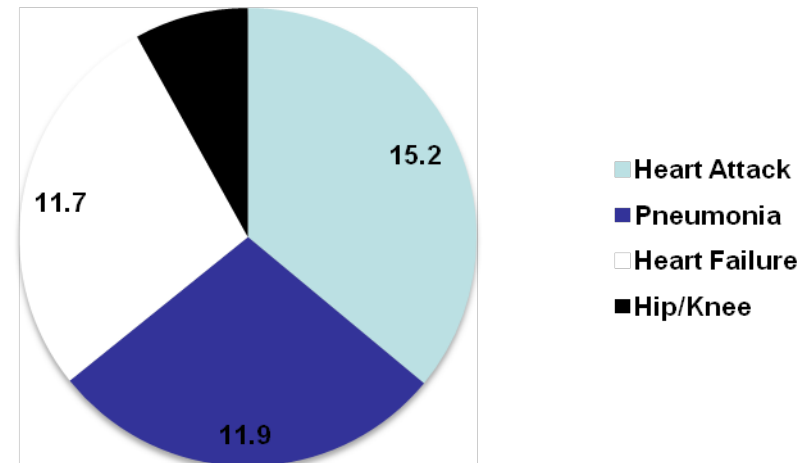
- Critical Care Costs — **\$56.6 - \$81.7 Billion during 2000 -2005<sup>1</sup>**
- **13.4% of Hospital Costs<sup>1</sup>**
- **4.1% of Health Expenditures**

## Top Intervention Areas in Critical Care<sup>2</sup>

National Average **Readmission Rate**



National Average **Mortality Rates**



1. Society of Critical Care Medicine Link:

<http://www.sccm.org/Communications/Pages/CriticalCareStats.aspx>

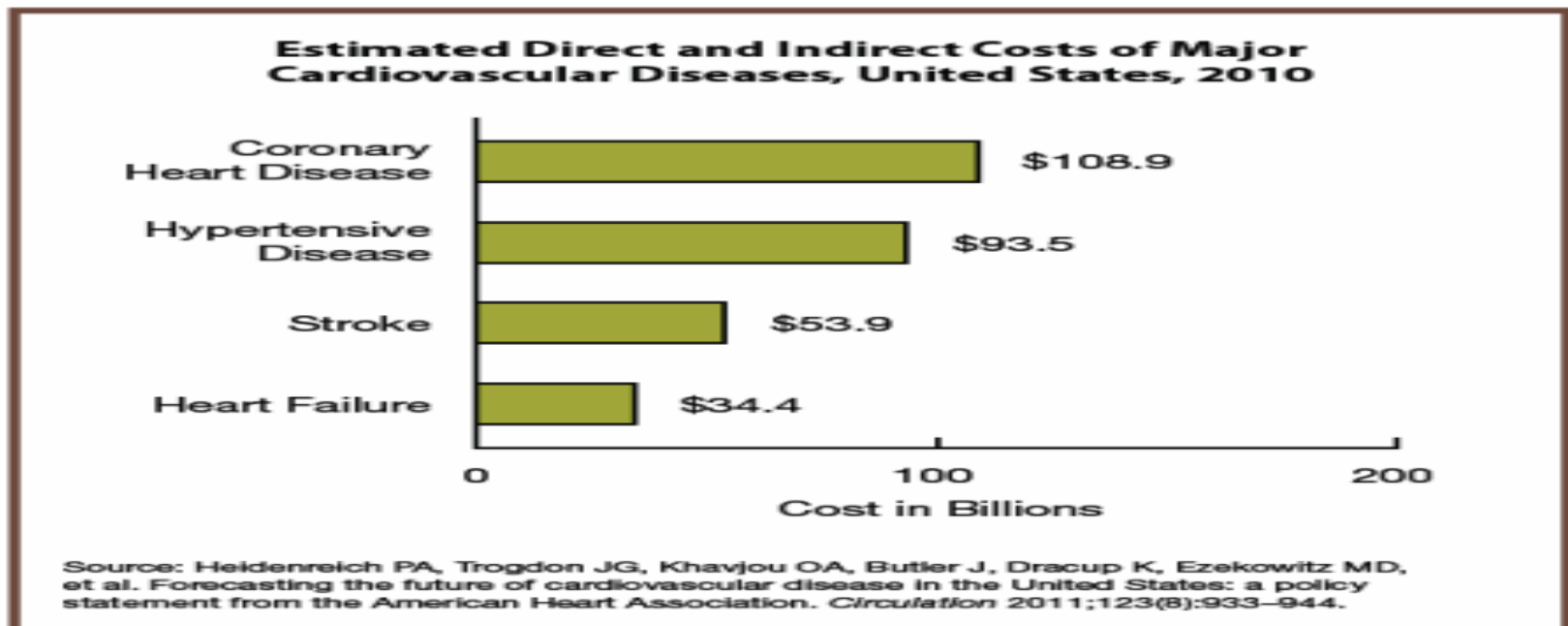
2. Data from Medicare, "Medicare.gov Database," Link:

<https://data.medicare.gov/Hospital-Compare>

# Chronic Care

- Heart Diseases, Cancer, Stroke, Diabetes, and Arthritis.
- **7 in 10 Deaths** Per Year in US<sup>1</sup>
- **133 Million Americans—Nearly 1 in 2 Adults Affected**<sup>1</sup>
- **75% of Healthcare Costs**<sup>1</sup>

## Direct & Indirect Costs of Chronic Heart Disease<sup>2</sup>

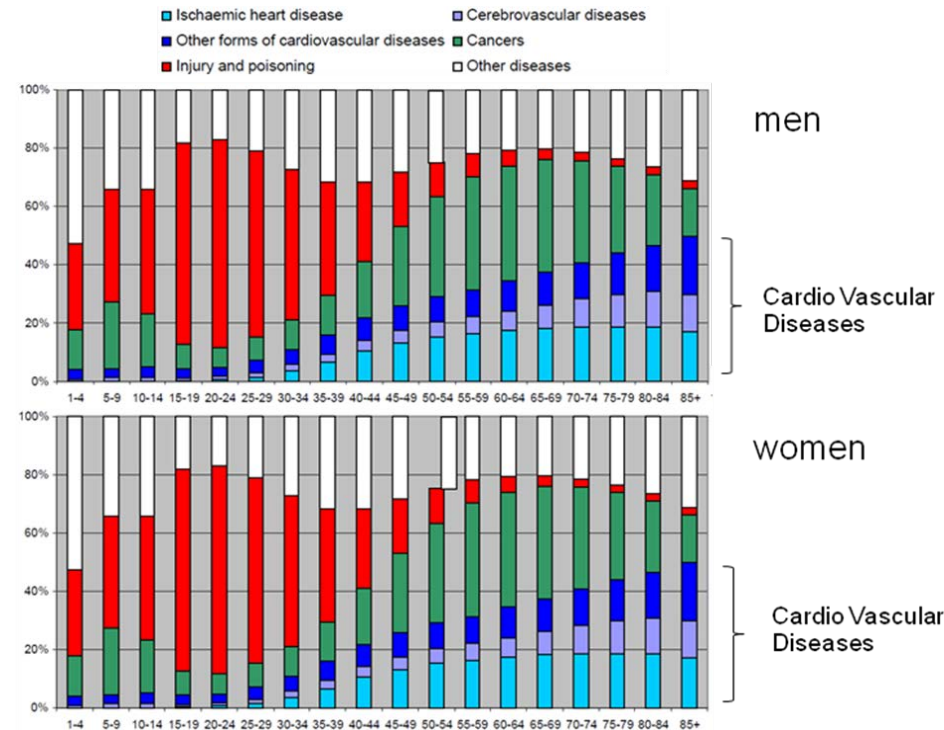


1. CDC Website Link: <http://www.cdc.gov/chronicdisease/resources/publications/aag/chronic.htm>

2. CDC Website Link: <http://www.cdc.gov/chronicdisease/resources/publications/aag>

# EU: Cardiovascular Diseases

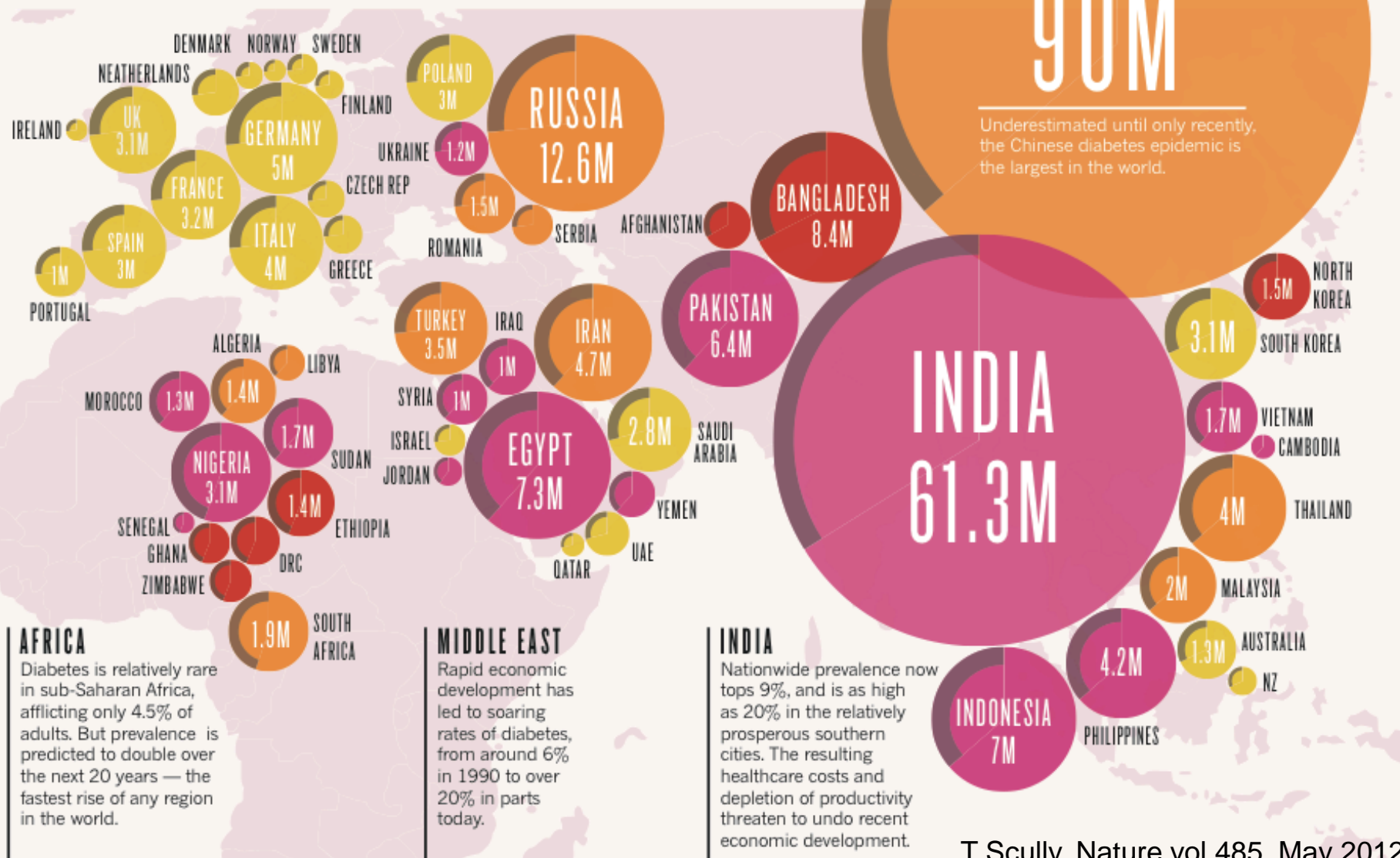
- Cardiovascular disease (CVD) is the main cause of death (30% worldwide) and disability.
- The main forms of CVD are coronary heart disease and stroke.
- About 12 million people die of heart attacks or strokes each year (but they can often be prevented). Nearly two-thirds of them die before they can reach medical care.
- In the U.K. alone, each year CVD costs the health care system around £1.8 billion



Proportional mortality rate of CVD within EU.  
Source: EUROSTAT (<http://epp.eurostat.ec.europa.eu>)-2007

## REAL PEOPLE

Percentages and predictions can mask the enormity of the diabetes problem. Large numbers of people with diabetes are unaware they have the disease because they have not been diagnosed (shown as the shaded ridge in the country bubbles). The imperative for public-health professional is to diagnose and treat people as soon as possible.

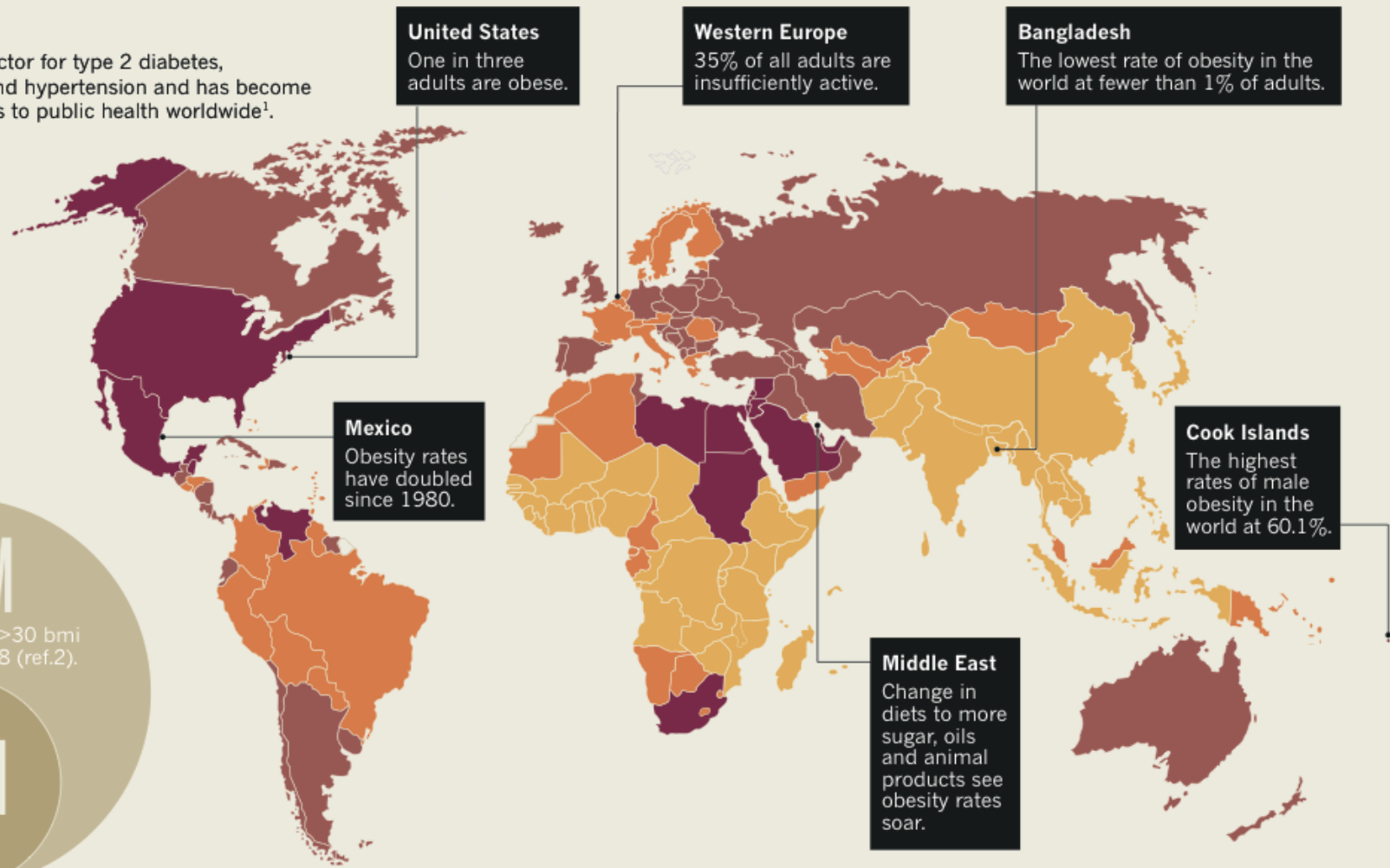
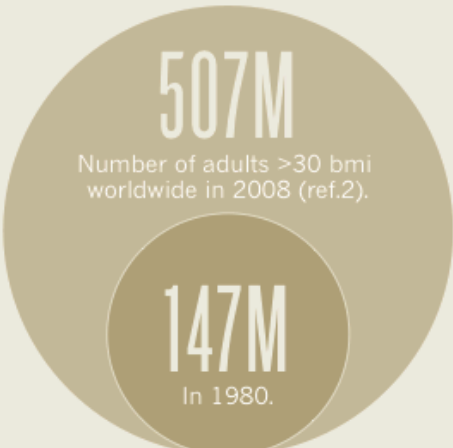


**GLOBAL SPREAD**

Obesity is a major risk factor for type 2 diabetes, cardiovascular disease and hypertension and has become one of the leading threats to public health worldwide<sup>1</sup>.

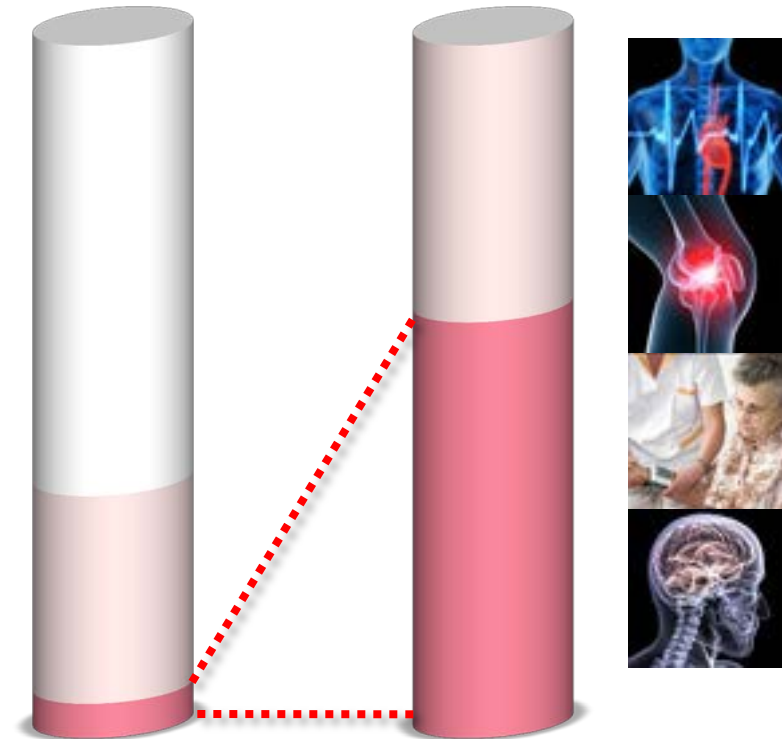
Prevalence of adult obesity 2008 (%)

- >30
- 20-29
- 10-19
- <10



# Global: Burden of Chronic Diseases

- Diabetes
- Hypertension
- Chronic Heart Failure
- Asthma
- Depression
- Rheumatic disease

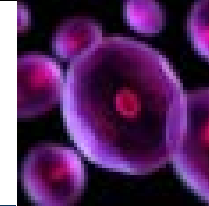
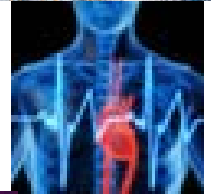
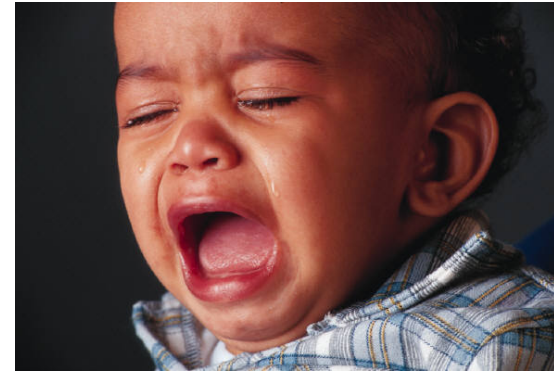


- 5% of the population –
- 60% of the Health Costs



# Challenges in Global Healthcare

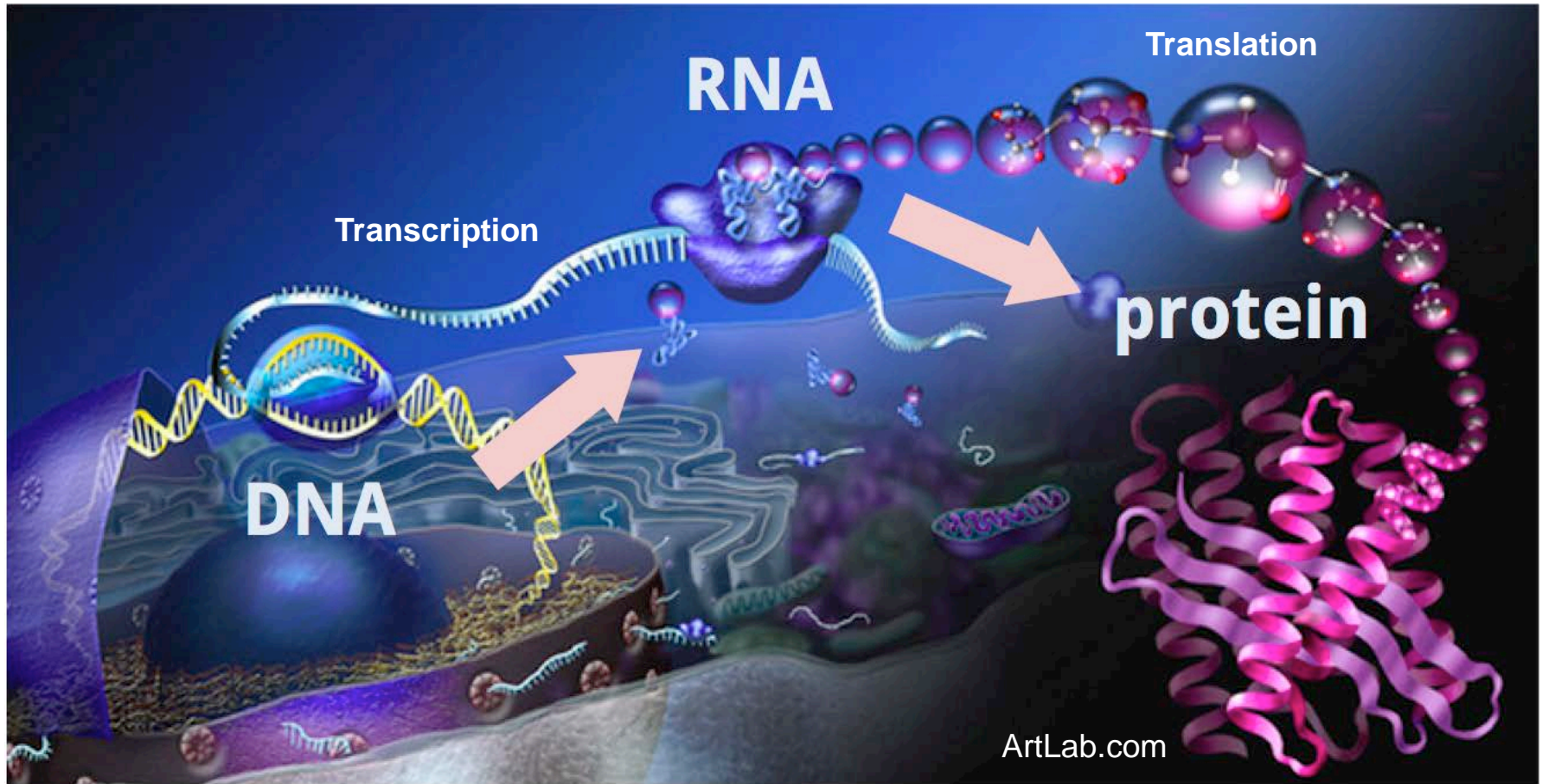
- Aging populations
- Rising costs
- Prevention
- Urbanization & environmental impact
- Personalised medicine
- Chronic and infectious diseases
- Emerging economies and healthcare policies
- Technological advances



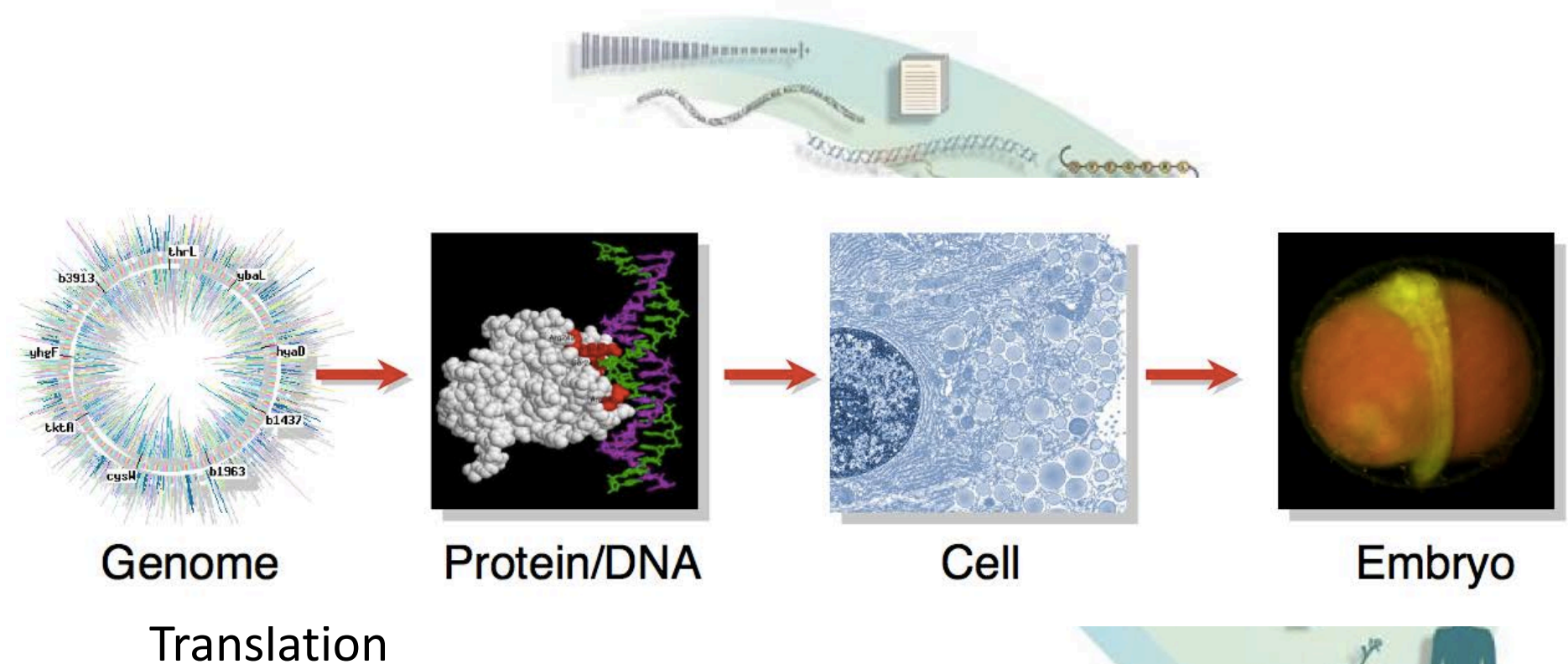


# Big Data Challenge!

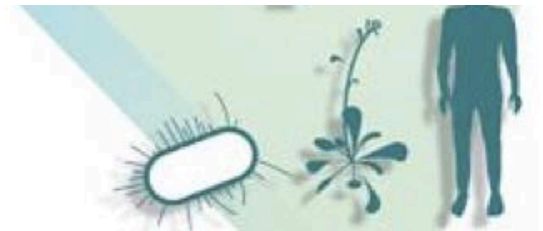
# Data Explosion – molecules of life



# Data Explosion: “Systems Medicine”

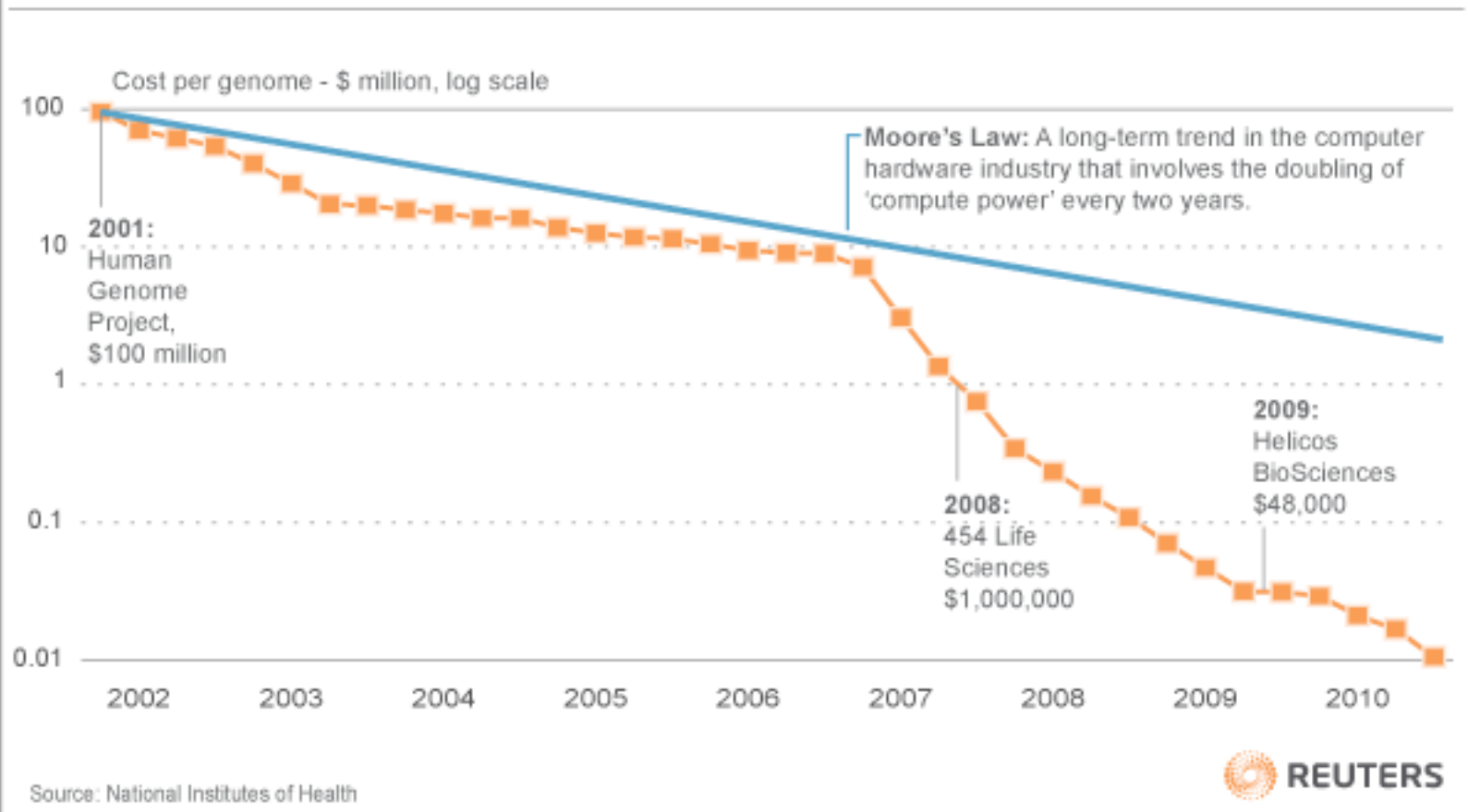


**Wellness:** New Industry of 21<sup>st</sup> Century

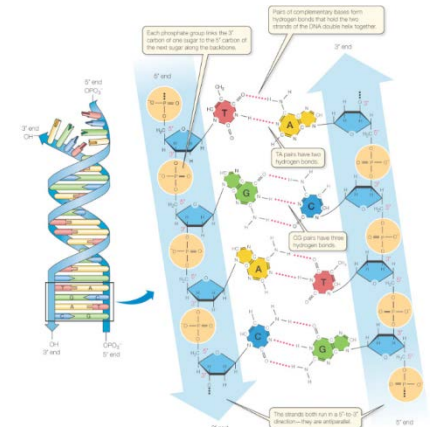
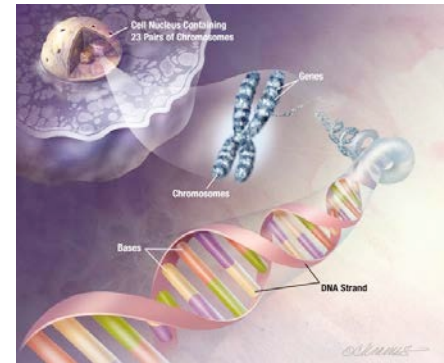
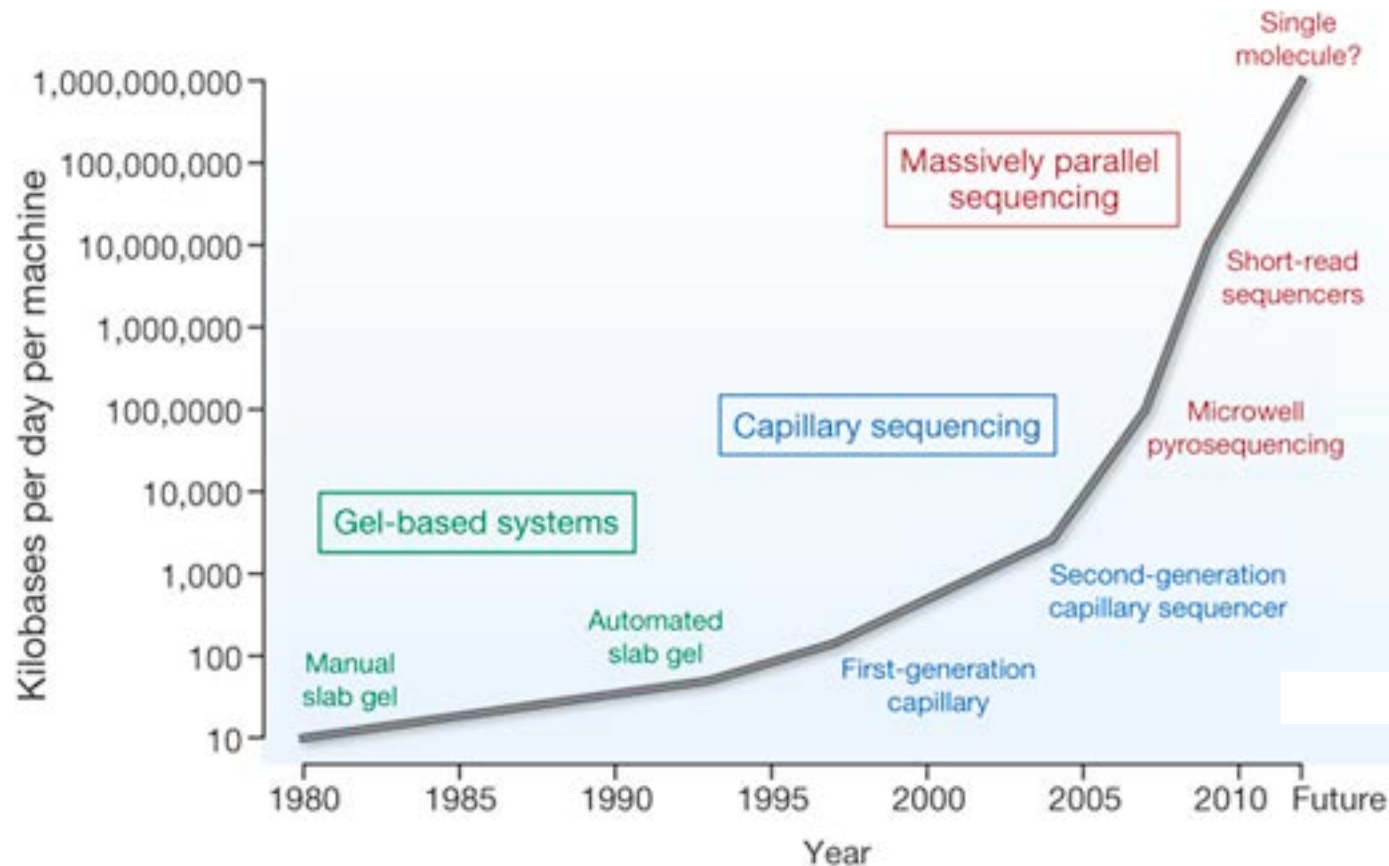


# Technology Advancement: Accelerate Data Explosion

## DNA sequencing costs have gone down



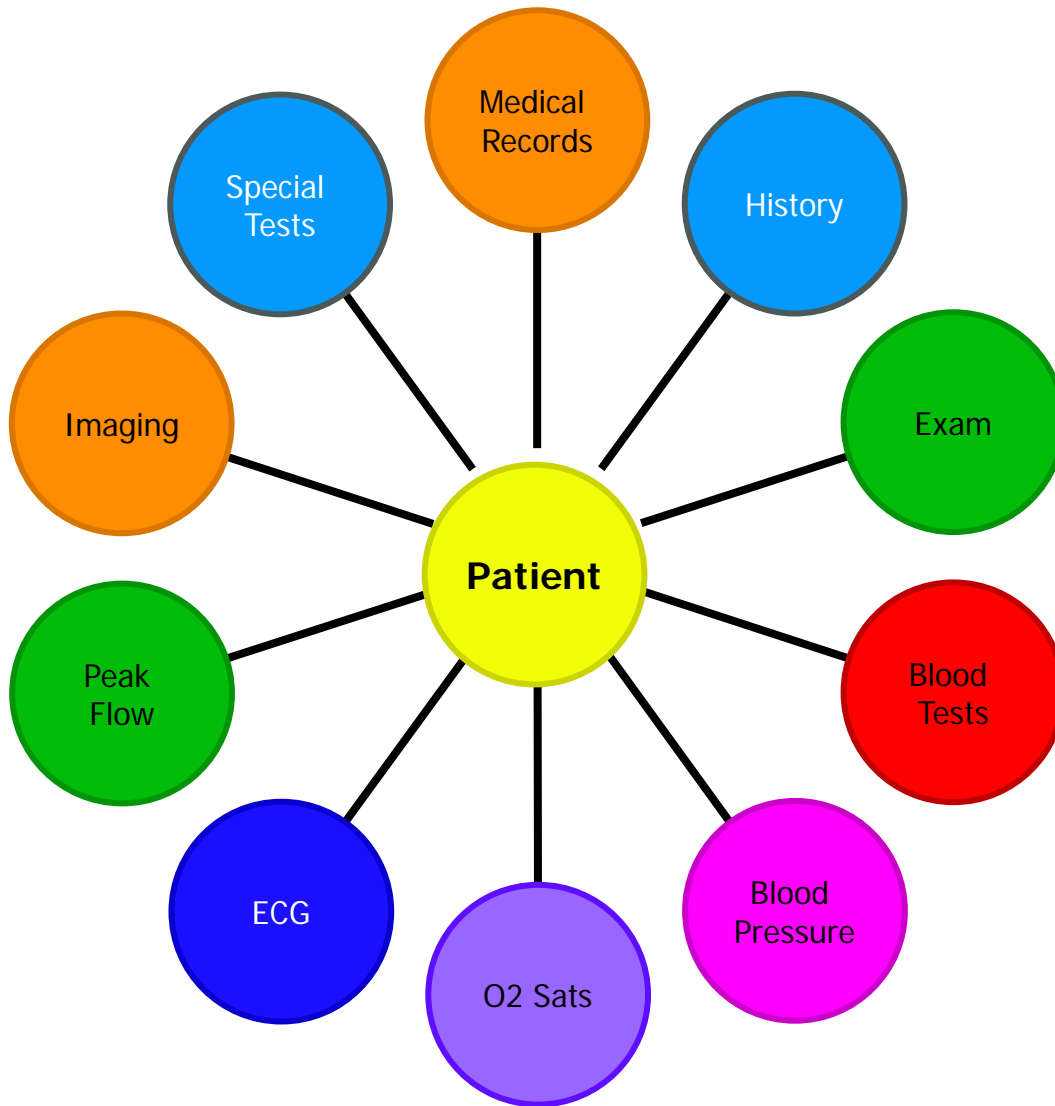
# Technology Advancement: Accelerate Data Explosion



Nature 458, 719-724



# Sensors & Monitoring Tools



Only a **SNAPSHOT** of a patient's health

# Healthcare Case: What Are **Big Data** Challenges?

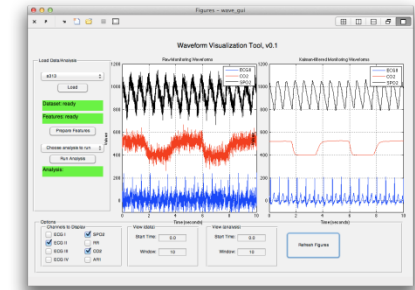
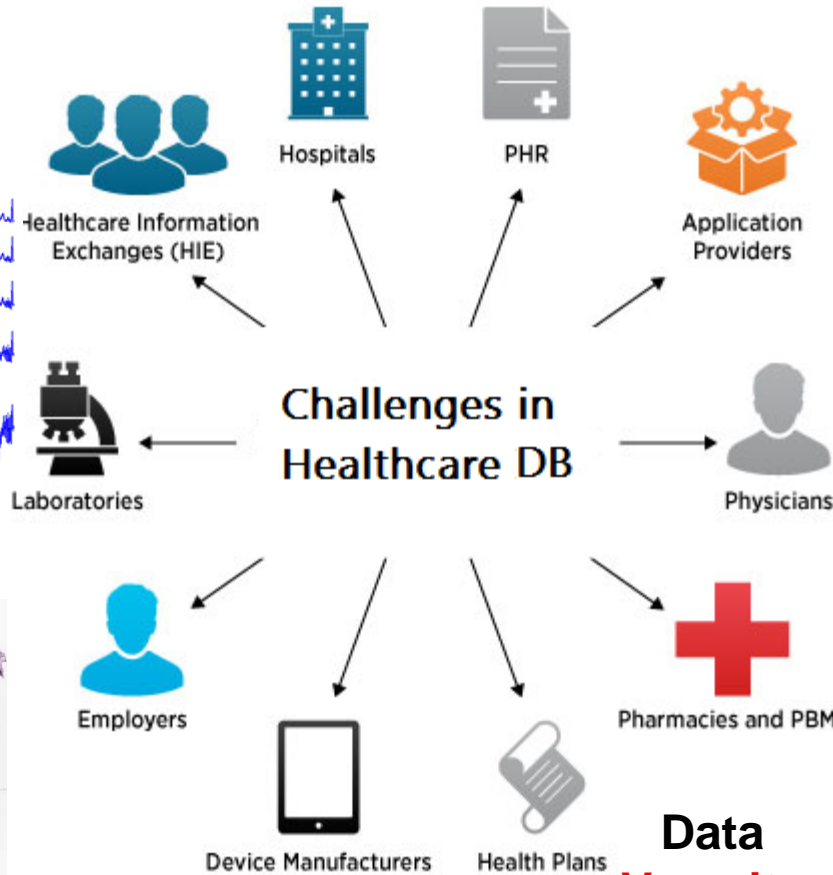
**Data Volumes**

**Data Security and Privacy**

**Data Variety: Integration**

**Multiple Data Sources**

**Challenges in Healthcare DB**



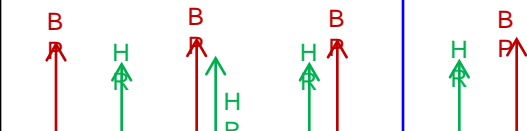
	a	b	c	d	e	f	g	h	i	j
1	0.044218	0.052703	0.050014	0.065004	0.070464	0.069074	0.042758	0.034188	0.044889	0.069898
2	0.052213	0.059495	0.068434	0.079227	0.091303	0.096289	0.215285	0.204214	0.199074	0.095366
3	0.058438	0.064895	0.083359	0.098755	0.120024	0.138277	0.106753	0.270636	0.093508	0.131472
4	0.063694	0.078635	0.099791	0.125664	0.168548	0.202203	0.167049	NA	0.150047	0.184089
5	0.072261	0.088754	0.114974	0.155086	0.216554	0.300849	0.318282	NA	0.260556	0.281371
6	0.075399	0.096025	0.130976	0.185066	0.290089	0.470630	0.884177	1.194673	0.807329	0.471330
7	0.081875	0.103812	0.140768	0.204933	0.380883	0.793022	NA	NA	NA	0.842231
8	0.097937	0.125888	0.170683	0.263682	0.483970	1.262145	NA	NA	NA	0.959375
9	0.095425	0.124800	0.169188	0.256222	0.455050	0.992783	3.811475	NA	NA	0.880478
10	0.047182	0.110146	0.162320	0.226156	0.396969	0.813113	0.923707	1.361367	0.881282	0.493867
11	0.042532	0.104121	0.142186	0.189260	0.278936	0.577036	0.498285	0.542218	0.452789	0.304803
12	0.078097	0.089172	0.110108	0.153305	0.196383	0.245496	0.274543	0.307134	0.296109	0.201095
13	0.066426	0.077618	0.092574	0.122202	0.140490	0.171543	0.184249	0.191360	0.187911	0.140831
14	0.059583	0.072583	0.086635	0.106795	0.120430	0.133944	0.139902	0.143040	0.138708	0.100649
15	0.053329	0.058247	0.062411	0.080967	0.090509	0.099485	0.106845	0.104037	0.099009	0.093850

**Data Velocity**

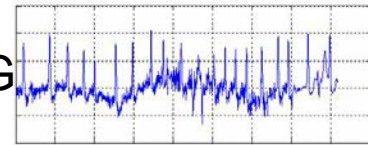
**Data Veracity**

**Different Time for Blood Pressure, Heart Rate and Medication**

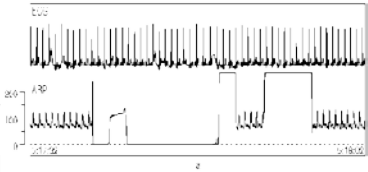
**Medication**



**ECG**



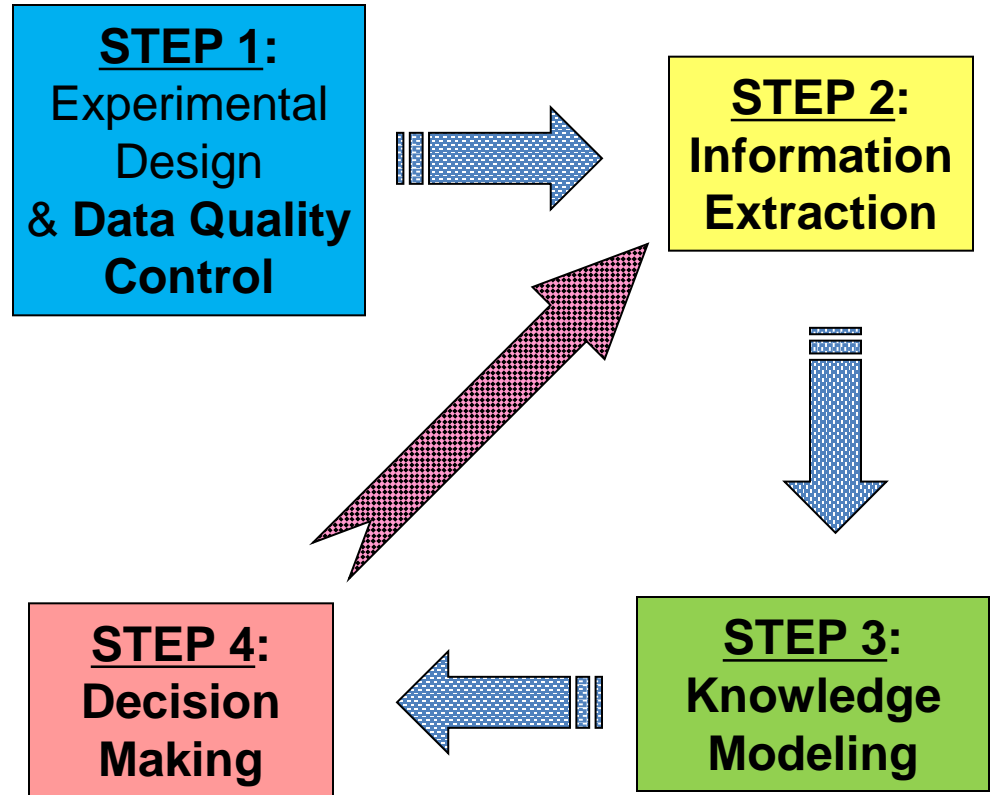
**Arial Blood Pressure**



\*Opus-Telecom UK Journal of Telecommunications

# Science Behind Big Data: Informatics

**Data** →  
**Information** →  
**Knowledge** →  
**Decision** →  
**Action**



## People + Policy

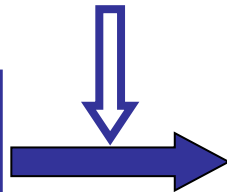


# US National of Academy of Engineering Grand Challenge of the 21<sup>st</sup> Century

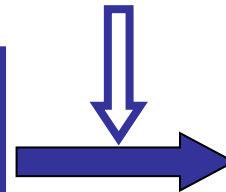
## Advance Health Informatics

**Biomedical and Health Informatics**

Individual &  
Population



Biomedical  
Eng.  
Biotechnology



4P  
Health

**Accelerator, Enabler, Hub**

# Role of Our Community

- Bring engineering to biology
- Build analytic tools and innovative devices
- Turn data into knowledge to stratified patient management
- Influence health and care policy
- Transform clinical practice





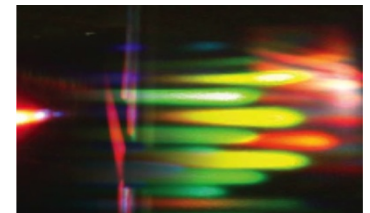
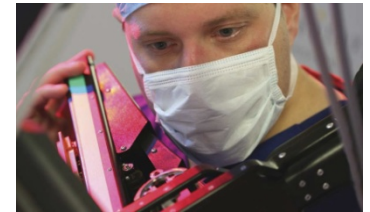
# EMBS Activities in Biomedical Big Data

**Guang-Zhong Yang, PhD, FREng, FIEEE**

Editor-in-Chief, IEEE J Biomedical and Health Informatics

**May D. Wang**, Kavli Fellow, GRA Distinguished Cancer Scholar, IEEE EMBS BHI-TC Chair

**Stephen TC Wong**, BMI Chair of Methodist Institute, IEEE EMBS BHI-TC Co-Chair



# Technical Committee

# EMBS Establishes BHI Technical Committee

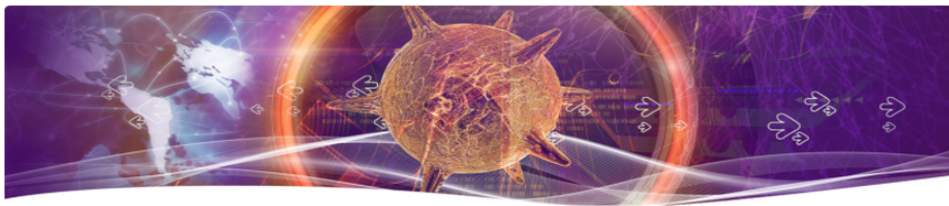
## IEEE ComSoc Student Competition 2014

The theme of the Student Competition 2014 is "Communications Technology Changing the World". The Student Competition Selection Committee includes 40 officers of IEEE and ComSoc and representatives of almost all the ComSoc Technical Committees.

The official announcement from the IEEE Communications Society, with details and the link to the submission form, is posted at the [Student Competition home page](#).

The submission deadline is **extended to 15 September 2014**.

## J-BHI Special Issue on "Big-Data for Health"



### Important Dates:

Deadline for Submission: **29 September 2014**

First Reviews Due: **1 December 2014**

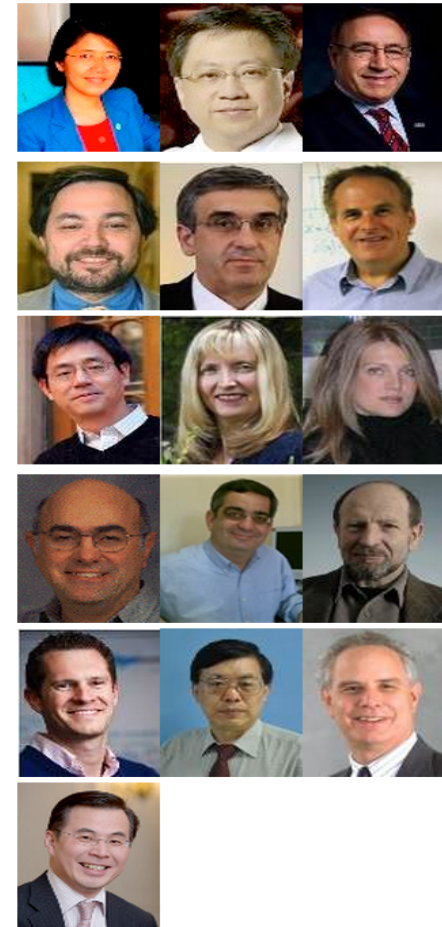
Final Decision: **18 February 2015**

### Scope:

In promoting big-data as a source of innovation in healthcare and accelerating the translational pathways from the laboratory bench to the patient's bedside, the purpose of this special issue is to address the latest technical development and practical applications of big-data for health. Specific focus will be placed on the impact of big-data on bioinformatics, imaging informatics, sensor informatics, medical informatics and public health informatics, including initiatives that enable use of big-data analytics in health systems for improved clinical decision making, enhanced efficiency of care provision, policy development and policy implementation.

Priorities will be given to papers reporting original work supported by large cohort studies with clearly demonstrated clinical translational values supplemented by on-line data sets or algorithms that can be shared by the research community.

## Members



- 1) **For Research Community: News + Conferences + Career Opportunities + Funding Opportunities**
- 2) **For General Public: Recent Publications**
- 3) **For Education: Webcasts and Audiocasts**

# Biomedical and Health Informatics

Basic Research

Biomedical Informatics Methods,  
Techniques, and Theories

**Sensor and Sensor Informatics**

Applied Research  
And Practice

Bioinformatics

Imaging  
Informatics

Clinical  
Informatics

Public Health  
Informatics



# **Mission: Informatics Driven by/Drive Innovation**

## **1) Sensor Informatics**

- Wearable and Implantable Sensors
- Need: Continuous Monitoring Data Analytics

## **2) Bioinformatics**

- \$1,000 Genomes, Low Cost Metabolomics, Metagenomics, etc.
- Need: Highly Reproducible and Reliable Biomarkers in Translation

## **3) Imaging Informatics**

- Novel Imaging Modality for Real-Time Imaging
- Need: Novel Analytics

## **4) Clinical Informatics**

- Multi-Modality, Multi-Temporal Scale, Multi-Spatial Scale
- Need: Quality! Reliable Causality for Decision Support!

## **5) Public Health Informatics**

- Infectious Disease, Aging Population Chronic Condition
- Integration with All Above, and Social Media for Behavior Change

# EMBS Journals related to Big Data in Healthcare



# IEEE Journal of Biomedical and Health Informatics

## Journal EiC:

**Dr. Guangzhong Yang: Fellow of Royal Academy of Engineering, Fellow of IEEE**

—JBHI Special Issue on **“Big Data for Health”**

—TBME Special Issue (Nantia Nikita): Evidence-Based Clinical and Health Informatics

• **Advisory Board of J-BHI: 11 TC Members**

• **Advisory Board of TBME: 3 TC Members**



## IEEE JOURNAL OF BIOMEDICAL AND HEALTH INFORMATICS

A PUBLICATION OF  
THE IEEE ENGINEERING IN MEDICINE AND BIOLOGY SOCIETY  
THE IEEE COMMUNICATIONS SOCIETY  
THE IEEE SIGNAL PROCESSING SOCIETY



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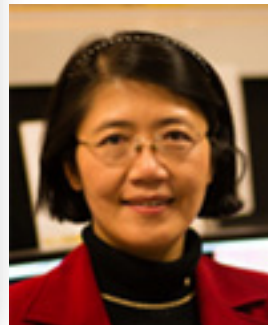
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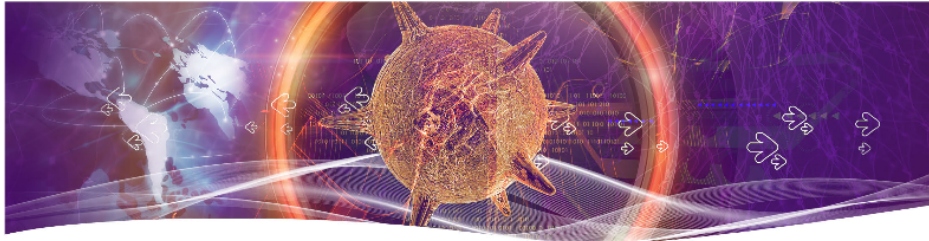
Published in MEDLINE

JULY 2014 VOLUME 18 NUMBER 4 JBHI89 (ISSN 2168-2194)



IEEE





## J-BHI Special Issue on “Big-Data for Health”

### Guest Editors/Editors

**Rifat Atun**  
Harvard University  
ratun@hsph.harvard.edu

**Yves Lussier**  
The University of Arizona  
ylussier@uic.edu

**Stephen Wong**  
Houston Methodist Research  
Institute  
STWong@houstonmethodist.org

**Guang-Zhong Yang**  
Imperial College London  
g.z.yang@imperial.ac.uk

### KEY DATES

**DEADLINE FOR SUBMISSION:**  
29th September 2014

**FIRST REVIEWS DUE:**  
1<sup>st</sup> December, 2014

**REVISED MANUSCRIPT DUE:**  
19<sup>th</sup> January, 2015

**FINAL DECISION:**  
18<sup>th</sup> February, 2015

### Editor-in-Chief:

Guang-Zhong Yang, PhD,  
FREng, FIEEE, FIET, FAIMBE, FIAMBE  
Director & Co-Founder,  
The Hamlyn Centre  
Level 4, Bessemer Building  
Imperial College London  
London SW7 2AZ  
T: +44 (0)20 7594 1499  
F: +44 (0)20 7594 5196

Developments in the fields of biomedical and health informatics are driving major expansion in big-data, not only because of the sheer volume of information generated, but also due to the complexity, diversity, and the rich context of the data that encompasses discoveries from basic sciences to clinical translation, to health systems and large-scale population studies on determinants of health. This general trend also brings socio-legal implications. Whilst technological advances are overcoming many of the traditional barriers for transmitting, storing and sharing information securely, health data is growing faster than healthcare organizations can consume it. Managing, extracting, analysing, integrating, visualising and communicating useful information from the myriad of data generated continuously in real-time in addition to existing biomedical and health information represent major challenges in big-data research. A further important challenge relates to translation of analytical outputs to useful intelligence for more effective clinical decision-making and for policy formulation. New data analytic tools to facilitate scalable, accessible and sustainable data infrastructure for effective management of large, multiscale, multimodal, distributed and heterogeneous data sets and convert data into knowledge for support cost-effective decision aids, disease management, and care delivery need to be developed.

In promoting big-data as a source of innovation in healthcare and accelerating the translational pathways from the laboratory bench to the patient's bedside, the purpose of this special issue is to address the latest technical development and practical applications of big-data for health. Specific focus will be placed on the impact of big-data on bioinformatics, imaging informatics, sensor informatics, medical informatics and public health informatics, including initiatives that enable use of big-data analytics in health systems for improved clinical decision making, enhanced efficiency of care provision, policy development and policy implementation.

The topics of the special issue include, but are not limited to:

- Multiple-omics comparisons and analyses (inclusive of deep sequencing);
- Emerging informatics framework for big-data, as well as programming models and environments to support big-data for health;
- Big data analytics, machine learning algorithms and scalable/parallel algorithms (e.g. including the map-reduce paradigm) for biomedical and health informatics;
- Data fusion, integration, knowledge management and engineering; novel visualisation methods and scalable search architectures;
- Socio-legal and ethical issues related to big data in the context of privacy and security – data preservation, provenance, protection, as well as data integrity and privacy standards and policies;
- Incorporation of behavioural data through pervasive sensing and social media for promoting personal health, disease prevention and population health management;
- Applications of big-data for drug discovery and development, stratified patient management, targeted therapy and minimally invasive surgery, chronic and infectious diseases, outcomes research, coordinated care, environmental health, social health and informatics underpinning major disease management (e.g. neurological disorders, cancer, cardiovascular diseases, diabetes and obesity);
- Big data and analytics for improving management of healthcare institutions to enhance efficiency, effectiveness and equity;
- Novel approaches, with illustrative country case studies on use of big-data and innovative analytical approaches for measuring health system performance, policy analysis and development, and resource allocation.

Priorities will be given to papers reporting original work supported by large cohort studies with clearly demonstrated clinical translational values supplemented by on-line data sets or algorithms that can be shared by the research community.

### Submission of manuscripts

Submitted articles must not have been previously published or currently submitted for journal publication elsewhere. As an author, you are responsible for understanding and adhering to our submission guidelines (<http://jbi.embx.org/for-authors/>). When submitting, authors are requested to choose “Big-Data” in the manuscript type to indicate that the paper is intended for this special issue. The managing editor for coordinating this special issue is Dr Carmen Poon.

# Sept. 29, 2014

# JBHI - Bimonthly Highlights

Home | Journal of Biomedical and Health Informatics

Imperial College London | Home | Journal of Biomedical and Health Informatics

jbhi.embs.org

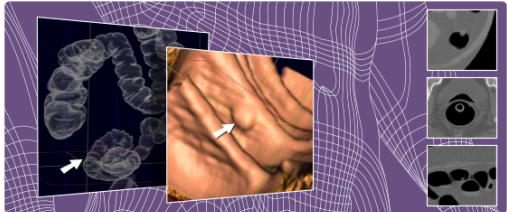
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**EMB** IEEE Journal of Biomedical and Health Informatics  
Retitled from IEEE Transactions on Information Technology in Biomedicine (T-ITB)

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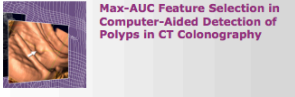
## Featured Article



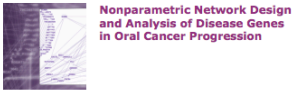
**Max-AUC Feature Selection in Computer-Aided Detection of Polyps in CT Colonography**

A feature selection method based on a sequential forward floating selection procedure is proposed to improve a non-linear SVM (Support Vector Machine) classifier's performance in detection of polyps in CTC (Colonography).


See All Highlights ▶



**Nonparametric Network Design and Analysis of Disease Genes in Oral Cancer Progression**



**Near-Realistic Mobile Exergames With Wireless Wearable Sensors**



**Blind End-Member and Abundance Extraction for Multispectral Fluorescence Lifetime Imaging Microscopy Data**


## About This Journal

**Current Issue | Early Access | JBHI Archive | Popular Articles | Statistics**


IEEE Journal of Biomedical and Health Informatics (J-BHI) publishes original papers describing recent advances in the field of biomedical and health informatics where information and communication technologies intersect with health, healthcare, life sciences and biomedicine. Papers must contain original content in theoretical analysis, methods, technical development, and/or novel clinical applications of information systems.

Retitled from the IEEE Transactions on Information Technology in Biomedicine (T-ITB) in 2013, the J-BHI is one of the leading journals in computer science and information systems with a strong interdisciplinary focus and biomedical and health application emphasis. Topics covered by J-BHI include, but are not limited to: acquisition, transmission, storage, retrieval, management, processing and analysis of biomedical and health information; applications of information and communication technologies to the practice of healthcare, personal well-being, preventive care and early diagnosis of diseases, and discovery of new therapies and patient specific treatment protocols; and integration of electronic medical and health records, methods of longitudinal data analysis, data mining and knowledge discovery tools.

Manuscripts may deal with these applications and their integration, such as clinical information systems, decision support systems, medical and biological imaging informatics, wearable systems, body sensor networks, informatics in biological and physiological



**Call for Papers: Special Issue on Unobtrusive Assessment of the Mechanical Aspects of Cardiovascular Performance**



**Call for Papers: JBHI Special Issue on Telehealth Systems and Applications**

**EMB** IEEE Journal of Biomedical and Health Informatics  
Retitled from IEEE Transactions on Information Technology in Biomedicine (T-ITB)

IEEE



[JBHI Home](#) | [Editorial Board](#) | [Research Highlights](#) | [Early Access](#) | [Submission](#)

## Call for Papers - Upcoming Special Issue

- Telehealth Systems and Applications**  
Deadline: 31 March 2014
- Unobtrusive Assessment of the Mechanical Aspects of Cardiovascular Performance**  
Deadline: 1 May 2014

## J-BHI 2014 March Issue Highlights

### Max-AUC Feature Selection in Computer-Aided Detection of Polyps in CT Colonography

J.-W. Xu and K. Suzuki  
Volume 18, Issue 2, Page: 594-605

A feature selection method based on a sequential forward floating selection procedure is proposed to improve a non-linear SVM (Support Vector Machine) classifier's performance in detection of polyps in CTC (Colonography). [Read More](#)

### Nonparametric Network Design and Analysis of Disease Genes in Oral Cancer Progression

K. Kalantzaki, E. S. Bei, K. P. Exarchos, M. Zervakis, M. Garofalakis, and D. I. Fotiadis  
Volume 18, Issue 2, Page: 562-573

This paper proposed a framework for constructing and analyzing gene-networks from sparse temporal data with the aim of understanding the mechanisms which affect the progression of oral cancer. [Read More](#)

### Near-Realistic Mobile Exergames With Wireless Wearable Sensors

B. Mortazavi, S. Nyamathi, S. I. Lee, T. Wilkerson, H. Ghasemzadeh, and M. Sarrafzadeh  
Volume 18, Issue 2, Page: 449-456

This paper presents a framework for the development of 'Exergaming' (the combination of exercise and video gaming) using body-worn sensors. Instead of mapping movements to existing games, the proposed framework captured real sports movements using body-worn sensors to form the basis for the design of a realistic game. [Read More](#)



# EMBS Sponsors 12 Journals

- Transactions on ...
  - **Biomedical Engineering** (since 1964; forerunner since 1948)
  - Neural Systems and Rehabilitation Engineering (1993)
  - **NanoBioscience** (2002)\* EMBS lead
  - Medical Imaging (1982)\* 4 way lead share
  - **Comput. Biology & Bioinformatics** (2004)\* (CompSci Lead)
  - Biomedical Circuits and Systems (2007)\* (Circuits Lead)
  - Computational Imaging (new for 2015)\* (Signal Processing Lead)
- Reviews on Biomedical Engineering (2008)\*
- Journal on ...
  - **Biomedical and Health Informatics** (1997)
  - **Translational Engineering in Health & Medicine** (2013 open access)
- **IEEE Life Science Letters**\* – new for 2015 (LSTC lead)
- IEEE PULSE – a magazine for Students of All Ages
- IEEE also publishes Transactions on Ultrasonics and Transactions on Nuclear Sciences each with 25% biomedical content

\* Joint sponsorship

## TBME ranked top 5 according to H-index among 118 biomedical engineering journals

Ranking	Journal	H-index
1	Nature Biotechnology	265
2	Biomaterials	196
3	IEEE Transactions on Medical Imaging	131
4	Physics in Medicine and Biology	113
<b>5</b>	<b>IEEE Transactions on Biomedical Engineering</b>	<b>107</b>
6	Annual Review of Biomedical Engineering	80
7	Journal of Biomedical Materials Research- Part A	78
8	Journal of Biomechanical Engineering	77
9	Annals of Biomedical Engineering	73
10	Medical Image Analysis	69

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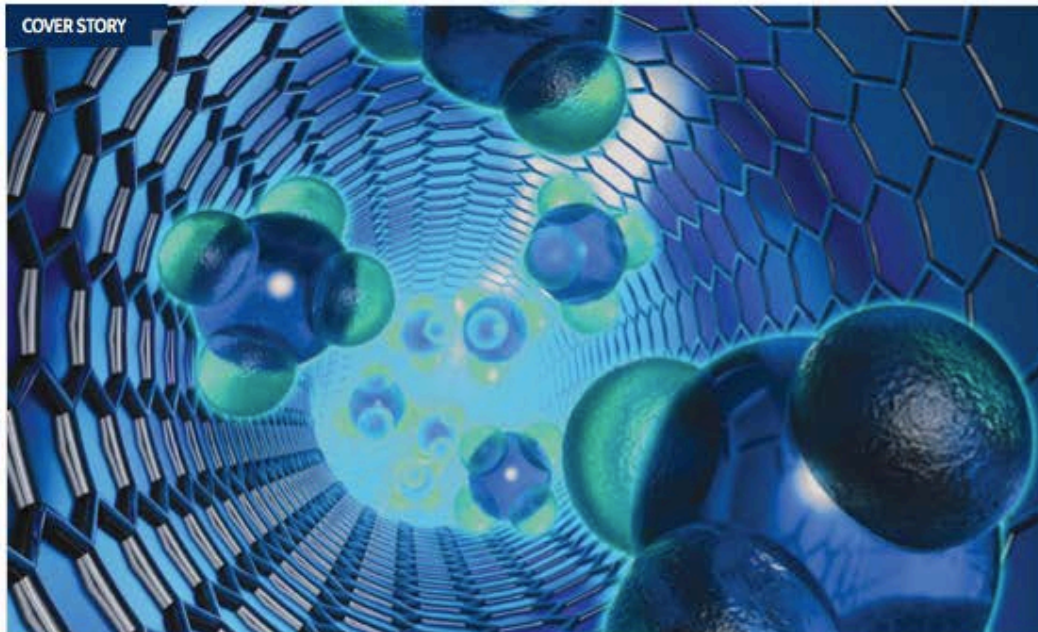
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## Current Issue

<http://pulse.embs.org/>

COVER STORY



## How Nanomaterials Are Reshaping Biomedical Technology

FEATURED



## At the Interface of Disciplines

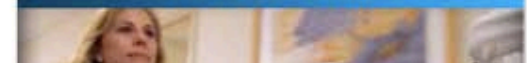
Shannon Fischer | March 13, 2014 | 0 Comments

Five years ago, Jeffrey Karp sat down to a dinner party with Massachusetts General Hospital dermatologist R. Rox Anderson.....

[Read more](#)

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FUJIFILM



# EMBS Conferences

Special Topic  
Conferences Related to  
Big Data Analytics



# EMBS Steering Committee and TC for BHI



Yuan-Ting  
Zhang



Paolo  
Bonato



Metin  
Akay



Carolyn  
McGregor



May D.  
Wang



Dimitrios  
Fotiadis



Andre  
Laine



Stephen  
Wong



Guang-Zhong  
Yang

- **Organizing the BHI' 2014 June 1<sup>st</sup> – 3<sup>rd</sup>, 2013**
  - July 2013: 3 EMBS members join organizing committee: **Drs. Fotiadis, Laine, Akay**
  - Aug. 2013: Monthly Conf. Calls → Help implement **best-practice for Special Topic Conf using NeuEng. STC,**
  - Nov. 2013: **BHI' 2014 website** CfP correction by Dr. Fotiadis
  - Nov.2013: Finalize **keynote speakers**
  - Dec. 2013: Extended paper submission deadline Dec. 9<sup>th</sup>, 2013 to Jan. 22<sup>nd</sup>, 2014
  - Jan. 2014: 250 Paper Submission, 210 Accepted
  - Feb 2014: EMBS **J-BHI, JTEHM Special Issues** BHI' 2014,
  - Mar. 2014: Elsevier journal special issue CBM pending
  - Mar.2014: around 40 1-page submissions
  - April 2014: Fund raising **2,000 Euros**
  - Registered **Attendees: 265**



Dr. Nigel Lovell  
Dr. Bruce Wheeler



# IEEE EMBS Special Topic Conferences, BHI 2014

## Biomedical and Health Informatics'2014 Organizing Team

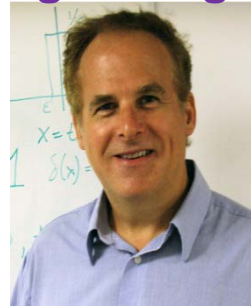
Dr.  
Sergio  
Guillen  
Barrio  
nuevo



Dr. Vicente Traver  
Salcedo



Dr. Dimitrios Fotiadis



Dr. Andrew Laine



Dr. Maria Teresa  
Arredondo



Dr. Metin Akay

## Highlight of Programs:

- 6 Keynote Speakers, <http://bhi.embs.org/2014/>
- 15 Invited Speakers for 11 BHI-TC and J-BHI Sponsored Sessions
- Young Researcher Program (Rapid Fire, Presentation, Meeting with EiCs, How to Write Papers, etc.)
- **Initiating Valencia EMBS Student Chapter**

## Actions:

- Special Issue for Journal of Biomedical and Health Informatics (13 out of 250 invited)
- Special Issue for Journal of Translational Engineering in Health and Medicine (19 out of 250 invited)
- BHI' 15 with IFMBE (In Asia, Tentatively Fall 2015)

# Coming Soon

- **BHI 2015 – Fall 2015, likely Shenzhen, China**  
(IFMBE, with EMBS co-sponsorship)
- **BHI 2016 – Feb 2016, Las Vegas**  
(just before **HIMSS**; IFMBE co-sponsor)

# QUALCOMM TRICORDER XPRIZE<sup>®</sup>

The \$10 Million Global  
Competition to Put Healthcare  
in the Palm of Your Hand.



# IEEE EMBC 2014: **X-Prize**



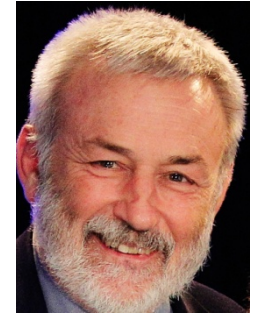
**Prof. Guang-Zhong Yang, FREng, FIEEE**  
Editor-in-Chief,  
IEEE J Biomedical and  
Health Informatics



**Rick Valencia,**  
**Senior Vice**  
**President and**  
**General Manager**



**Grant Company,**  
**Senior Director,**  
**XPRIZE**



**Prof. Bruce C. Wheeler**  
President, IEEE EMBS,  
Professor of BME  
Univ. of Florida



**Prof. dr. sc. Ratko Magjarevic**  
Electrical Engineering and  
Computing University of  
Zagreb, Croatia  
President of IFMBE



**Prof. Shuming Nie**  
Coulter Distinguished Chair Prof  
Dept of BME, Emory University  
and Georgia Institute of  
Technology



**Prof. Rashid Bashir**  
Abel Bliss Prof. of Eng. and  
Head, Dept. of Bioengineering  
and ECE, Univ. of Illinois  
at Urbana-Champaign



**Prof. Yuan-Ting Zhang**  
The Chinese University  
of Hong Kong and  
the HICAS, China.



# EMBS Supports Global Conferences on Big Data



**CISP'13-BMEI'13**

**16-18 Dec 2013, Hangzhou Normal University**

**6<sup>th</sup> Int'l Conf on BioMedical Engineering and Informatics**



# IEEE HI-POCT Conference 2014

IEEE Healthcare Innovation  Point-Of-Care Technologies  
Conference



# EMBS Special Topic Conferences

- **Intl Symposium BioMedical Imaging (ISBI)** Beijing, San Francisco, Barcelona, Chicago, Rotterdam, Boston, Paris, Washington, Arlington
- **Neural Engineering** San Diego, Capri, DC, Cancun, Hawaii, Turkey
- **Biomedical Circuits and Systems** Lausanne, Rotterdam, Taiwan, San Diego, Cyprus, Beijing, Baltimore, Montreal, London
- **Healthcare Innovations Conference** Bethesda, Washington, Houston, Seattle
- **Point-of-Care Healthcare Technologies** Bangalore
- **Grand Challenges in Biomedical Engineering**
  - Washington (3), Singapore
- **Biomedical and Health Informatics** Greece, China, Spain
- **Biomedical Imaging** Barcelona, San Francisco, Beijing
- **Biorobotics** Rome, Sao Paulo
- **Micro/Nano Engineering in Medicine** Hawaii
- **Rehabilitation Robotics** Seattle Zurich

*First Student Run EMBS Conference in Cairo, Egypt  
October 2013 240 attendees*



# Cross-Society Partnerships

EMBS is one of the most connected  
Societies within IEEE

# Collaboration with Other IEEE Societies in BME

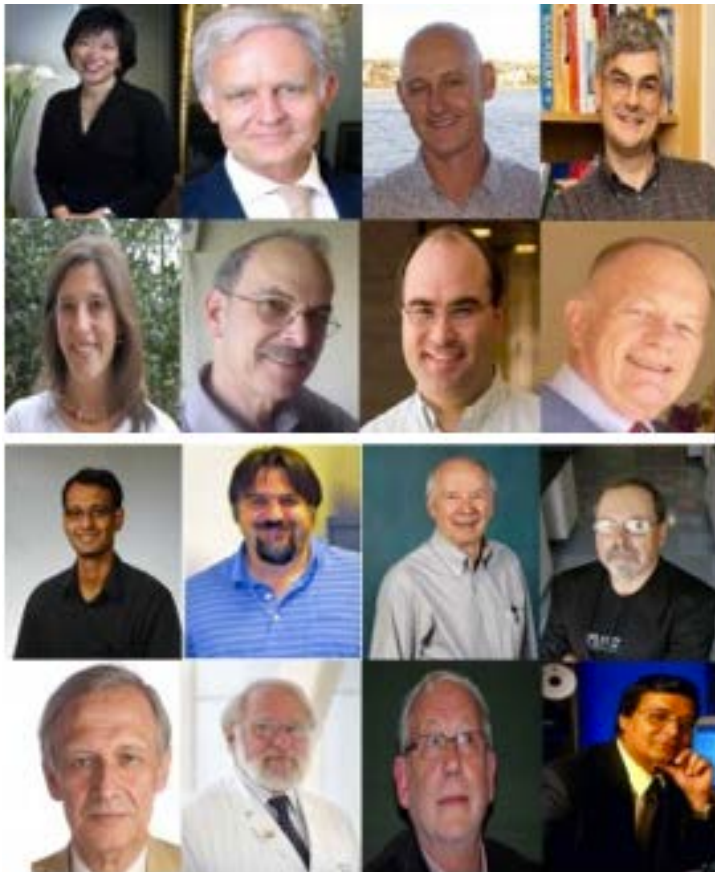
- Ultrasonics – journal plus conferences
- Signal Processing – share imaging journal and conference
- Nuclear – share imaging journal
- Computer – share Bioinformatics Journal
- Circuits – share BioCircuits journal, cosponsor conferences
- Communications –share conferences, co-developing journal
- Microwave – developing shared journal
- Life Sciences – journal, Grand Challenge mtgs, newsletter
- Biometrics Council – on-line journal/newsletter
- Computational Intelligence – share journal
- Consumer Electronics – developing tracks at conferences

# Topic Specific EMBS Partnerships with IEEE Sister Societies

- 1) EMBS-Computer Society: IEEE T-Computational Biology and Bio-Medicine
- 2) EMBS-SPS (Genomic Signal Processing)
- 3) EMBS-Communications (BHI)
- 4) EMBS-LSI (Life Sciences Initiative):

# Technical Committee on Computational Biology and the Physiome – Grace Peng (Chair)

## Technical Committee on Computational Biology and the Physiome



# EMBS with Other Societies: Big Data

- 1) EMBS-HIMSS (Intelligent Hospital, Co-Localize BHI' 16)
- 2) EMBS-IFMBE (2015 Conference in Aisa)
- 3) EMBS-Wireless-Life Sciences Alliance: Julien Penders
- 4) Wearable Sensors and BSN (EAI, IFMBE, Indep Org): Guangzhong
- 5) EMBS-AMIA (2014 Jeff Williamson)
- 6) EMBS-Genome Alliance
- 7) EMBS-Dataplooza

# EMBS Summer Schools

Training the next generation of  
Data Scientists in Healthcare Analytics

# EMBS Summer Schools

*One week immersion courses for graduate students with expert instructors*

International Summer Schools on ...

- ... Biomedical Imaging (France)
- ... Biomedical Signal Processing (Italy)
- ... Biocomplexity and Biodesign (Turkey)
- ... Medical Devices and Biosensors (Hong Kong)
- ... Information Technology in Biomedicine (Greece)
- ... Neural Engineering (Shanghai) – *New!*
- ... Telemedicine (Slovakia) – *New!*



# EMBS Summer Schools: Health Big Data

## 1) Aisa:

Hongkong – Sensor and Sensor Health Informatics

## 2) Europe-Aisa:

Turkey – Global Health Informatics

## 3) Europe:

Slovakia – Mobile Health Informatics

Finland – Behavioral Health Informatics

## 4) South America:

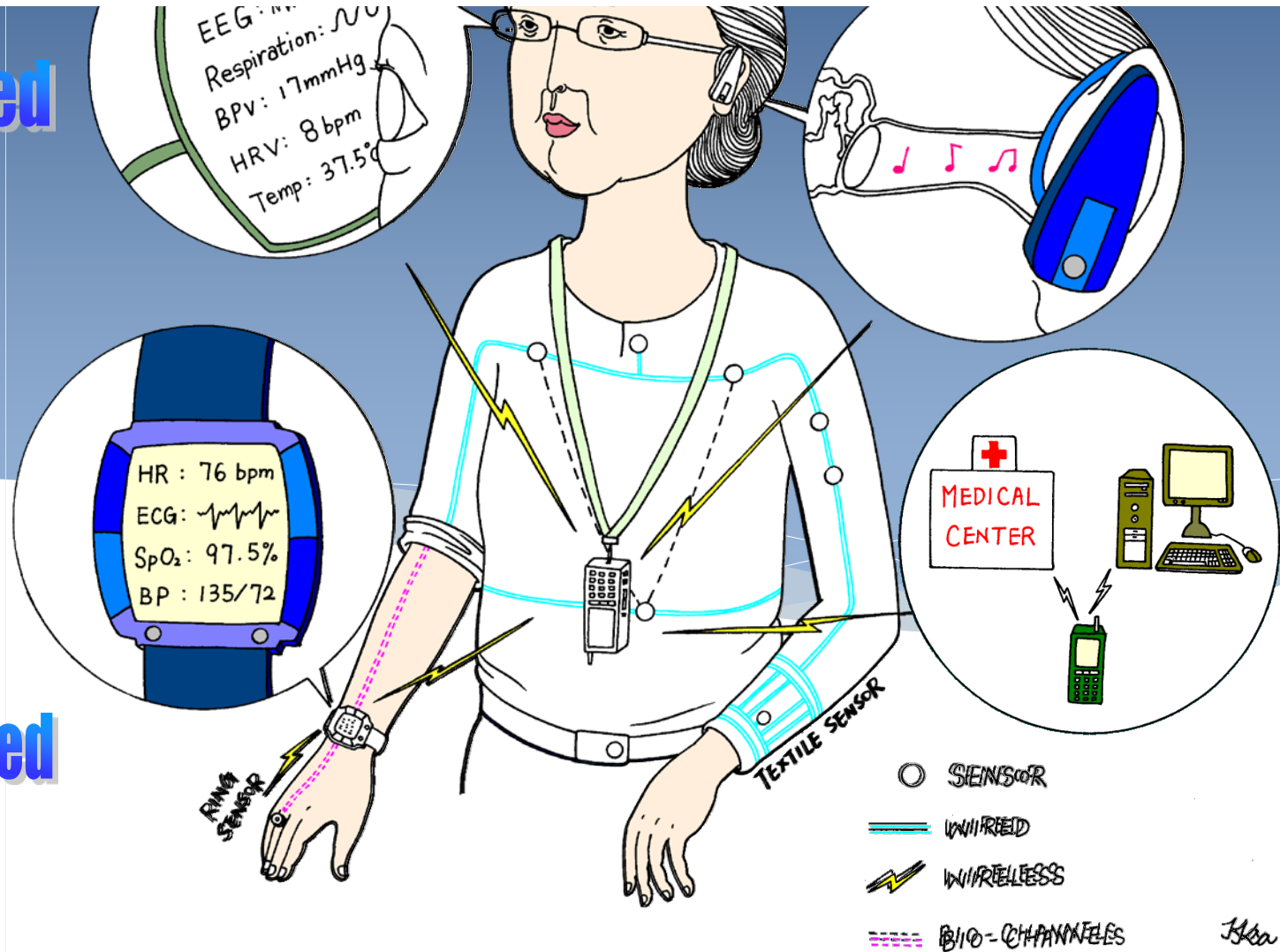
Chronic Health Informatics

# **EMBS Patents and Standards**

Impact on building  
Wellness Infrastructure

# New Meaning to Personalized: Wearable BSN Systems

**M**iniaturised  
**I**ntelligent  
**N**etworked  
**D**igitalised  
**S**tandardised





**Prof. Yuan-Ting Zhang, PhD \***

- Title: Professor and Director
- Affiliation: Joint Research Center for Electrical Engineering, The Chinese University of Hong Kong, and the Key Lab for Health Informatics of the Chinese Academy of Sciences (HICAS) at SIAT, Shenzhen, China
- Contact: [ytzhang@ee.cuhk.edu.hk](mailto:ytzhang@ee.cuhk.edu.hk)
- Weblink: <http://www.bme.cuhk.edu.hk/~ytzhang.html>

# **First IEEE Standard on Wearable Cuffless Blood Pressure Measuring Devices (P1708)**

## **2014 IEEE-SA Emerging Technology Award**

\* Dr. Zhang holds the fellowships from the International Academy of Medical and Biological Engineering (IAMBE), the Institute of Electrical and Electronics Engineers (IEEE), and the American Institute of Medical and Biological Engineering (AIMBE) in recognition of his outstanding contributions to the development of wearable medical devices and mobile health technologies.

# Big Data Gives New Meaning to Pervasive

**Billions of mobile devices**

**+ Billions of sensors**

**+ Billions using social networks**

**=**

**Unprecedented opportunities for population-level sensing**



twitter



Kevin Patrick, Measuring Personal Health with Mobile Devices to Study Gene-Environment Interactions. Talk at NSF Workshop Population Health, Jan 12-13, 2012. Washington DC. Available at <https://wiki.engr.illinois.edu/display/hi+workshop/NSF+Workshop+Population+Health>.

facebook

# *New Meaning to Personalized:*

## *Genomics and Environment*

### NIH Exposure Biology Program

**"Genes load the gun; environment pulls the trigger"**

– Francis Collins, MD, PhD

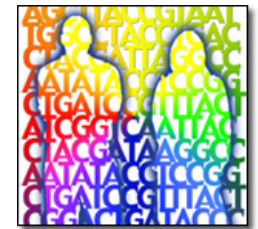
## Environmental Sensors

- **Diet/Physical Activity**
- **Chemicals/Biologics**
- **Psychosocial Stress/Addictive Substances**



**DEVICES**

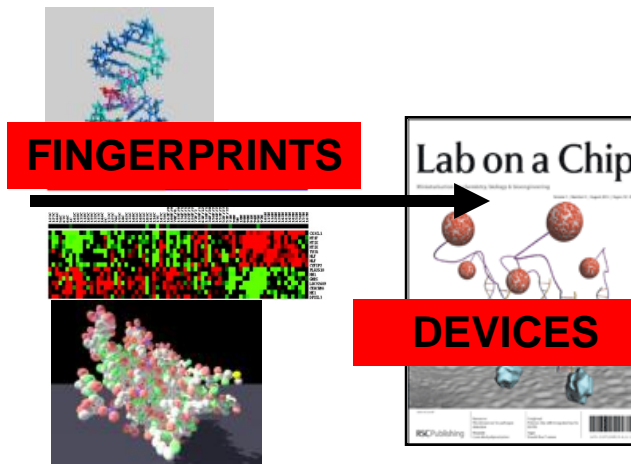
**APPLICATION**



## Genome Wide Association

## Biological Response

- **Biomarkers**
- **Centers–biomarkers/biosensors**
  - **Inflammation**
  - **Oxidative stress**
  - **Programmed cell death**
  - **Epigenetic markers**



**FINGERPRINTS**

**DEVICES**

Kevin Patrick, Measuring Personal Health with Mobile Devices to Study Gene-Environment Interactions. Talk at NSF Workshop Population Health, Jan 12-13, 2012. Washington DC. Available at <https://wiki.engr.illinois.edu/display/hiworkshop/NSF+Workshop+Population+Health>.



# New Meaning to Predictive: Advanced Medical Informatics Opportunities in Medical Imaging Informatics

SOFTWARE

## The computer will see you now

BY KATHERINE BOURZAC

S92 | NATURE | VOL 502 | 31 OCTOBER 2013

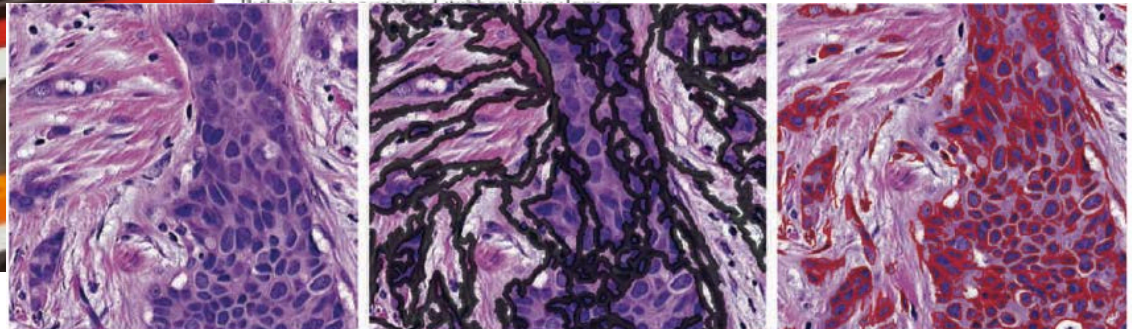
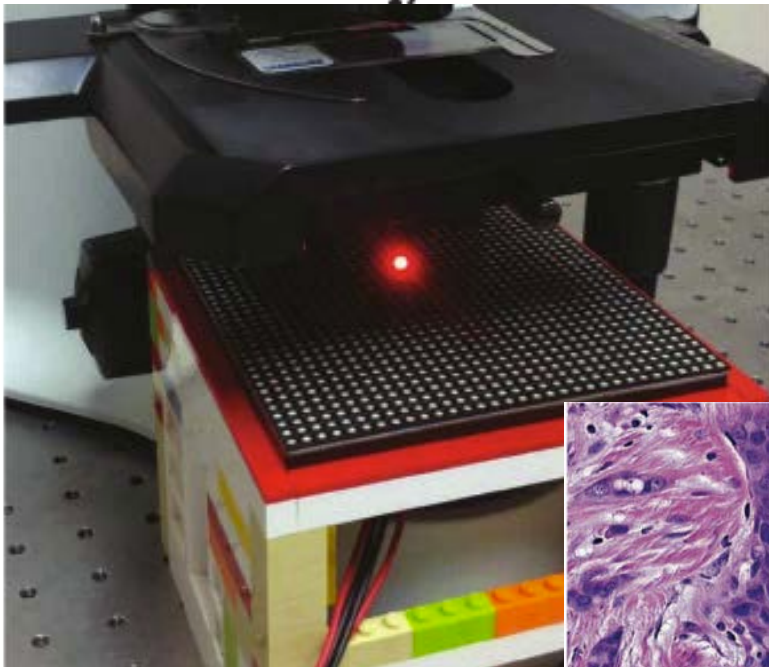
starting to change. Just as lenses once revealed vistas that were previously invisible to the human eye, so software is opening up a new window on biology.

The latest digital tools make it possible to do a visual search in microscopy images, automate diagnosis, and sync image data with the genomic profiles of tumours. Some researchers are even doing away with lenses altogether, creating computational microscopes based on inexpensive hardware that could be used for point-of-care diagnostics, particularly in poor areas with few doctors.

Breast cancer image is analyzed to predict patient's prognosis

BIG DATA

OUTLOOK MEDICAL IMAGING



Breast cancer image at X200 magnification (left) is broken down into superpixels (black) by an algorithm before it predicts the patient's prognosis.

# **Global Funding Opportunities for Biomedical Big Data**

One World: Joining forces

# 10 Disruptive Forces in Healthcare

Shideh Sedgh Bina, Insigniam, 2014

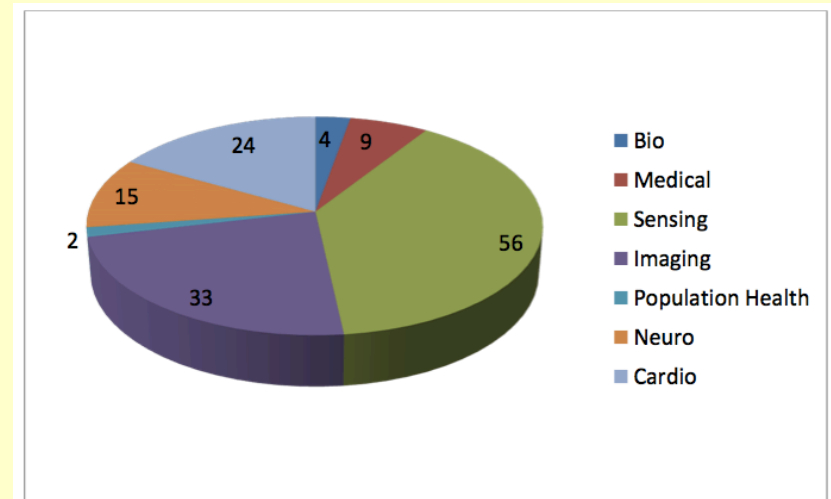
- Transition to value-based reimbursement: provide more affordable, higher quality care at lower reimbursement rates
- Shifting volumes and lower reimbursements
- **Moving from caring for sick individuals to managing the health of a population**
- **Advances in health information technologies**
- **Acceleration in introduction of digital health tools, advanced medical technology and medical models**
- Shifting demographics: older, more diverse, larger income disparities, greater access
- Projected provider shortages
- **More informed and involved patients**
- Increasing government regulation
- Shrinking availability of capital

# Global Connectedness / Opportunities

1. European Union:  
FP7, and Health2020  
Brain Mapping
2. USA: National Institutes of Health - **Big Data to Knowledge (BD2K)**
3. UK: Medical Research Council
4. Asia: China Minister of Science and Technology (MoST) 973 Projects

## ■ Integrated Informatics

- 1) Data Fusion
- 2) Data to Knowledge
- 3) Knowledge to Decision
- 4) Decision to Action



# New Dimensions to Big Data

- Curation and Management
- Infrastructure
- Performance Analyses
- Semantics
- Standards
- Data Visualization
- Security, Privacy, Legal Issues
- Data Analytics and Intelligence from Big Data
- Scientific Discovery from BD
- Applications of BD



Mark Guyer. NIH and Biomedical 'Big Data'. Presentation to BD2KTraining Workshop. July 29, 2013. Available at <http://www.genome.gov/pages/extranets/bd2ktraining/>

May Wang. Making Sense of Big Biomedical Data by Integrated Data Analytics for Personalized Health Care. Talk given at US Turkey Advanced Study Institute on Global Healthcare Grand Challenges, Antalya, June 16-20, 2013.

# Summary of IEEE/EMBS in Big Data Health:

## Challenges and Opportunities



# EMBS Focus in Biomedical and Health Informatics

## Linking Three Elements of BHI:

- Sensors to Signals ... to
- Big Data ... to
- Intelligence in Support of Health Decisions
- *Builds on IEEE and EMBS Strengths in Technology and in the Interpretation of Biomedical Data*

**Spectacular Area for our Students and Members  
to have a Huge Impact on our World**

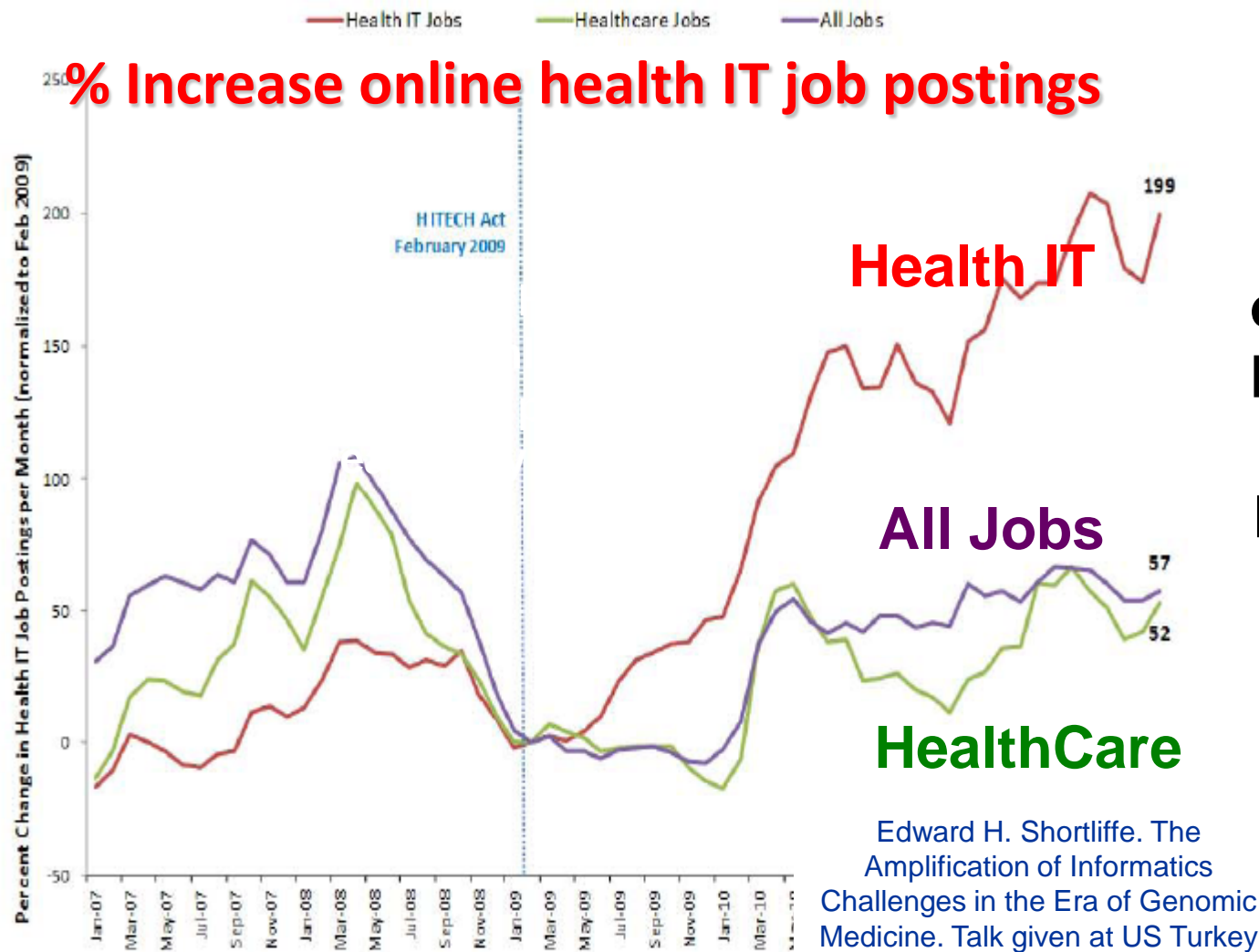
# Biomedical/Health Informatics Exploits the Enormous Strengths in

- **Electrical Engineering**
- **Computer Engineering**
- **Computer Science**
- **Industrial Engineering**
- **Biomedical Engineering**

## IEEE Life Science Community

EMBS is supporting its members, recruiting new members, and collaborating world wide

# Health IT Expanding Rapidly



SOURCE: ONC analysis of data from O'Reilly Job Data Mart

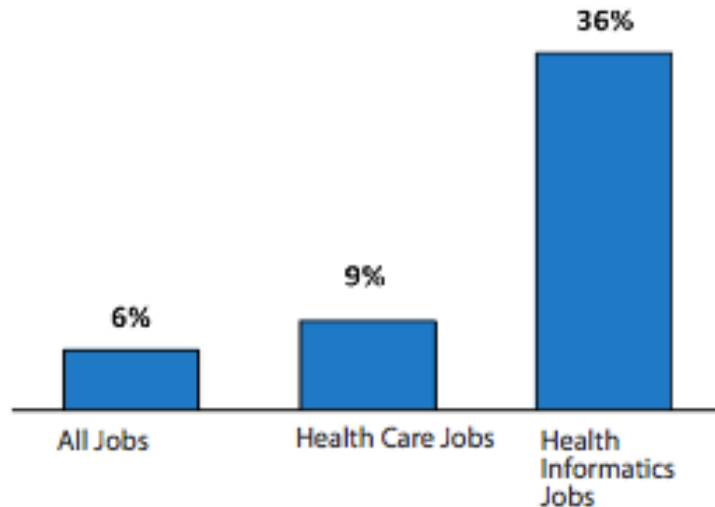
From ONC Databrief 2 May 2012

**USA: Number of Health IT Job Postings/Month Equals Entire BME Job Market**

Edward H. Shortliffe. The Amplification of Informatics Challenges in the Era of Genomic Medicine. Talk given at US Turkey Advanced Study Institute on Global Healthcare Grand Challenges, Antalya, June 16-20, 2013.

# Employment: Growth is Very Broad and Strong

Job Listing Growth 2007 - 2011



**US Bureau of Labor Statistics: IT jobs in health care expected to increase by **20% annually****

Computerworld Aug 4, 2011

[http://www.computerworld.com/s/article/9218753/Healthcare\\_industry\\_leads\\_market\\_in\\_IT\\_hiring?taxonomyId=132&pageNumber=1](http://www.computerworld.com/s/article/9218753/Healthcare_industry_leads_market_in_IT_hiring?taxonomyId=132&pageNumber=1)

**HIMSS Meeting in New Orleans: 1200 vendors, 35,000 attendees**

## **A Growing Jobs Sector: Health Informatics**

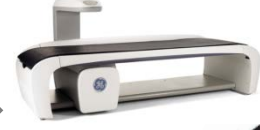
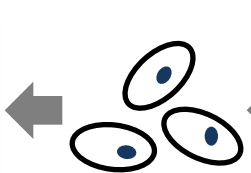
Burning Glass Technologies, June 2012

<http://www.jff.org/publications/education/growing-jobs-sector-health-informatics/1432>

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	A	B	C	D	E	F	G
1	chr	1	5.250	223.6	48.6	108.6	
2	chr	2	5.208	228	50.7	115.6	
3	chr	1	5.375	163.8	25.2	41.2	
4	chr	2	5.375	164.4	26.9	44.2	
5	chr	3	5.333	162.4	25.9	42	
6	chr	5	5.332	154.4	24.3	37.6	
7	chr	1	5.375	164	27.3	44.4	
8	chr	1	5.625	248	40.5	122.8	
9	chr	2	5.625	247.6	49.7	123	
10	chr	3	5.792	252.6	38.4	97	
11	chr	1	5.790	239	36	86	
12	chr	2	5.792	238.4	33.1	79	
13	chr						

**Integrated Personal Omics Profile**

**Integrated Personal Clinical Profile**

## Omic Information

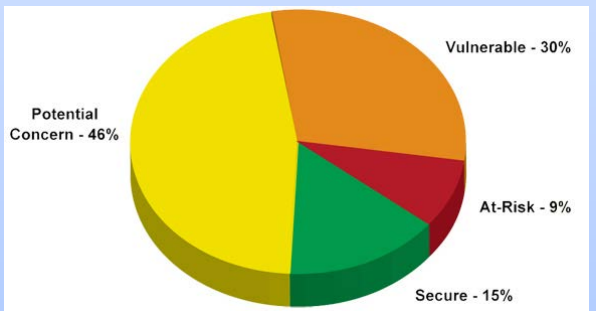
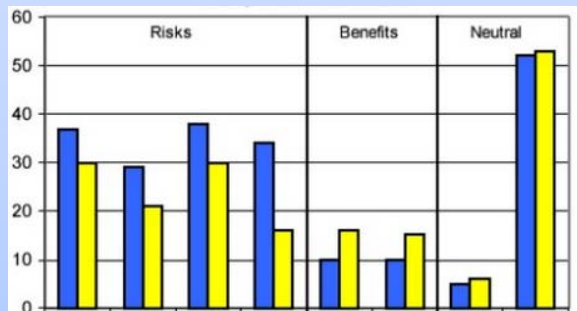
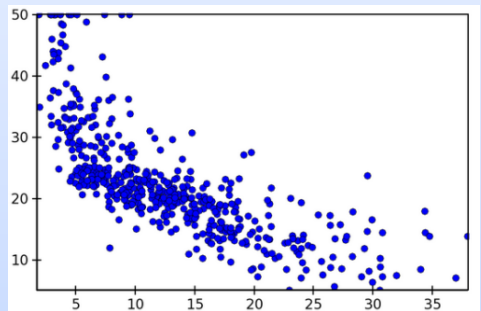
- Transcriptomics
- Genomics
- Transcriptomics
- Epigenomics
- Proteomics
- Metabolomics

## Clinical

- Questionnaires
- Assessments
- Laboratory Tests

## Chronic Condition:

xxx



**Summary, Score, and Recommendation**

# Thanks for Slides and Thoughts from

- May Wang
- YT Zhang
- Ed Shortliffe
- Metin Akay
- Guang-Zhong Yang
- Bruce Schatz: NSF Workshop on Population Health (multiple contributors)
- NIH: BD2KTraining Workshop



# Passion and Impact of Engineering in Medicine and Biology:

## Big Data for Health and Humanity

“It’s a Great Time for all the Flavors of Big Data  
in Biomedical and Health Informatics”

Thanks for listening!