Weill Cornell Medicine

Big Data Course for Computational Medicine

mHealth and Participatory Medicine

Fernando Martin-Sanchez PhD, FACHI, FACMI
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Department of Healthcare Policy and Research

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hpr.weill.cornell.edu

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Environmental and Participatory Health Informatics
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Outline

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General description of the module

3

Participatory technologies and the individual exposome

2

Intro to Participatory Medicine

4

Participatory Medicine Informatics

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General description of the module

Fernando Martin-Sanchez PhD, FACHI, FACMI

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- Assistant Professor (interim) Division of Health Informatics, Dept. of Healthcare Policy and Research
- Environmental and Participatory Health Informatics (ENaPHI) Research Group
- PhD in Informatics, PhD in Medicine, MSc in Knowledge Engineering, BSc Molecular Biology and Biochemistry
- Joined Weill Cornell in December 2015
  - Professor and Chair of Health Informatics, Melbourne Medical School (2011-2015)
  - Director, Health and Biomedical Informatics Research Centre, (HaBIC) the University of Melbourne (2013-2015)
  - Head of Dept. Medical Bioinformatics. National Institute of Health Carlos III of Spain. (1998-2010)

- Research interests: biomedical data integration, participatory health informatics, exposome informatics, precision medicine

→**Email: fem2008@med.cornell.edu**

mHealth and Participatory Medicine

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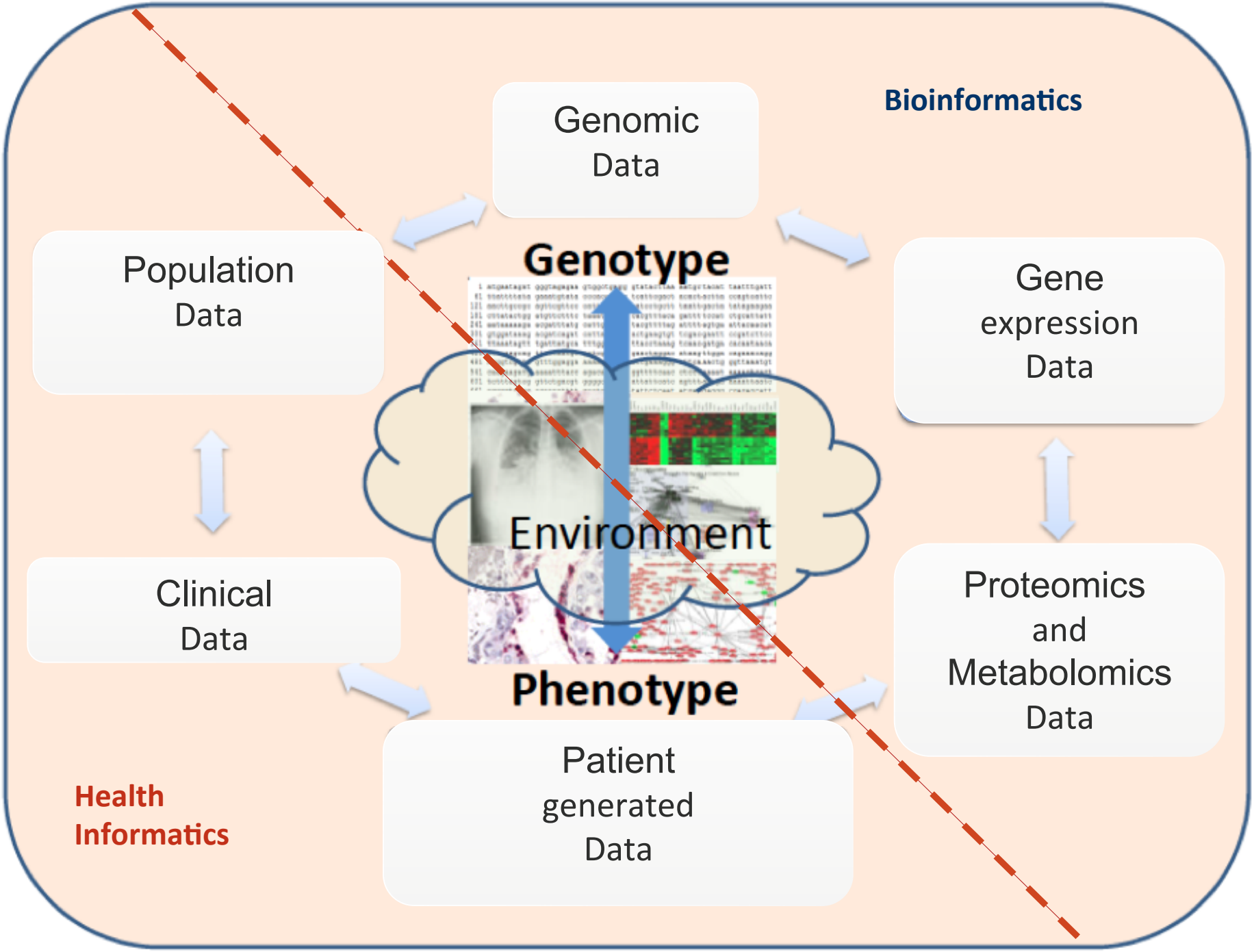
- **Digital health** (participatory) technologies
  - smartphone apps,
  - personal sensing devices,
  - direct-to-consumer e-services
  - social media

accessible and affordable for individuals

- Health Informatics is moving into new territories, beyond provider-generated clinical data - PGHD (**Patient-generated health data**)
  1. Monitoring of *individual environmental health risk factors*. **Exposome**
  2. **Participatory Medicine**
- This module will examine how participatory health technologies and informatics can contribute to generate richer and more robust **data sets for biomedical and clinical research** about health conditions, health interventions, and health outcomes.
- These new sources of individual **big and small data** (continuous, comprehensive and personalized) pose great challenges for Health Informatics and will require new approaches to data collection, storage, standardisation, integration, analysis and visualisation.


Bioinformatics
Genomic Data
Population Data
Gene expression Data
Genotype
Environment
Phenotype
Clinical Data
Proteomics and Metabolomics Data
Patient generated Data
Health Informatics

Person-Generated Health Data

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- Gregory Abowd (2011) predicted "*within 5 years, the majority of clinically relevant data...will be collected outside of clinical settings*."
- PGHD—health-related data created, recorded, or gathered by or from individuals to help address a health concern
- **Individuals are responsible for recording data and decide how to share it (Personal Health Data)**

Potential Benefits	Challenges
•Personalized/ preventative medicine •Reduction of unnecessary patient visits and/ or hospital admissions •Easy and continuous monitoring •A cheap treatment for many chronic diseases	•Verifying measurement validity •Lack of standardization (interoperability) •Specific challenges for clinicians •Specific challenges for patients •Financial and technical •Legal

Mark Liber

Key Features	Framingham Heart Study	Precision Medicine Initiative Cohort Program
Year Started	1948	2016
Number of Individuals	5,209*	1,000, 000
Age	30-62	All
Ancestry	>95% European	Diverse, cross-section of Americans
Medical data obtained	Every 2 yrs at office visit	Real world, real time, via mobile devices, Web
Focus	Heart disease	All medical conditions, health
Data return to participants	No	Yes
Data available for research community	No	Yes

* Initial cohort

Dr. Eric Topol

A different way to recruit research participants

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- For a recent breast cancer study, epidemiologist Kathryn H. Schmitz of the University of Pennsylvania sent out 60,000 letters—and netted 351 women. Walking each participant through the paperwork took 30 minutes or more. Such inefficient methods of finding test subjects have been the norm for medical research.
- Apple, working with Stanford University School of Medicine, developed MyHeart Counts, an app for monitoring cardiac health. Within the first 24 hours, 10,000 participants signed up for the study.
- Kelton and Makovsky Health -fifth annual “Pulse of Online Health” found that 66 percent of Americans would use a mobile application to manage health-related issues.
- The patient’s voice has largely been missing from most of the design and the focus of clinical studies (Ken Mandl, Harvard).
- Citizen science, participatory health

Contents

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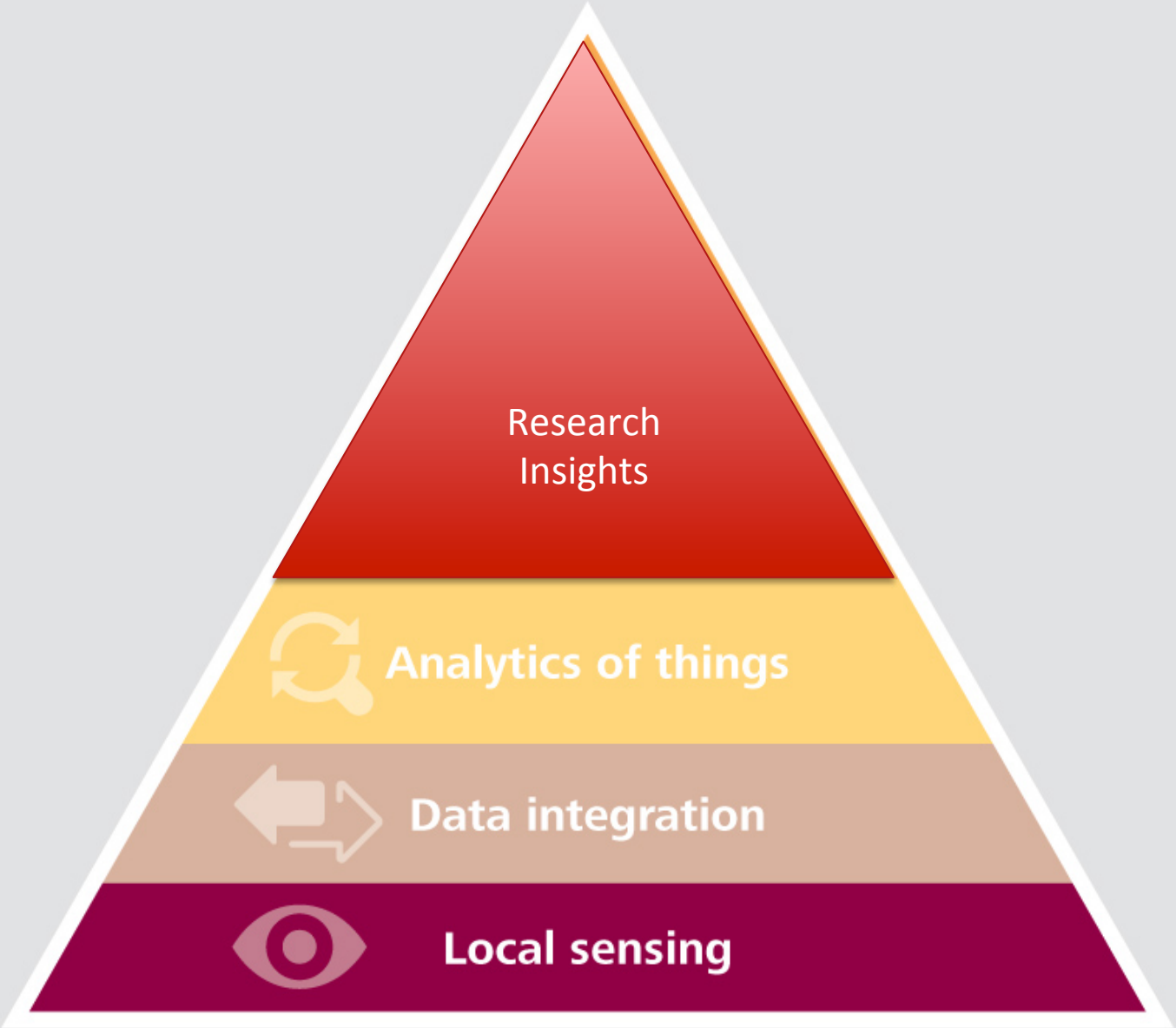
- Introduction to Participatory Medicine
- Participatory technologies and the individual exposome (mobile Health and the Self-Quantification as new sources of Big -and Small- data)
- Participatory Health Informatics
  - **From Sensors to information**
    - Data collection
      - ✓ Hardware (sensors, portable devices, smartphones)
      - ✓ Software (Apps, Healthkit, Carekit, ResearchKit, ResearchStack)
    - Data storage
    - Data aggregation and integration (Apple Health, Validic, Shimmer, Open mHealth, ohmage-omh, Wolfram Connected Devices project, Samsung ARTIK Cloud, Qualcomm Life, Human API, EHR integration aspects)
  - **From Information to Knowledge**
    - Data access
    - Data analysis
    - Data visualization
  - **From knowledge to Application (relevant initiatives)**
    - Health eHeart study, Google Baseline, 100K Wellness Project, Precision Medicine Initiative, Health Data Exploration and Network, mPower study, Open Humans, N-of-1 (single subject) studies, BD2K Centers of Excellence (emobilize, MD2K)

Figure 1. The Internet of Things "stack"



Graphic: Deloitte University Press | DUPress.com

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Introduction to Participatory Medicine

Current challenges in Medicine

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- Need of earlier diagnosis
- More personalized therapies
- Clinical trials and the development of new drugs need to be faster and more effective
- Improve disease classification systems
- Risk profiling, disease prediction and prevention
- Control health system costs
- Citizens should take more responsibility for the maintenance of their own health.

→**Emphasis on prevention, not cure**

Personalised medicine

↓

Precision medicine

↑

Participatory Health

Conference PHC

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To offer a forum to learn and discuss how health informatics and information technologies can be successfully applied to encourage individuals to play a more active role in their health.

This will enable cooperative models of care that have the potential to contribute to more preventive approaches, better disease management, health promotion and control of health system costs.

hic2014

Participatory Health Conference

Improving YOUR HEALTH using technological advances and information

11 August 2014 Melbourne Convention & Exhibition Centre

Also Known As…

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- Personalized preventive health maintenance
- Participatory medicine
- Patient-centric care
- Democratization of health information

The Convergence of the Digital Revolution and Medicine

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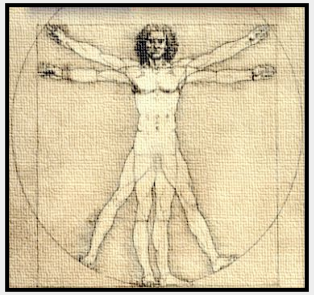
- We are witnessing the impact of the digital revolution in other domains (banking, insurance, leisure, government, …)
- **Although digital technology has greatly affected healthcare at the hospital or research centre level.**
- The digital revolution has not yet reached medicine at the patient/citizen level

- THIS IS STARTING TO HAPPEN NOW !!!



Availability of devices, sensors, apps, DTC services and Social Networks

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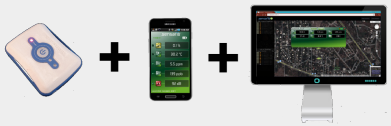
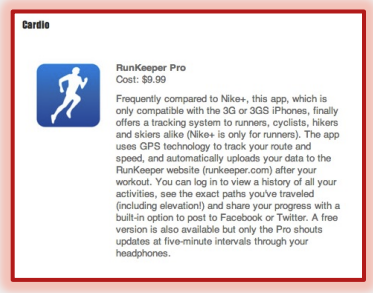
Wearables

DTC lab tests



Sensors

Apps



History of Participatory Health

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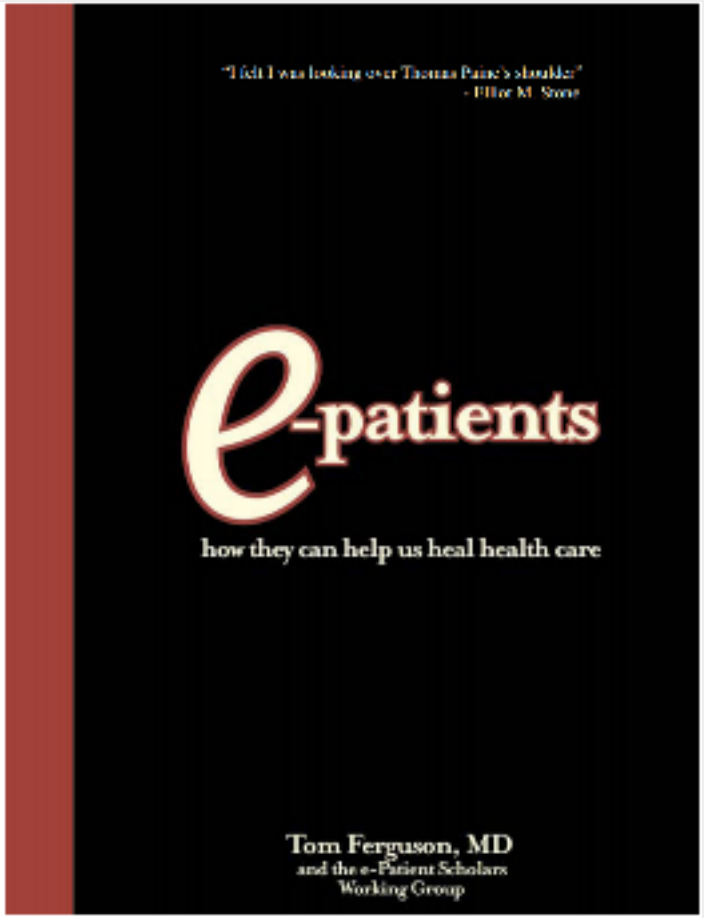
- Tom Ferguson MD (died in 2006)
- Coined the term e-patient
- "*e-patient: how they can help us to heal health care*"

e-patients.net
because health professionals can't do it alone



History of Participatory Health

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- September 2009 – California Healthcare Foundation Report: *"Participatory Health: Online and Mobile Tools Help Chronically Ill Manage Their Care"*
- *"Partnership between patients and providers and trusted experts, one in which participation is enabled and enhanced by technology and information"*

- *"Patients are the most under-utilized resource, and they have the most at stake. They want to be involved and they can be involved. Their participation will lead to better medical outcomes at lower costs with dramatically higher patient/customer satisfaction"*

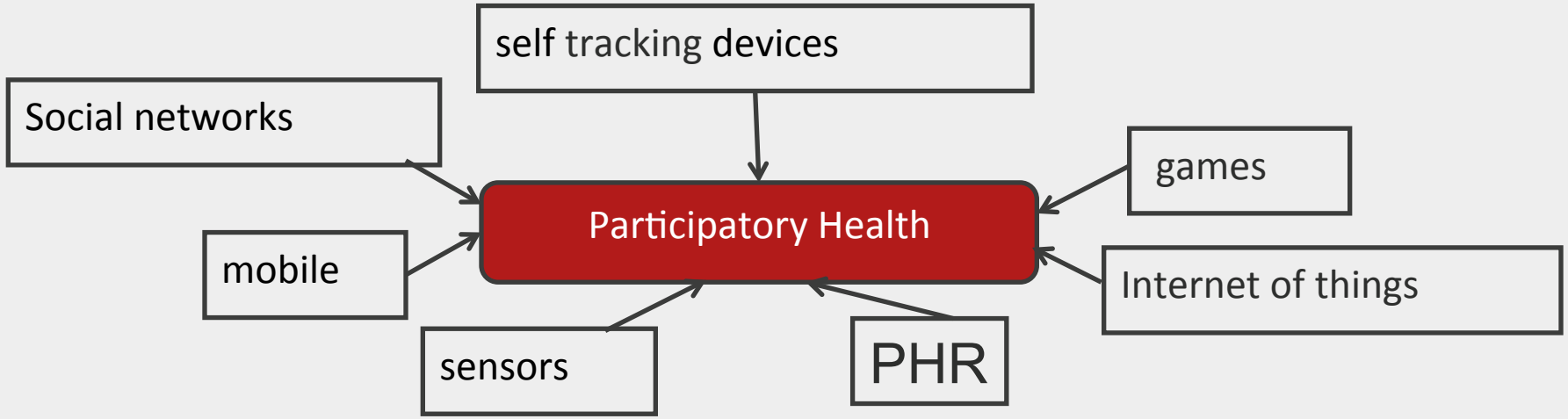
Charles Safran MD

History of Participatory Health

2009. → Patients empowered, informed and involved in decision making, prevention and learning

Society for Participatory Medicine

Journal of Participatory Medicine



Definition

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Regina Holliday

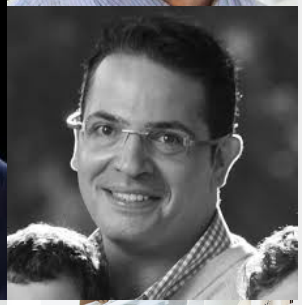
Society for Participatory Medicine

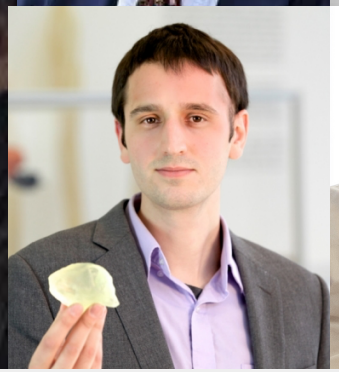
"Movement in which networked patients shift from being mere passengers to responsible drivers of their health, and in which medical care providers encourage and value them as full partners".

E-patients

- Gimme my damn data!
- The patient will see you now…
- Let patients help
- Nothing about me without me!

- Dave de Bronkart
- Regina Holliday
- Hugo Campos
- Salvatore Iaconesi
- Stephen Keating
- Sonia Vallabh & Eric Minikel
- Stephen Damiani
- Matt Might





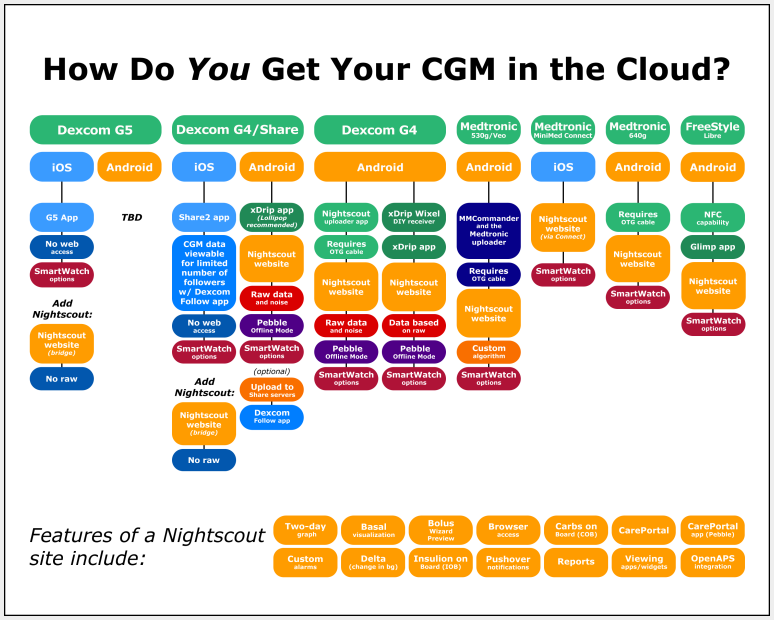
Casey Quinlan
@MightyCasey

I for one threw privacy overboard like a dead cat by planting this on my chest (PW protected, tho) #hcsmca

Reply ★ Favorite Buffer ••• More HootSuite

NIGHTSCOUT
#WeAreNotWaiting

Nightscout (CGM in the Cloud) is an open source, DIY project that allows real time access to a CGM data via personal website, smartwatch viewers, or apps and widgets available for smartphones.



Dana Lewis and her husband Scott Leibrand invented the Do It Yourself Artificial Pancreas System (#DIYPS)

She then took it a step further, founding the #OpenAPS movement to make safe and effective basic Artificial Pancreas System technology more widely available (and sooner).

IOM Workshop & Report 2013

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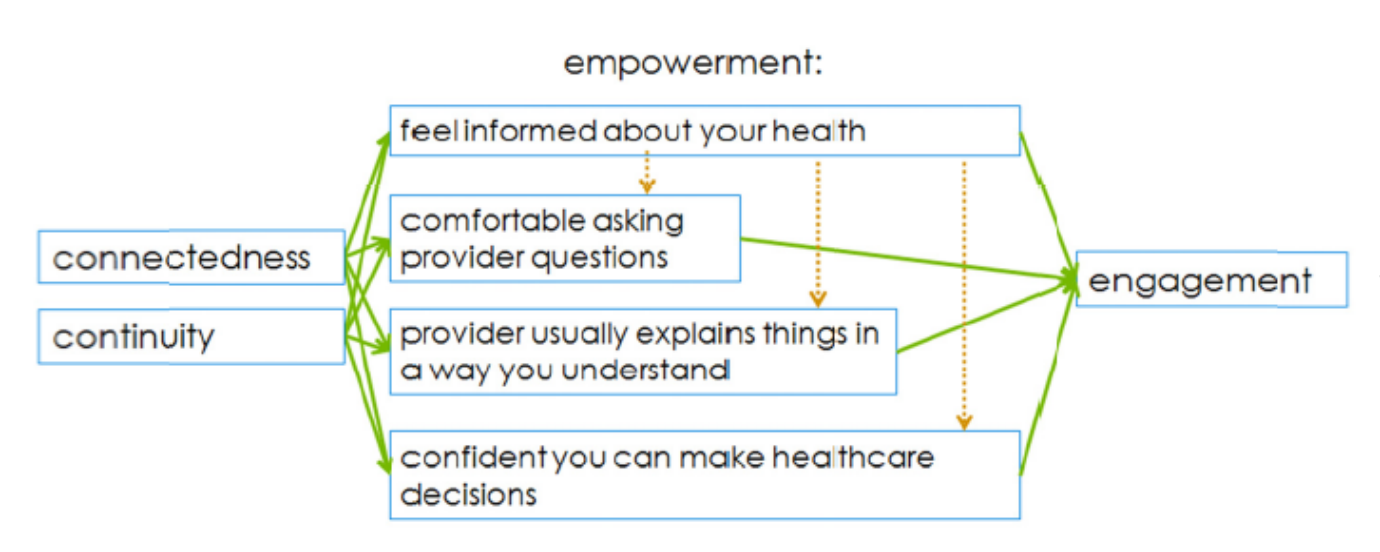
Partnering with Patients to Drive Shared Decisions, Better Value, and Care Improvement - Workshop Proceedings



Shared decision making

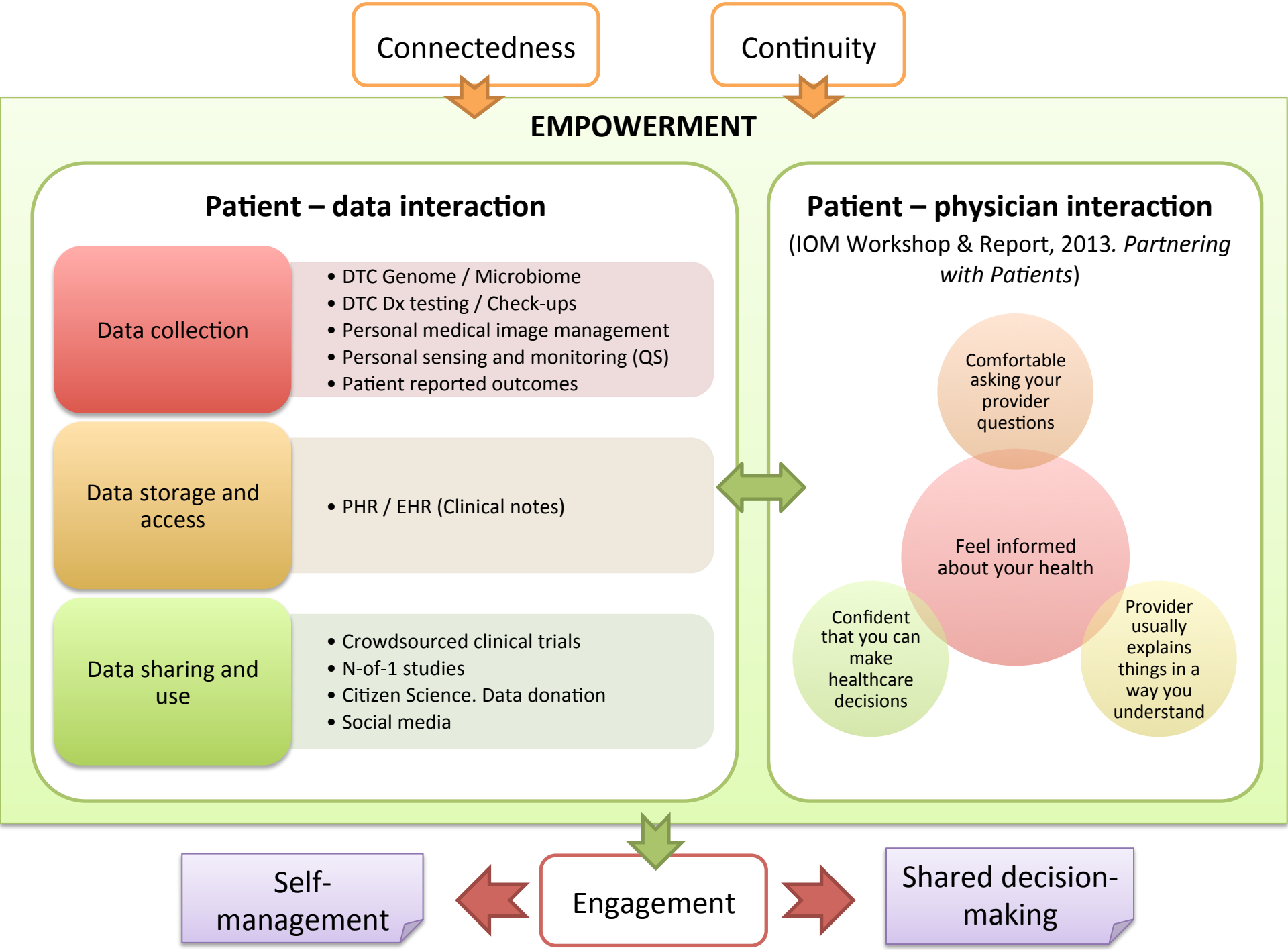

Connectedness
Continuity
EMPOWERMENT
Patient – data interaction
Data collection
• DTC Genome / Microbiome
• DTC Dx testing / Check-ups
• Personal medical image management
• Personal sensing and monitoring (QS)
• Patient reported outcomes
Data storage and access
• PHR / EHR (Clinical notes)
Data sharing and use
• Crowdsourced clinical trials
• N-of-1 studies
• Citizen Science. Data donation
• Social media
Patient – physician interaction
(IOM Workshop & Report, 2013. Partnering with Patients)
Comfortable asking your provider questions
Feel informed about your health
Confident that you can make healthcare decisions
Provider usually explains things in a way you understand
Self-management
Engagement
Shared decision-making

Table 1
Some examples of validated questionnaires capturing (aspects of) patient empowerment

Measure	Conditions-specific or generic?	Construct operationalised	Reference
Patient Enablement Instrument	Generic	Aspects of perceived control over illness	Howie et al. 1998 [19]
Patient Activation Measure	Generic	Activation levels (skills, knowledge, and beliefs needed by patients to self-manage, collaborate with healthcare providers and maintain their health)	Hibbard et al. 2005 [20]
The Empowerment Scale	Conditions-specific: Mental healthcare	Self-efficacy, power-powerlessness, community activism, righteous anger, and optimism-control over the future	Rogers et al. 1997 [21],
Diabetes Empowerment Scale	Conditions-specific: Diabetes	Self-efficacy	Anderson et al. 2000 [22]
Patient Empowerment Scale	Conditions-specific: Cancer	Use of coping resources, an aspect of personal control	Bulsara et al. 2006 [23]
Genetic Counselling Outcome Scale	Conditions-specific: Genetic conditions	Perceived personal control (cognitive, decisional and behavioural control), hope and emotional regulation	McAllister et al. 2011 [24]

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Medicine

Research and events

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Health 2.0

JMIR

Quantified Self
self knowledge through numbers

Medicine X
THE INTERSECTION OF MEDICINE AND EMERGING TECHNOLOGIES

Patients Included

Interest from Governments

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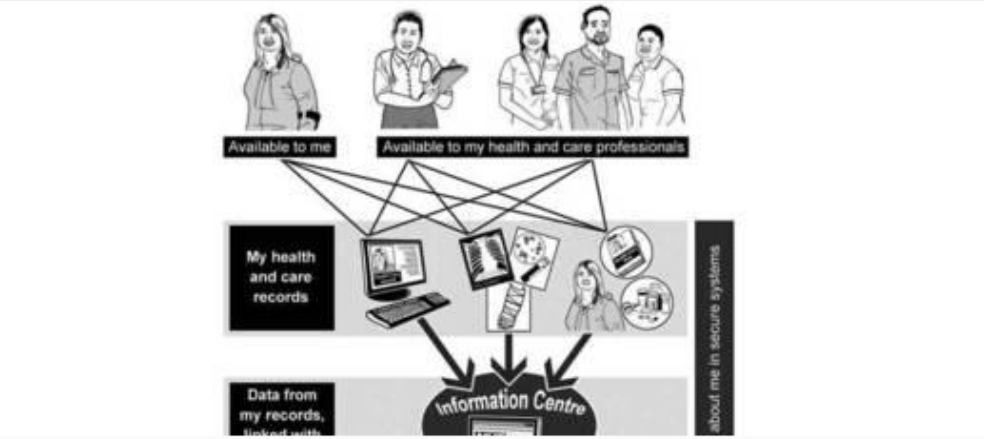
pcornet

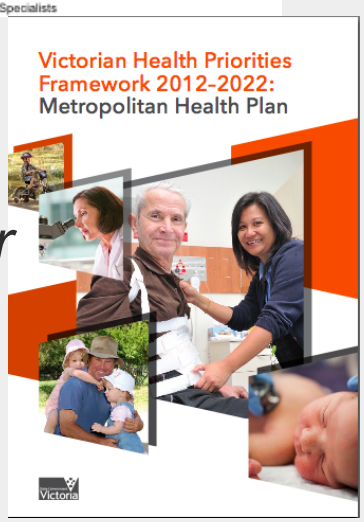
pcori
PATIENT-CENTERED OUTCOMES RESEARCH INSTITUTE

Australian PCEHR myHealth Record



New NHS Information strategy emphasises patient-centric healthcare records

People are managing their own health better.



Personal Genomics & Microbiome

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23andMe

Martin Varsavsky | Account | Help | Blog | Log out

Search

My Home
Inbox (1)

My Health
Disease Risk
Carrier Status
Drug Response
Traits
Health Labs

My Ancestry
Maternal Line
Paternal Line
Relative Finder
Ancestry Painting
Global Similarity
Ancestry Labs

Sharing & Community
Compare Genes
Family Inheritance
23andMe Community
Genome Sharing

23andWe
Research Surveys (21)
Research Snippets

disease risk

Share my health results with family and friends

Show results for Martin Varsavsky

See new and recently updated reports »

23andWe Discoveries were made possible by 23andMe members who took surveys.

Elevated Risk

Name	Confidence	Your Risk	Avg. Risk	Compared to Average
Atrial Fibrillation	★★★★	46.9%	27.2%	1.73x higher risk
Type 2 Diabetes	★★★★	36.1%	23.7%	1.53x higher risk
Prostate Cancer ♂	★★★★	23.6%	17.8%	1.32x higher risk
Colorectal Cancer	★★★★	7.4%	6.1%	1.22x higher risk
Restless Legs Syndrome	★★★★	2.5%	2.0%	1.25x higher risk
Ulcerative Colitis	★★★★	1.4%	0.8%	1.79x higher risk
Crohn's Disease	★★★★	0.8%	0.5%	1.50x higher risk
Esophageal Squamous Cell Carcinoma (ESCC) new	★★★★	0.4%	0.4%	1.21x higher risk
Stomach Cancer (Gastric Cardia Adenocarcinoma) new	★★★★	0.3%	0.2%	1.22x higher risk
Alopecia Areata	★★★			
Ankylosing Spondylitis update	★★★			

HMP
HUMAN MICROBIOME PROJECT

µBiome

Personal diagnostic testing

- **"Test at home, treat online"**
- Urinary tract infection, strep throat, flu, cholesterol, Lyme disease, Mono, sexually transmitted diseases, pregnancy, yeast infections and others.
- (Not yet evaluated by regulatory agencies)

Personal medical image management

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How MediCle Works

Access to your personal X-rays, MRIs and other diagnostic images.
Get started today with our easy-to-use HealthVault App.

XRFiles BETA

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Empowering Patients

Personal Medical Image Archive in the Cloud

- **XRFiles is an easy way to share, store and manage your medical image exams.** Send them securely and in full fidelity to experts to seek 2nd opinion.
- **Your privacy is our priority. No one but you or people you authorized will have access to your exams.** Full real-time audit trail and permissions you can review, modify and revoke at any time keep you in full control.

Radiologists, PACS Admins

Patient image communications without CDs
licensed or hosted solutions

Call now to schedule a meeting
(650) 409-7292
or email to info@XRFiles.com

Quantified Self
self knowledge through numbers

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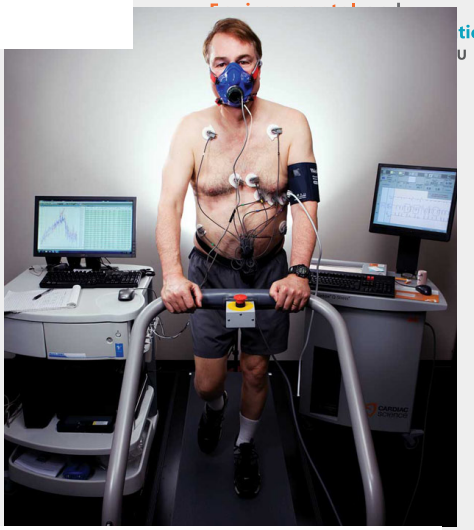
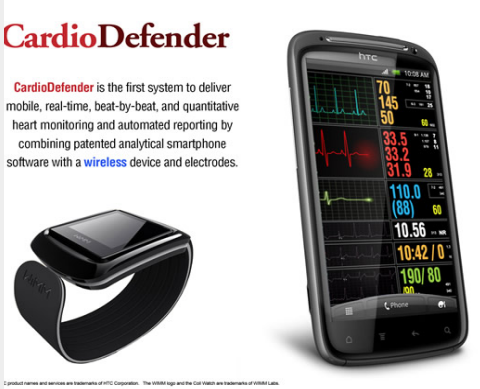
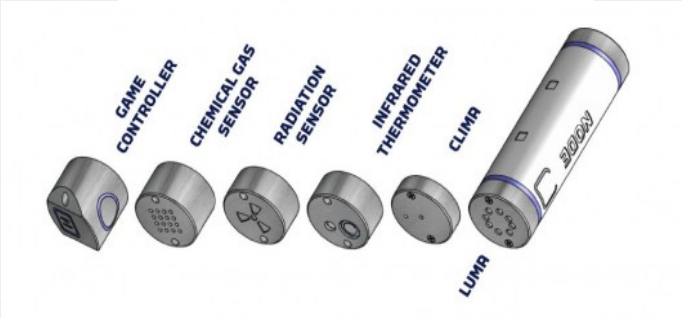
- Self tracking / self quantifying / self monitoring
- The belief that gathering and analysing data can help them improve their lives!
- Groups 228, Members 67K, Cities 89, Countries 31
- Quantified Self is a collaboration of users and tool makers who share an interest in self knowledge through self-tracking.
- There are three main “branches” to our work.
  - **The Quantified Self blog and community site.**
  - **Show and Tell meetings (Meetup groups) -**
  - **Quantified Self Conferences (US and Europe**







Personal Health Records

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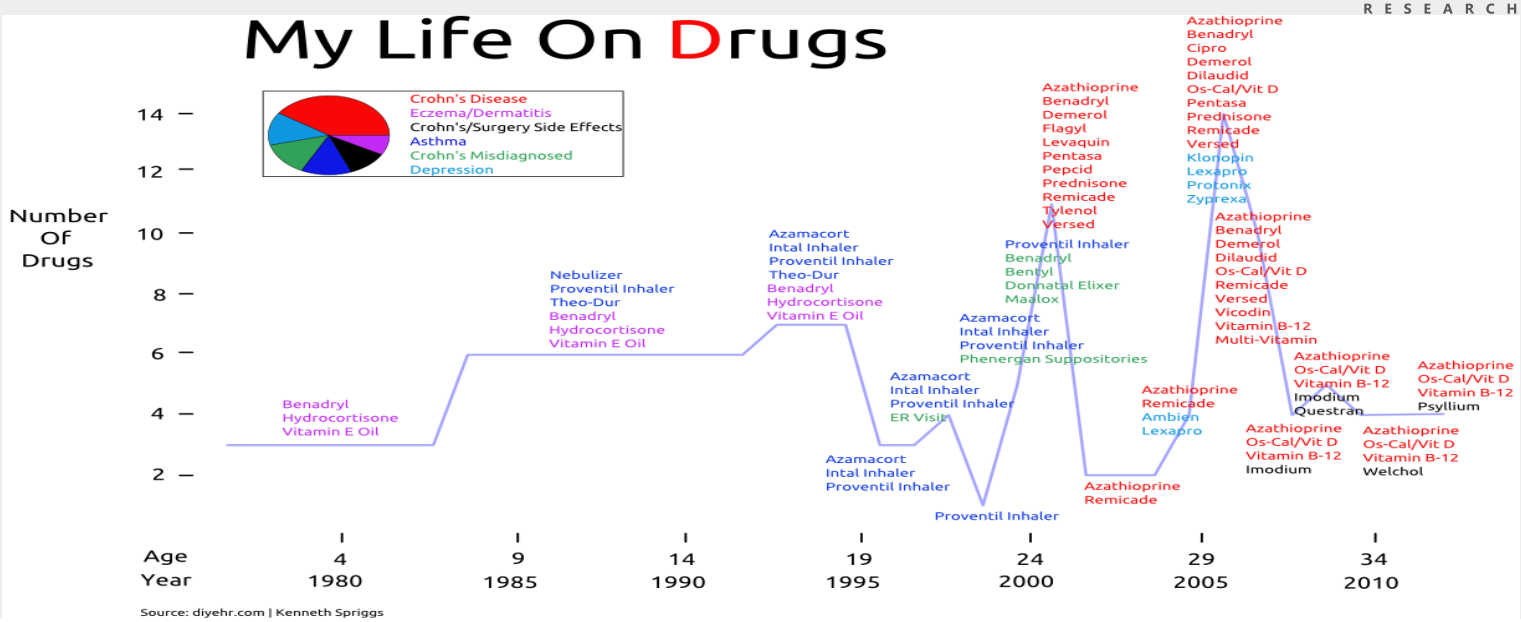

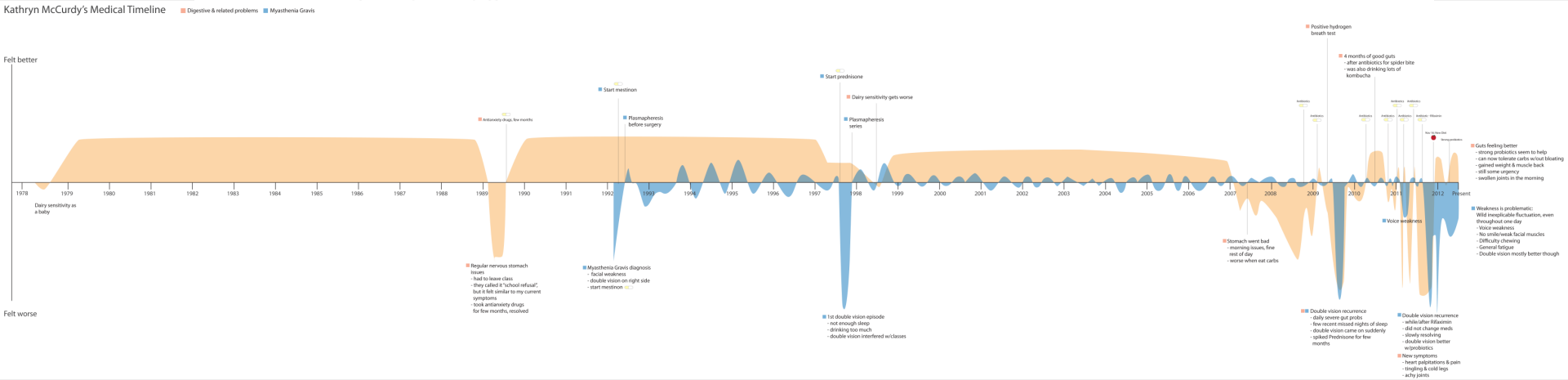

Open Notes – Patients reading Doctor's notes

ENaPHi Environmental and

OpenNotes

patients and clinicians on the same

About | Why Share Notes? | Who Is Sharing Notes? | Getting Started | Research | News

Mental Health Notes Empower Patients

Get Started

Find Pa

News

ACP American College of Physicians
Internal Medicine | Doctors for Adults

Annals of Internal Medicine

Established in 1927 by the American College of Physicians

Home | Current Issue | All Issues | Online First | Collections | In the Clinic | Journal Club | CME

2 October 2012, Vol 157, No. 7>

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Original Research | 2 October 2012

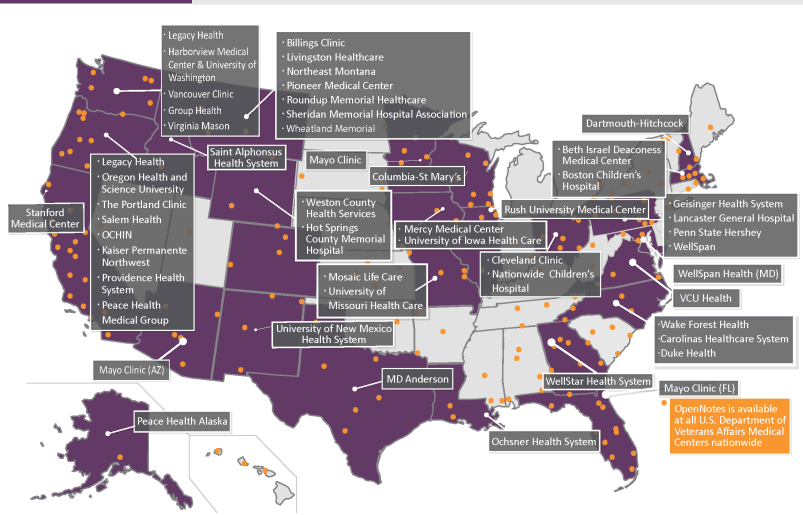
Inviting Patients to Read Their Doctors' Notes: A Quasi-experimental Study and a Look Ahead FREE

Tom Delbanco, MD*; Jan Walker, RN, MBA*; Sigall K. Bell, MD; Jonathan D. Darer, MD, MPH; Joann G. Elmore, MD, MPH; Nadine Farag, MS; Henry J. Feldman, MD; Roanne Mejilla, MPH; Long Ngo, PhD; James D. Ralston, MD, MPH; Stephen E. Ross, MD; Neha Trivedi, BS; Elisabeth Vodicka, BA; and Suzanne G. Leveille, PhD, RN

[+] Article and Author Information

OpenNotes

More than 7 million patients have easy access to their clinicians' notes



Open Notes – Patients reading Doctor's notes

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- Individuals with access to their health information are
  - better able to monitor chronic conditions,
  - adhere to treatment plans,
  - find and fix errors in their health records,
  - track progress in wellness or disease management programs, and
  - directly contribute their information to research.

Individuals' Right under HIPAA to Access their Health Information 45 CFR § 164.524

Crowdsourced clinical trials

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- Clinical Research with the patients, not on the patients
- Examples
  - **23andMe – Parkinson's Disease – PLoS Genetics, 2 new genetic associations**
  - **PatientsLikeMe – Nature Biotech. Self-reported data from 600 patients on the use of lithium for Amyotrophic Lateral Sclerosis (ALS)**
  - **Acor, RevolutionHealth, Curetogether, Genomera, Althea Health**

COMMENTARY

DATA SHARING

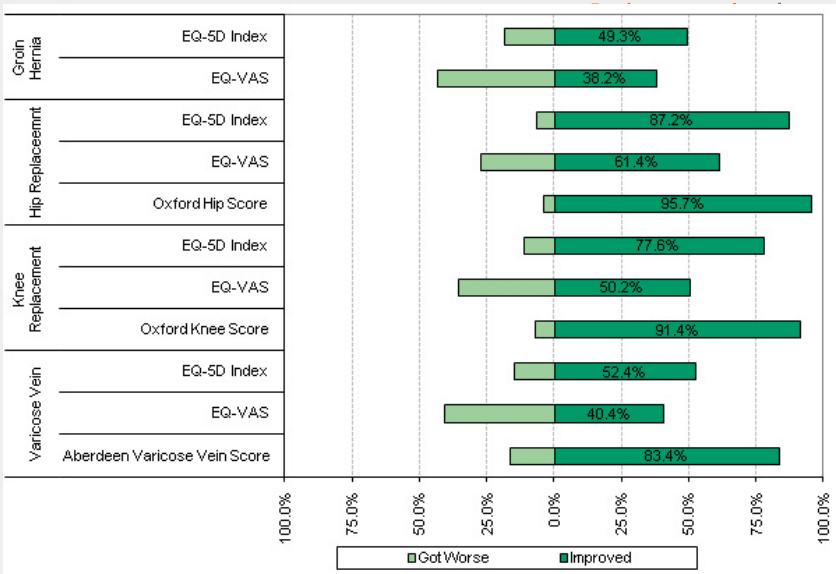
Power to the People: Participant Ownership of Clinical Trial Data

Sharon F. Terry[1*] and Patrick F. Terry[2]

Participation in clinical trials is dismally low. In this age of electronic sharing of information of all sorts, trial participants can easily share clinical trial data. The benefits of participant ownership and sharing of trial data appear to outweigh the risks. Thus, the time has come to crowd-source data for diagnostic and therapy development.

Patient reported outcomes

- Health services and outcomes research
- Measuring quality of care from the patient perspective



NHS PROMs

NIH

PROMIS®
Dynamic Tools to Measure Health Outcomes from the Patient Perspective

pcornet | The National Patient-Centered Clinical Research Network

pcori

Shared decision support

ELSEVIER

Expert Systems with Applications

Volume 39, Issue 14, 15 October 2012, Pages 11775–11781

Shared decision support system on dental restoration

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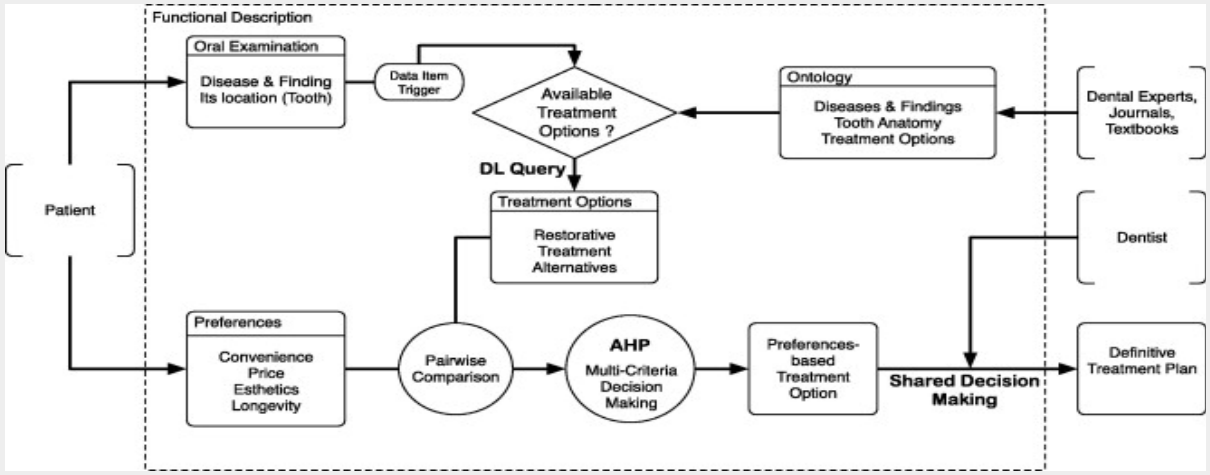
[b] Biomedical Knowledge Engineering Laboratory, Seoul National University, 28 Yongon-Dong, Choong-gu, Seoul 110-749, South Korea

[c] Dental Research Institute, Seoul National University, 28 Yongon-Dong, Choong-gu, Seoul 110-749, South Korea

http://dx.doi.org/10.1016/j.eswa.2012.04.074, How to Cite or Link Using DOI



The Blue Button and Blue Button +

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Blue Button
Download
My Data ®

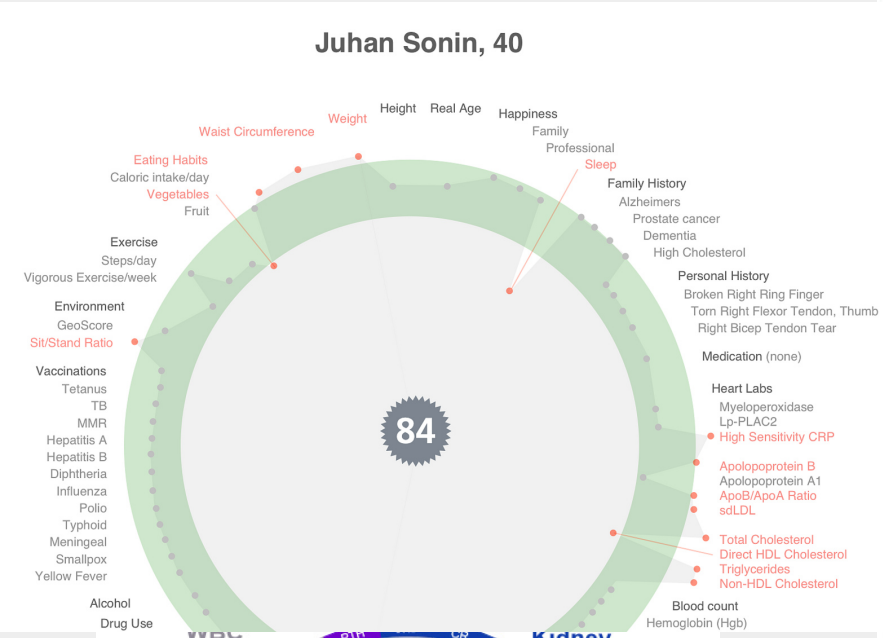
Meaningful use –
V/D/T
View/
Download/ Transmit.

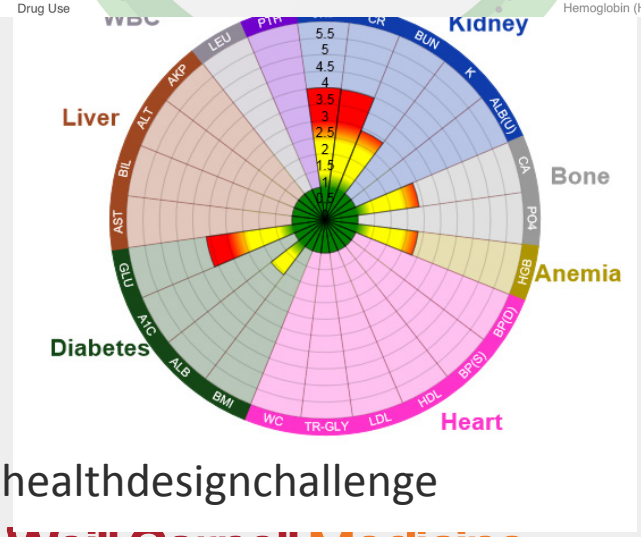
Blue Button +

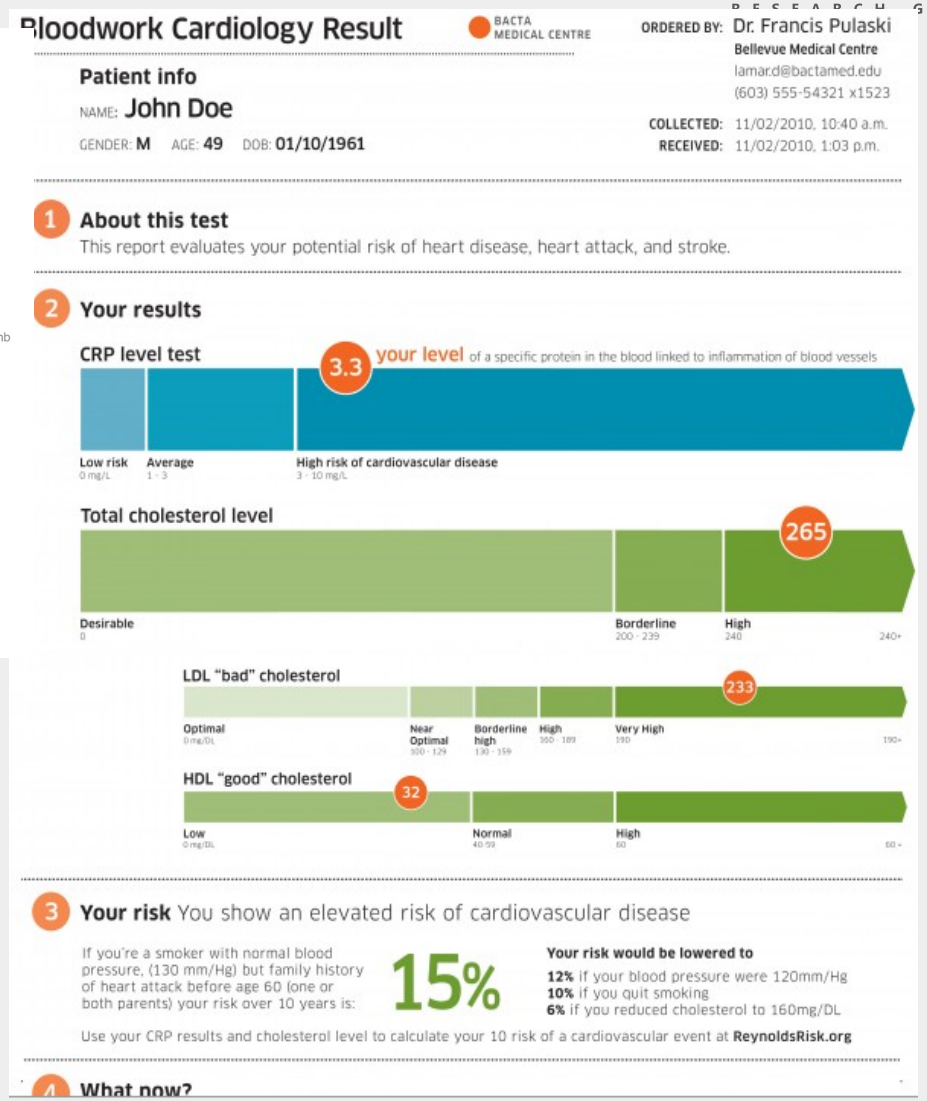
The Blue Button is a symbol for patients to view online and download their own personal health records.

Blue Button+ extends the Blue Button concept to include a standardized data format and additional functionality

Visualisation tools







healthdesignchallenge

Tensions

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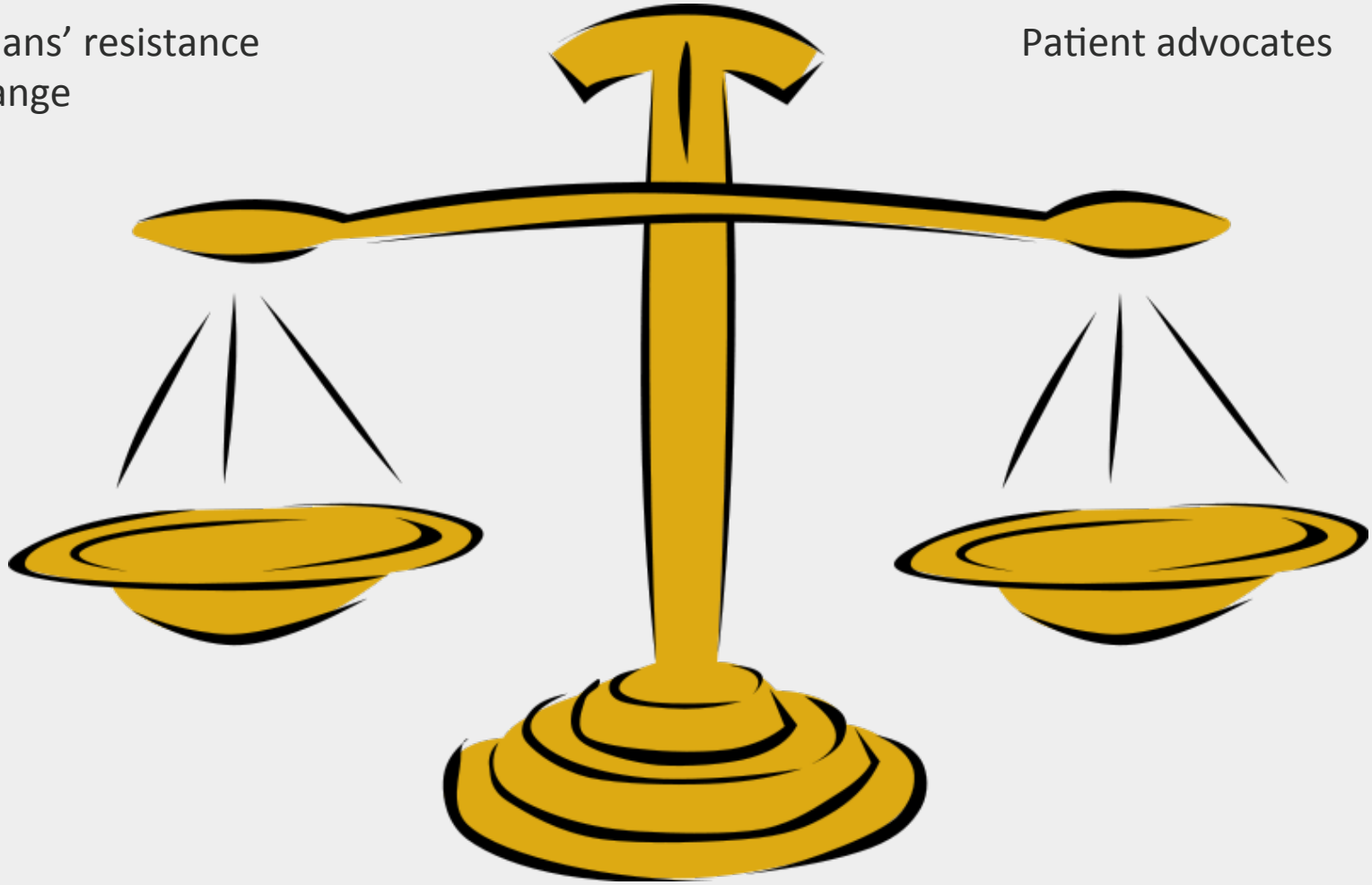
Clinicians' resistance to change

Patient advocates



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MEDICINE	PARTICIPATORY HEALTH
Provider-centric	Patient or Consumer-centric
Curative	Proactive
Passive role of the patient	Active
Clinical decision making	Shared decision making
Electronic medical record	Patient Health Record

Adherence, compliance vs activation
Literacy vs Clarity
Research n=they vs n=me and n=we

Patient-generated data

Submissions to Australian PCEHR Review - Nov 2013

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AMA

- it must be recognised that as a design feature of the PCEHR, patient control means that the PCEHR cannot be relied on as a trusted source of key clinical information.
- The absence of specific remuneration for medical practitioner contribution to the PCEHR reinforces the need to ensure that using PCEHR functions does not impose any additional workflow requirements on them.

Consumer Health Forum, Consumer e-health Alliance

- The 'personally controlled' aspect of the eHealth record is what makes it such a powerful consumer resource.
- Patients and potential patients – health consumers – must be informed and engaged as the ultimate users of the PCEHR.

US Doctors were the most open toward patients updating the information in their EHRs

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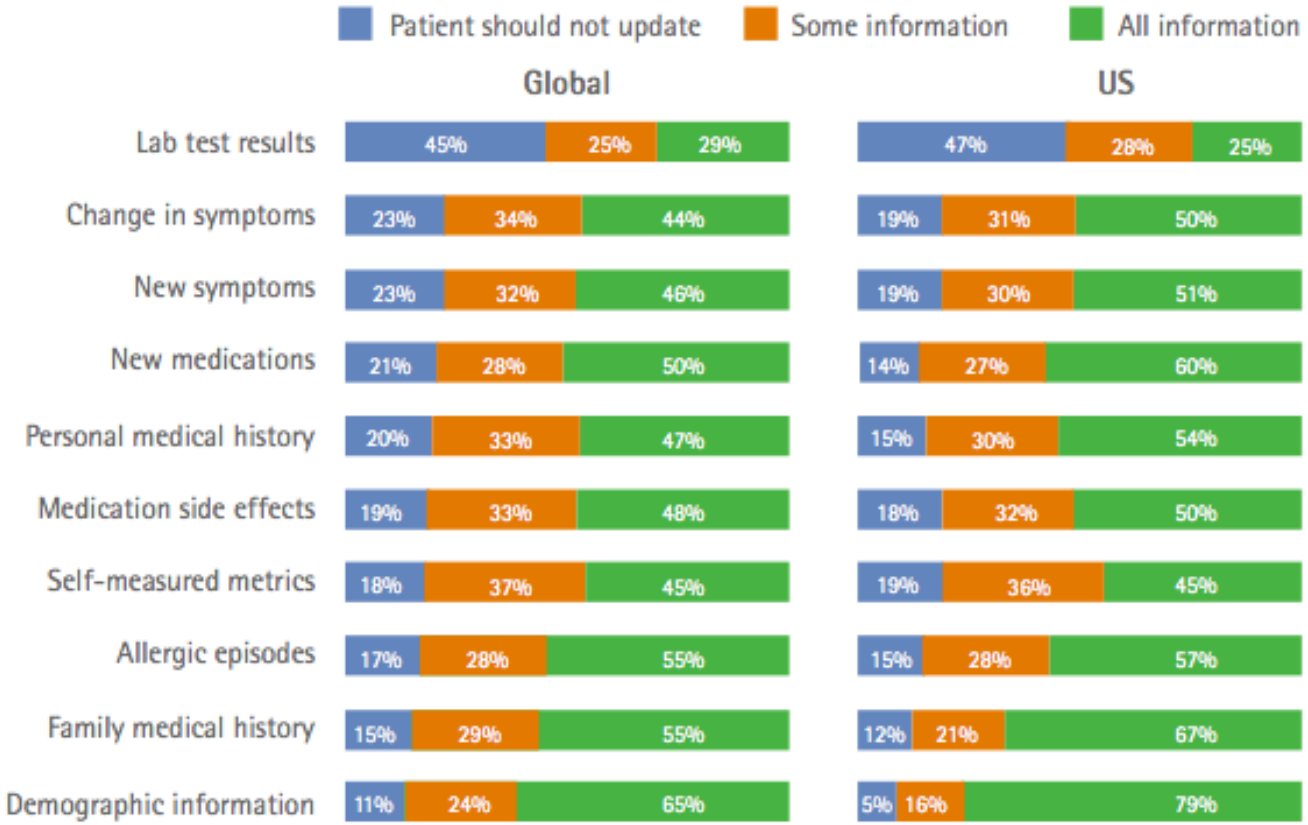
Figure 2: Information Patients Should be Able to Update in Electronic Health Record



Source: Accenture Doctors Survey

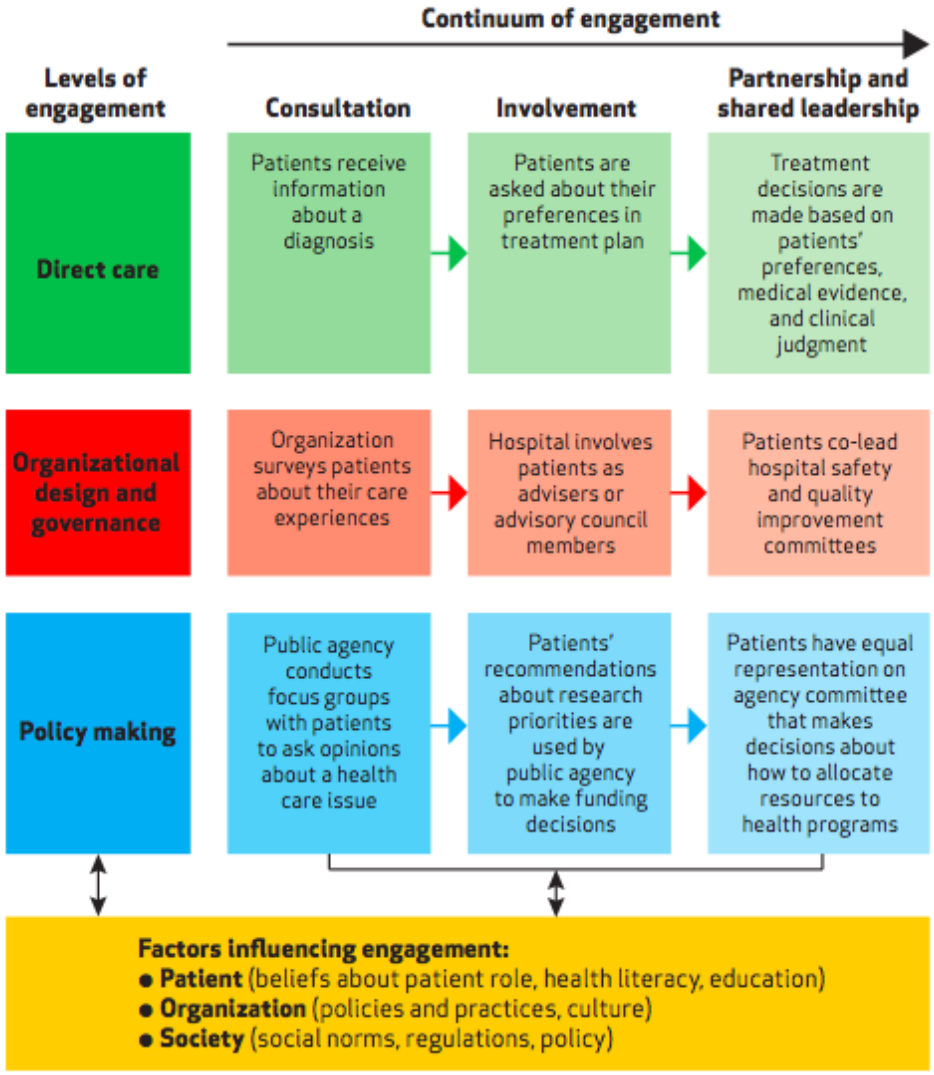
US doctors were the most open toward patients updating the information in their electronic health records, according to Accenture's eight country survey of 3,700 doctors.

Evolution

Shenkin B, Warner D. Giving the patient his medical record: a proposal to improve the system. NEJM, 1973

EXHIBIT 1

A Multidimensional Framework for Patient and Family Engagement in Health and Health Care



SOURCE Kristin L.Carman, Pam Dardess, Maureen Maurer, Shoshanna Sofaer, Karen Adams, Christine Bechtel, and Jennifer Sweeney, "Patient and Family Engagement: A Framework for Understanding the Elements and Developing Interventions and Policies," *Health Affairs* 32, no. 2 (2013): 223–31. **NOTE** Movement to the right on the continuum of engagement denotes increasing patient participation and collaboration.

Patients / citizens / scientists /

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- Stephen Keating
https://exponential.singularityu.org/medicine/can-selfies-save-us-with-steven-keating/

- Regina Holliday
https://vimeo.com/24857924

- Matt Might
http://healthsciences.utah.edu/innovation/algorithms/2015/five.php
http://matt.might.net/articles/my-sons-killer/

- Stephen Damiani
http://www.missionmassimo.com/

- Sonia Wallabh & Erik Minikel
https://www.youtube.com/watch?v=ni4RRMz2mJQ

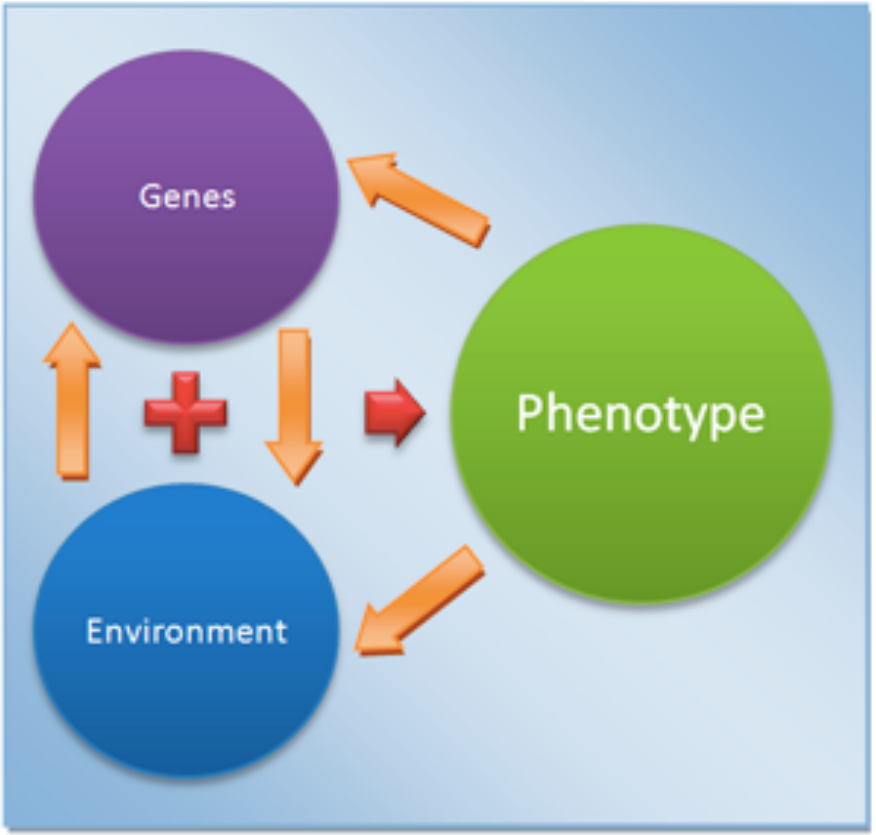
Weill Cornell Medicine

Participatory technologies and the individual exposome

P = G * E

Genome

Exposome



Phenome

Genotype * Expotype → Phenotype

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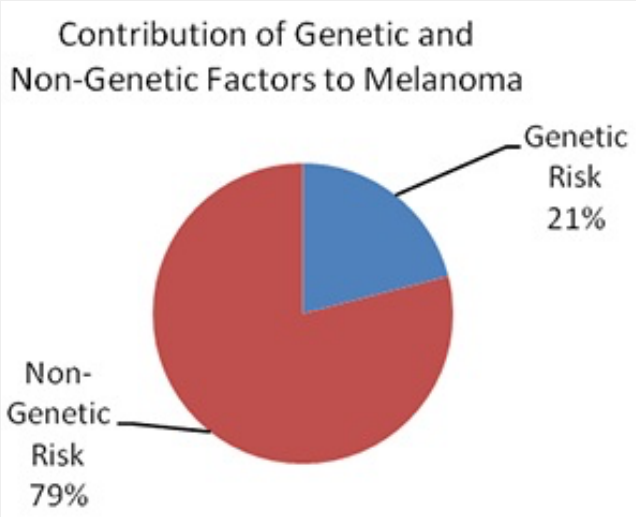
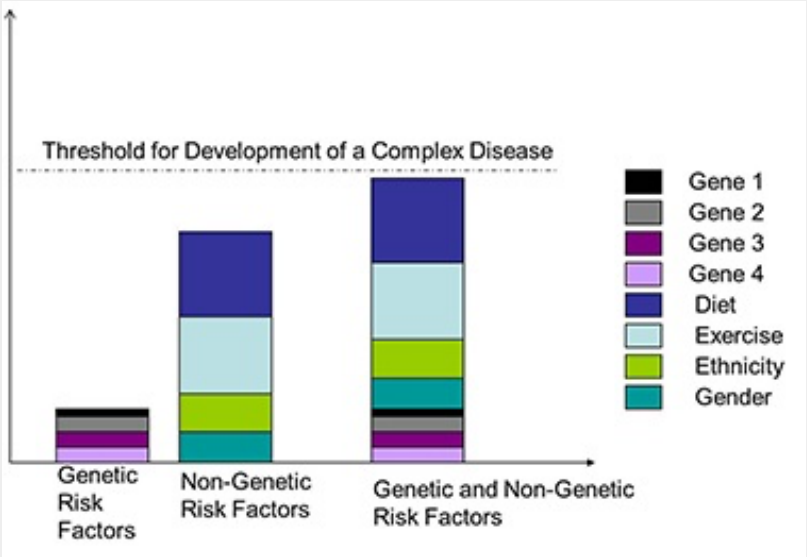
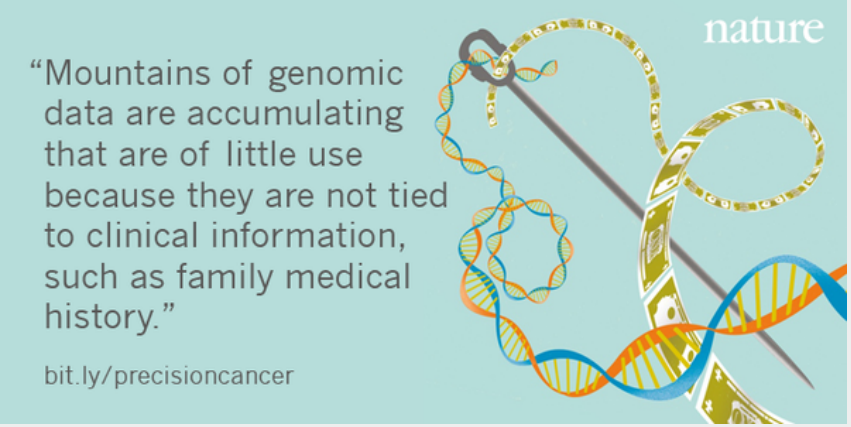




Coriell Personalised Medicine Collaborative



Marc Rubin, Nature 2015

Digital health

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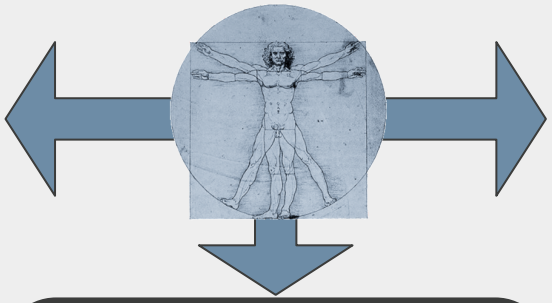
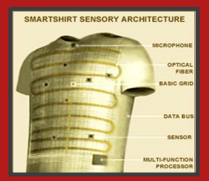
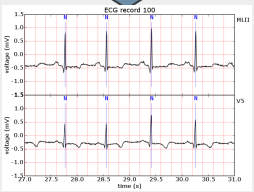
Exposome / Expotype

Environmental risk factors
(pollution, radiation, toxic agents, …)



Phenome / Phenotype





Anatomy, Physiological, biochemical parameters
(cholesterol, temperature, glucose, heart rate…)

Genome / Genotype

Biomarkers (DNA sequence,
Epigenetics)

Social media / Personal health record / EMRs / Research Repository

Personalized vs Precision Medicine

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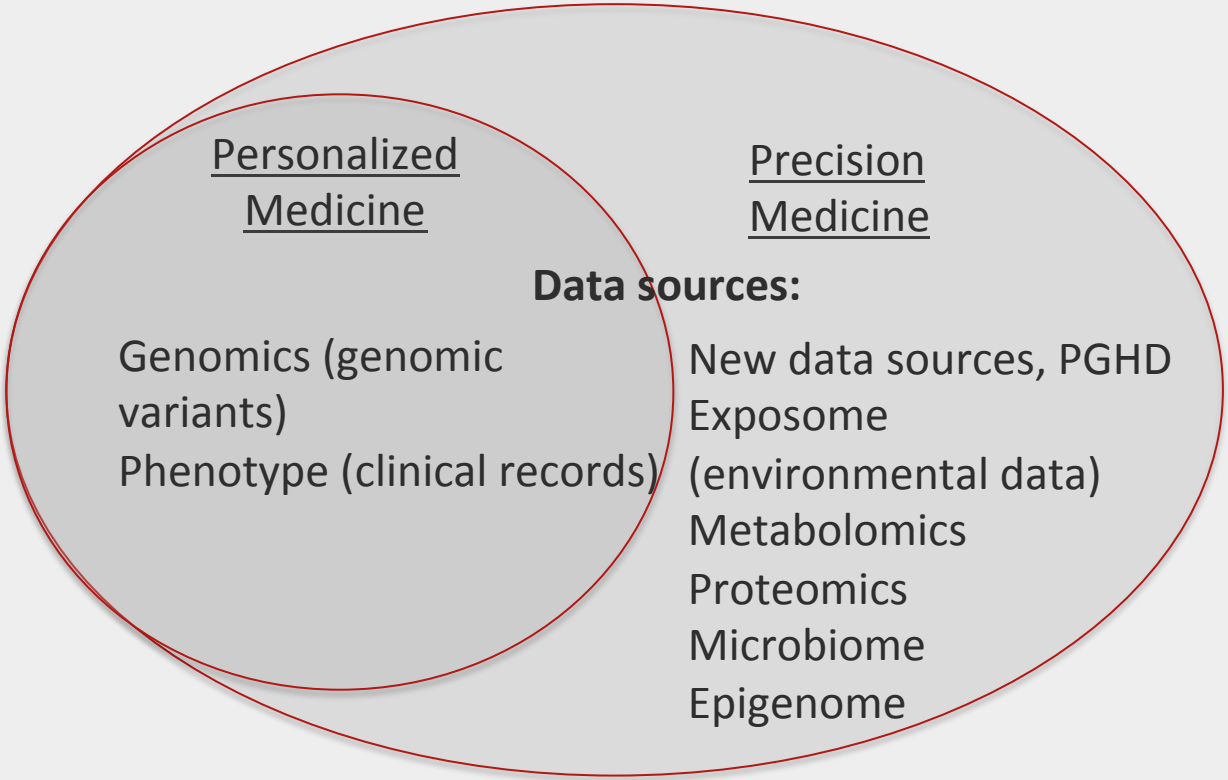
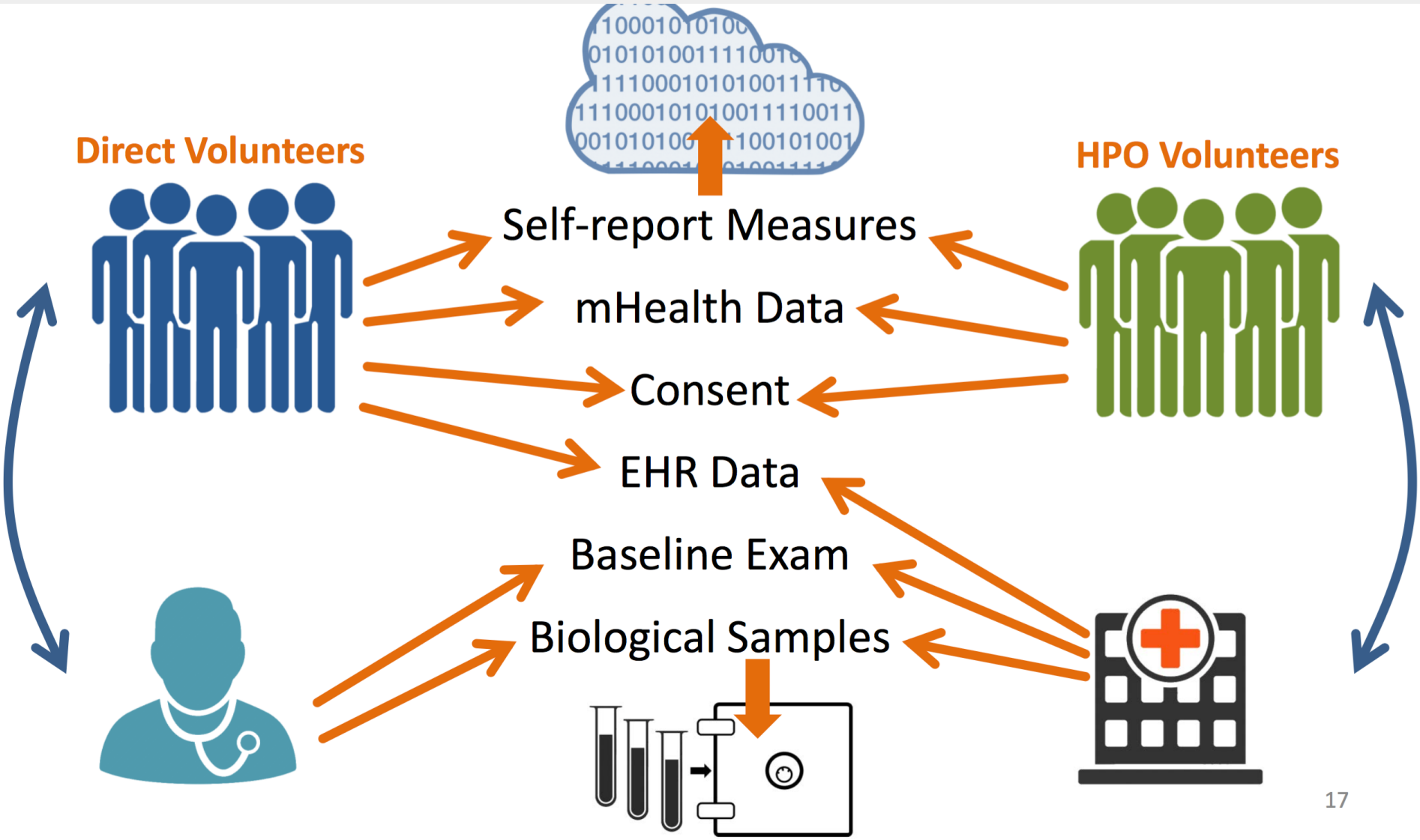


PM combines the knowledge of the patient's characteristics with traditional medical records and environmental information to optimize health.

PM does not only rely on genomic medicine but also integrates any other relevant information such as non-genomic biological data, clinical data, environmental parameters and the patient's lifestyle.

Servant N et al. Front Genet. 2014; 5: 152.


Direct Volunteers
HPO Volunteers
Self-report Measures
mHealth Data
Consent
EHR Data
Baseline Exam
Biological Samples
17

Role of Biomedical Informatics in the PMI

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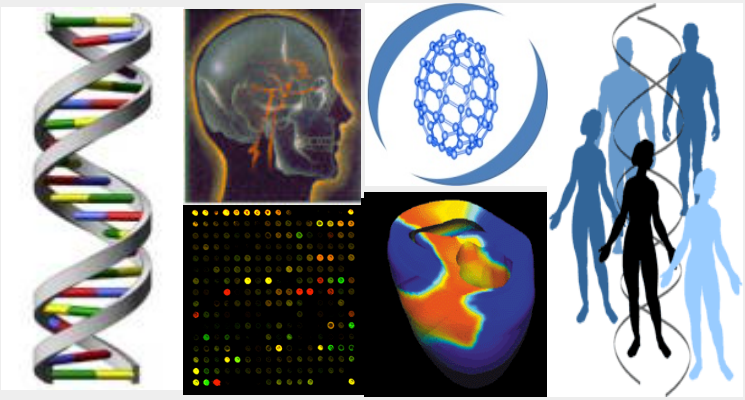
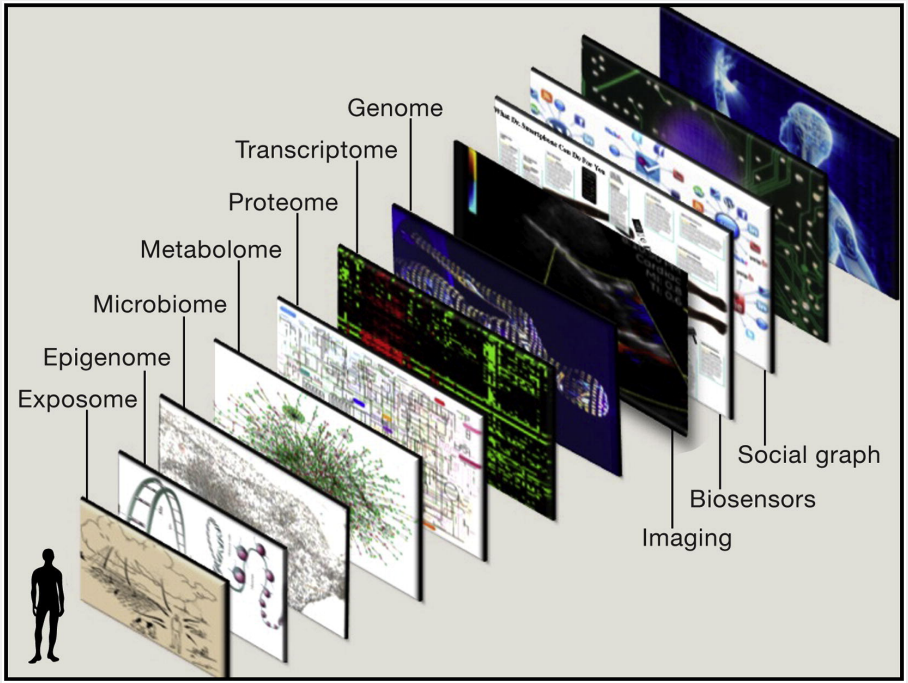
- ***Emerging approaches to disease prevention, diagnosis, and treatment through detecting, measuring, and analyzing individual variations in molecular, genomic, cellular, clinical, imaging, behavioral, physiological, and environmental data.***



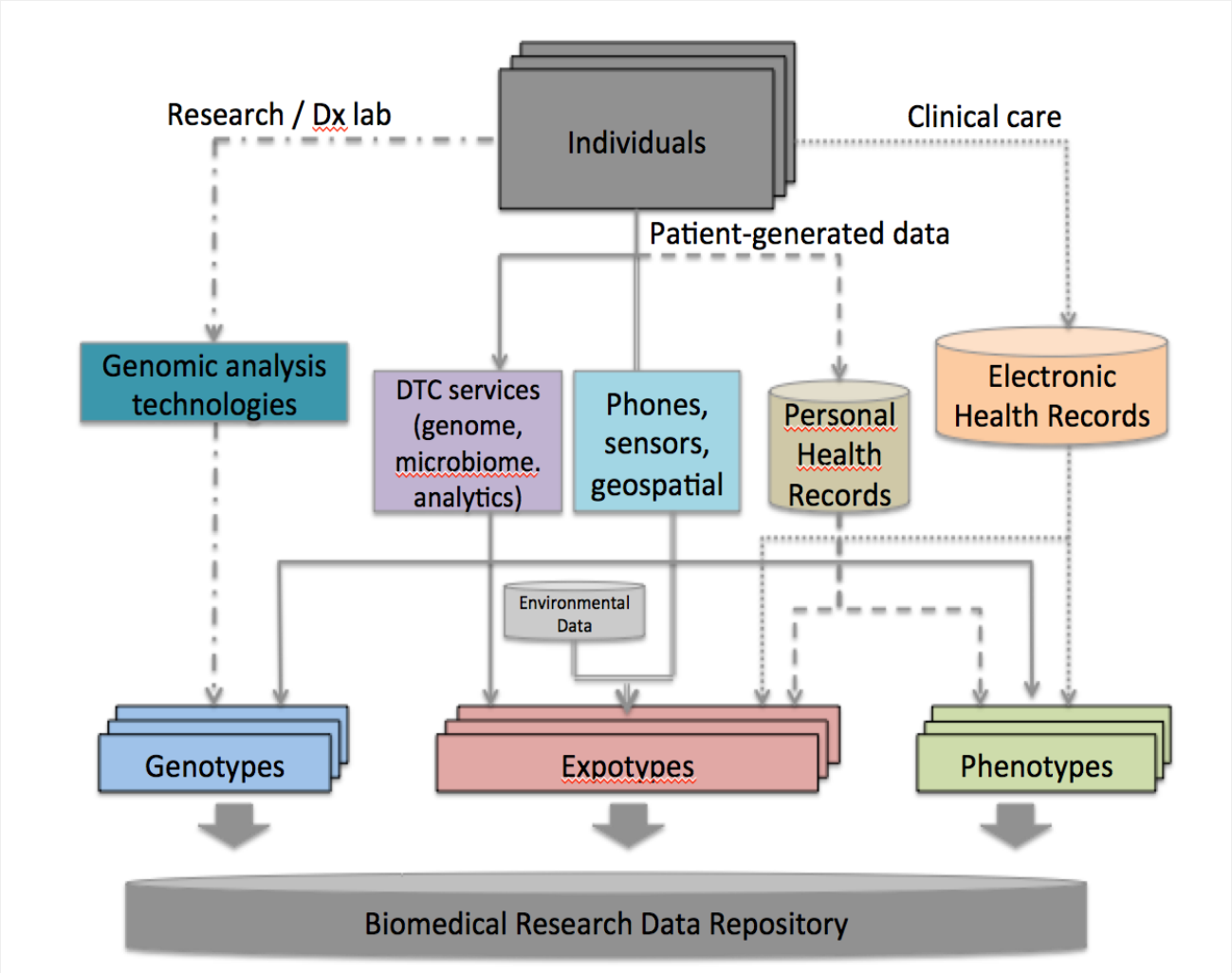
Final remarks

- *Precision medicine enables a safer, more efficient, preventive and proactive medicine, but needs to tackle the complexity and diversity of personal health information, beyond the genome sequence.*



Topol E. Cell 2014

Data flow


Research / Dx lab
Individuals
Clinical care
Patient-generated data
Genomic analysis technologies
DTC services (genome, microbiome, analytics)
Phones, sensors, geospatial
Personal Health Records
Electronic Health Records
Environmental Data
Genotypes
Expotypes
Phenotypes
Biomedical Research Data Repository

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From sensors to information

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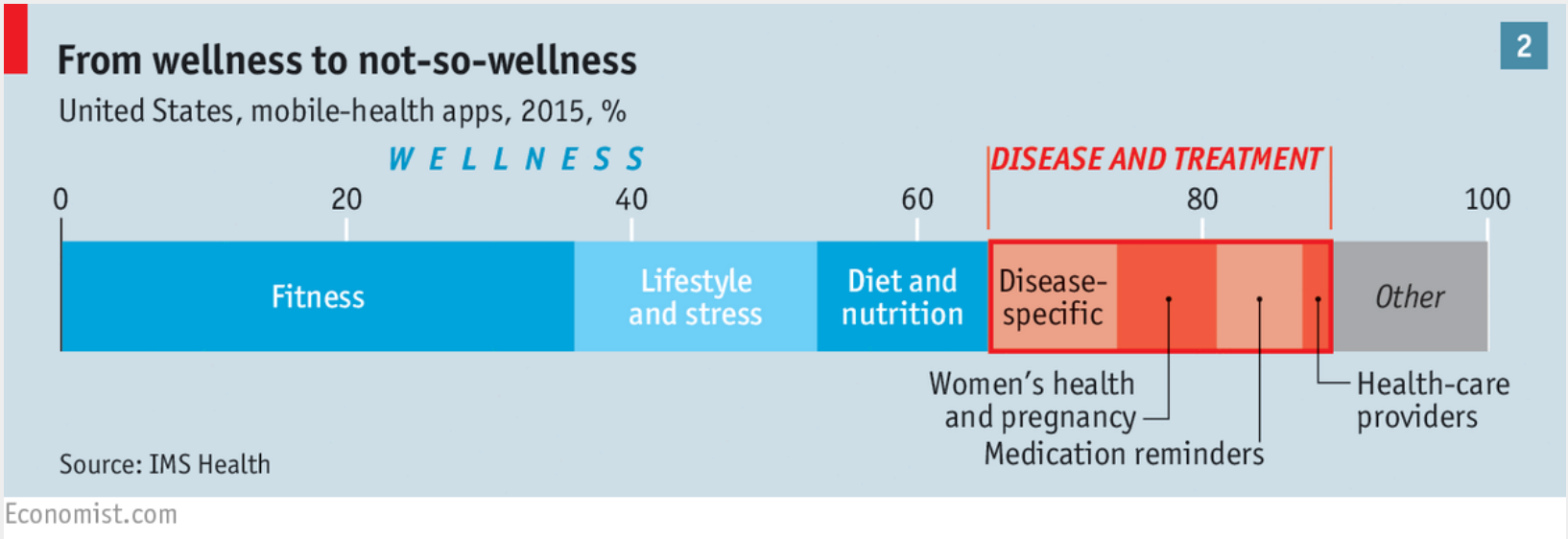
Data collection mApps

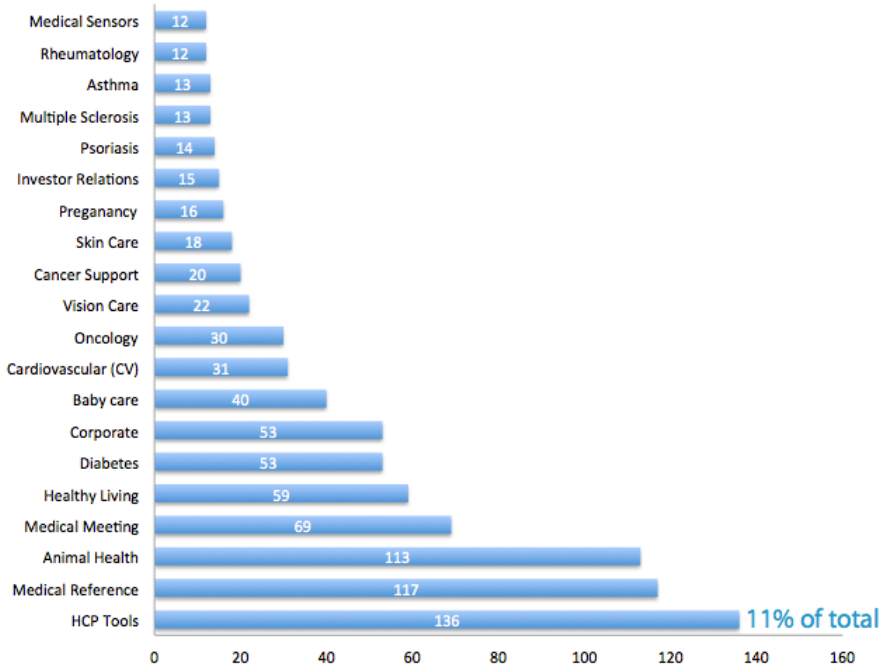
Choosing the best app

Mobile-health apps

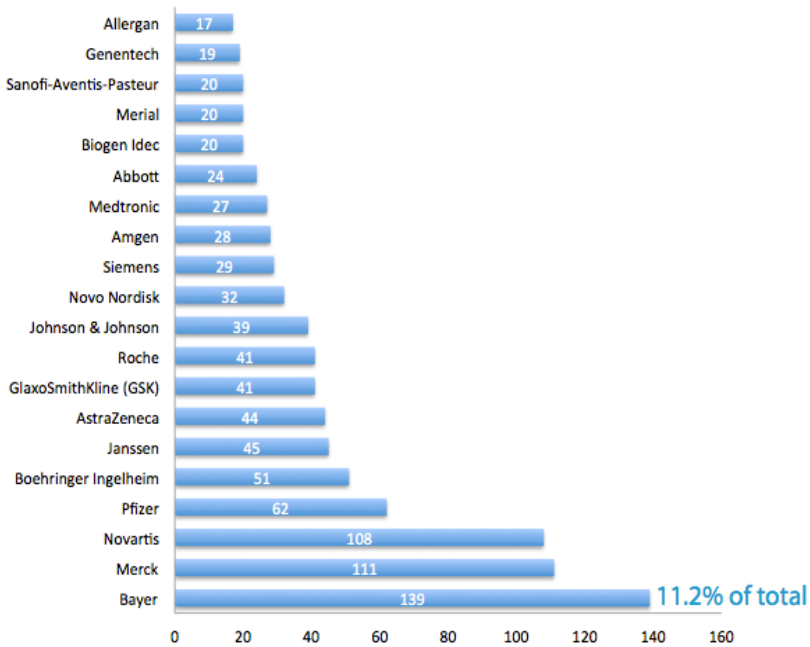
- There are now around 165,000 health-related apps which run on one or other of the two main smartphone operating systems, Apple's iOS and Google's Android. PwC, a consulting firm, forecasts that by 2017 such apps will have been downloaded 1.7 billion times (The Economist)



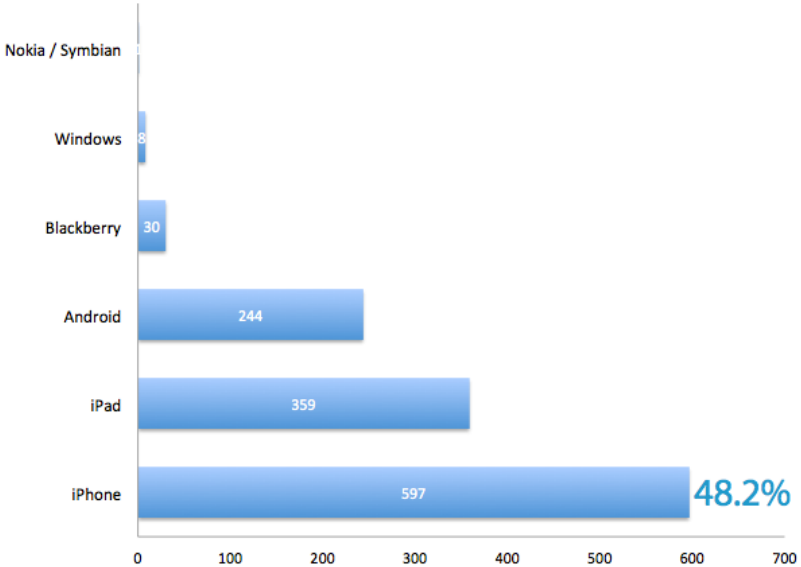
Top 20 Apps by condition (# of apps)



Top 20 App Makers (# of apps)



Apps by device



The Evolving Landscape of Medical Apps in Healthcare

http://hitconsultant.net/2014/06/23/the-evolving-landscape-of-medical-apps-in-healthcare/

JAMA Article

VIEWPOINT

In Search of a Few Good Apps

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Payer + Provider Syndicate, Boston, Massachusetts.

Adam B. Landman, MD
Harvard Medical School, Boston, Massachusetts, Brigham and Women's Hospital, Boston, Massachusetts, and Partners Information Systems, Wellesley, Massachusetts.

David W. Bates, MD
Harvard Medical School, Boston, Massachusetts, Brigham and Women's Hospital, Boston, Massachusetts, Partners Information Systems, Wellesley, Massachusetts, and Harvard School of Public Health, Boston, Massachusetts.

Corresponding Author: Adam C. Powell, PhD, Payer + Provider Syndicate, 8 Garrison St, Ste 101, Boston, MA 02116 (powell@payerprovider.com).

mHealth apps are mobile device applications intended to improve health outcomes, deliver health care services, or enable health research.[1] The number of apps has increased substantially, and more than 40 000 health, fitness, and medical apps currently are available on the market.[2] Because apps can be used to inexpensively promote wellness and manage chronic diseases, their appeal has increased with health reform and the increasing focus on value. The bewildering diversity of apps available has made it difficult for clinicians and the public to discern which apps are the safest or most effective.

The US Food and Drug Administration (FDA) has paid close attention to mHealth apps, because it has regulatory authority over their safety. The agency recently clarified that mHealth apps acting as medical devices or as accessories to medical devices will require FDA approval, whereas apps that provide users with the ability to log life events, retrieve medical content, or communicate with clinicians or health centers will not be regulated under its jurisdiction.[3] For example, an app that tracks glucose levels and suggests insulin dosages would be regulated, whereas an app that tracks a patient's weight and makes general suggestions about exercise would not. In general, apps that provide precise treatment recommendations and diagnostic information will receive more regulatory attention. Although the FDA has focused on safety, it has largely left the review and certification of apps to the marketplace.

The currently available reviews of mHealth apps have largely focused on personal impressions, rather than evidence-based, unbiased assessments of clinical performance and data security. Although evidence-based reviews are not extensively available for mHealth apps, they are available for other categories of health information technology software. For instance, KLAS has successfully made a business out of producing report cards on the quality of health information technology vendors and enterprise software packages, presumably simplifying the lives of hospital leaders.[4] This model has worked for enterprise software because users of expensive software are seemingly willing to fund unbiased reviews. However, this approach appears unlikely to work for mHealth apps because users of free and inexpensive apps are less financially invested in their decisions than hospitals. Furthermore, certification may be problematic in mHealth because certification companies ordinarily aim to generate revenues by charging the app developers they are evaluating—an inherent conflict of interest. Thus, there is a need for alternative models for app review and certification that are sustainable and free of conflict of interest.

However, given the sheer number of mHealth apps, it is unlikely that all will ever be meaningfully reviewed by a single organization. As a start, an organization could feasibly review the quality of the most widely used and clinically useful mHealth apps. Furthermore, guidelines could be established to help developers build high-quality apps and to serve as a basis for app review. The guidelines might include a broad range of categories, such as safety, accuracy, and security. By telegraphing these guidelines, as well as standardized approaches to achieving them, the organization will be able to influence mHealth app developers early in their planning process, enabling them to build their apps with these principles and a review process in mind.

App review organizations would likely need to include in their reviews a certification process to ensure that apps do not pose potential harm to their users or have significant security and privacy vulnerabilities. Certification entities in other industries are successfully protecting people from harm. For instance, the Health On the Net Foundation, a nonprofit, nongovernmental organization, plays an active role in evaluating the quality of online medical content and provides websites a certification that assures both consumers and clinicians of the accuracy of the medical content.[5] Similarly, Underwriters Laboratories is a well-respected for-profit entity that provides meaningful but optional information that consumers can use to evaluate the safety of electronic devices. In mHealth, the startup Happtique began certifying the operability, privacy, security, and content of apps but ultimately suspended its operations after a developer discovered that 2 certified apps handled data insecurely.[6] The attention that Happtique received suggests that many people consider the security of mHealth apps to be important and want them to be evaluated rigorously. From these cases, it appears that both nonprofit and for-profit certification are viable means of improving the quality of low-cost and free consumer products and services and that there is demand for mHealth apps to be certified. The Office of the National Coordinator for Health Information Technology (ONC) could help support the development of mHealth app guidelines and eventually commission app certification entities, as it is now doing for electronic health records (EHRs).

Another important role for app review organizations is illuminating the effectiveness of mHealth apps. Although more rigorous evaluations are needed across all mHealth, many apps share components (eg, reminders, logging, pedometer). Evidence for these common features might be cited in app reviews. For example, because countless apps use smartphone-based accelerometers as makeshift pedometers, it would be helpful to highlight that evidence suggests that pedometer-based walking interventions are associated with an average weight loss of 0.05 kg per week.[7] Greater focus on outcomes may shift the focus of app develop-

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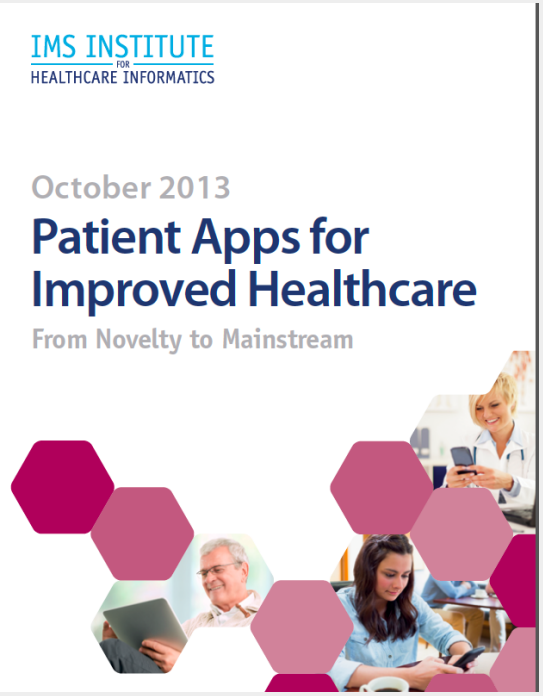
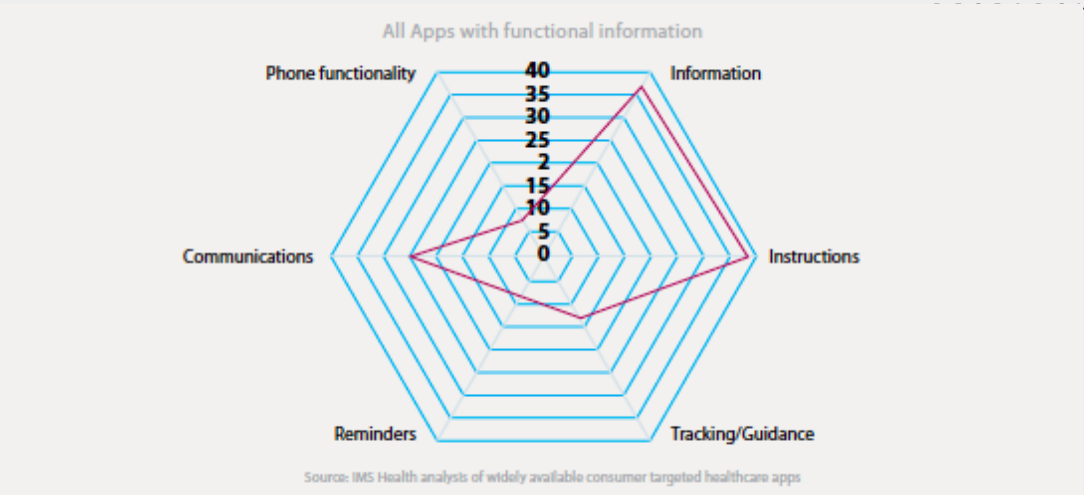
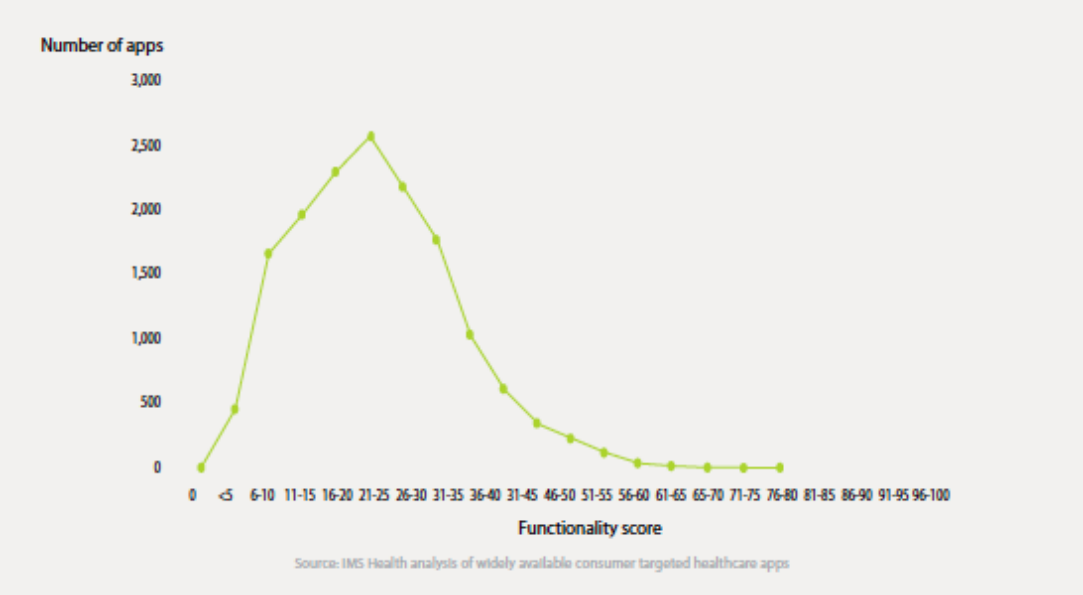
Evaluation - IMS Institute







Evaluation – RankedHealth.com

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RANKED

Curated Health Apps & Devices

With a Focus on Clinical Relevance, Safety, and Efficacy

Reviews by Clinicians, Researchers, & Patients.

Led by Experts From Top Ranked Teaching Hospitals & Universities.

CARDIOVASCULAR

Hello Heart Premium

Acceptable: 70

An outstanding mobile app for people interested in monitoring and tracking their blood pressure. However, it lacks high-quality evidence to backup their claims of helping people manage/ optimize blood pressure control.

REPRODUCTIVE HEALTH/ PREGNANCY

Ovia Fertility

Acceptable: 70

A well designed app intended for women of child-bearing age for fertility planning.

Acceptable

Clinical Effectiveness ●●●○○ 3

Functionality ●●●●○ 4

Usability ●●●●○ 4

70

Version: 1.9.6

Developer: Hello Doctor, Ltd

Review Date: 2016-03-02

Cost: $59.99; OR requires premium code from employer

MIT Hacking Medicine Institute

1. Mental Health
1. Fitness

2. Heart Disease
2. Medication Adherence

3. Diabetes
3. Symptom Tracking

4. Obesity
4. Reproductive Health

5. Sleep Disorders
5. Emergency/ Acute Care

Evaluation - MARS

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- Mobile App Rating Scale: A New Tool for Assessing the Quality of Health Mobile Apps

Criterion category	Frequency, N=349	(%)
App classification, confidentiality, security, registration, community, affiliation	12	(3.4)
Aesthetics, graphics, layout, visual appeal	52	(14.8)
Engagement, entertainment, customization, interactivity, fit to target group, etc	66	(18.9)
Functionality, performance, navigation, gestural design, ease of use	90	(25.8)
Information, quality, quantity, visual information, credibility, goals, description	113	(32.4)
Subjective quality, worth recommending, stimulates repeat use, overall satisfaction rating	16	(4.6)

Evaluation - FDA

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- The US Food and Drug Administration (FDA) has paid close attention to mHealth apps, because it has regulatory authority over their safety.

- The agency recently clarified that mHealth apps acting as medical devices or as accessories to medical devices will require FDA approval, whereas apps that provide users with the ability to log life events, retrieve medical content, or communicate with clinicians or health centers will not be regulated under its jurisdiction.

US Department of Health and Human Services, Food and Drug Administration. *Mobile Medical Applications: Guidance for Industry and Food and Drug Administration Staff.* http://www.fda.gov/downloads/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/UCM263366.pdf. September 25, 2013. Accessed January 3, 2014.

mHealth Evidence

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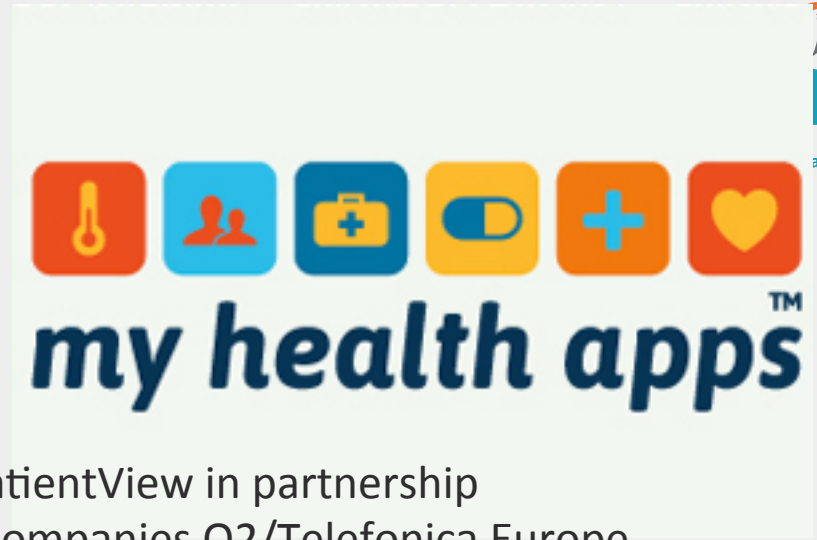
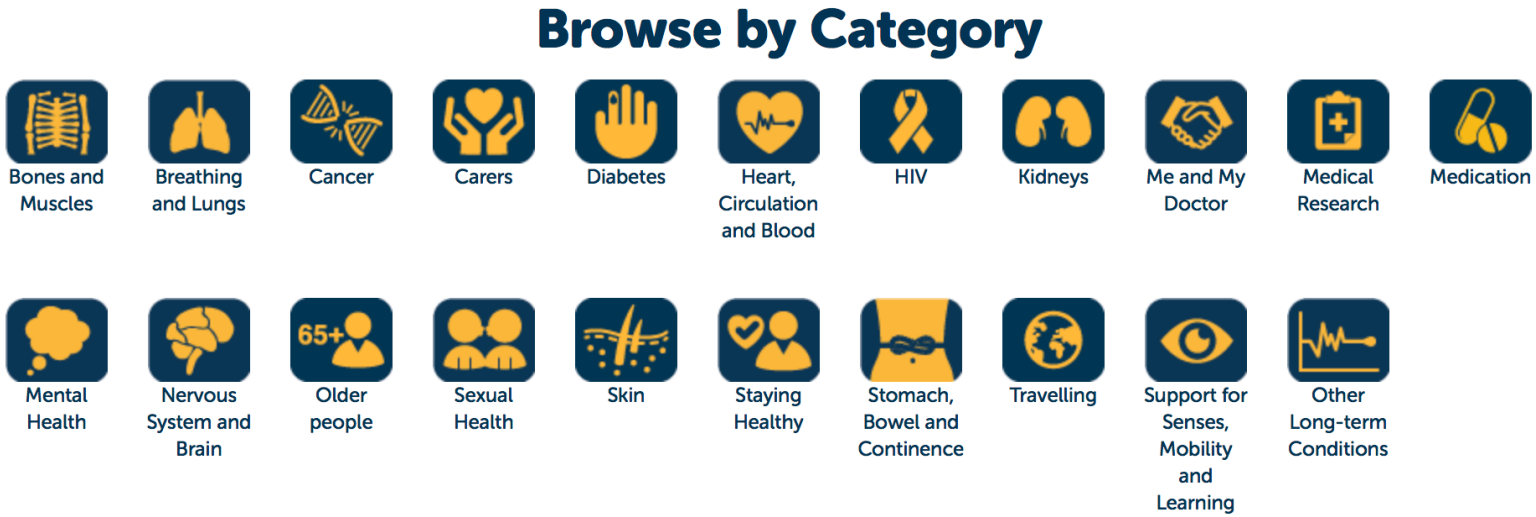
- Resource for cataloging, categorizing and grading mHealth evidence
  - **Peer-reviewed and grey literature on mHealth activities in developed and developing countries**
  - **Curated**
  - **Classified using a harmonized taxonomy**
  - **Scored based on objective criteria**
  - **Easily filtered and searchable**
    - Facilitate the identification of evidence-based, high-impact mHealth practices
- Launched by Johns Hopkins University via the federally funded Knowledge for Health project (5 years, $40 million)
- Partners
  - **Center for Communication Programs (JHU·CCP)**
  - **WHO mHealth Technical & Evidence Review Group (mTERG)/JHU Global mHealth Initiative (GmI)**

mHealth Evidence by K4Health

My Health apps



It has been launched by patient research firm PatientView in partnership with GSK, Janssen, Novo Nordisk and telecoms companies O2/Telefonica Europe and Vodafone Foundation.
307 apps, which have been selected by 456 patient groups, disability groups or



Health app directory

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PatientView's European Directory of Health Apps 2012-2013 contains mobile apps across 62 health specialities and features apps in 32 different European languages.

WHO mHealth Technical Evidence Review Group

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- **Guidelines for reporting of health interventions using mobile phones: mobile health (mHealth) evidence reporting and assessment (mERA) checklist**
- *BMJ* 2016; 352 doi: http://dx.doi.org/10.1136/bmj.i1174 (Published 17 March 2016) Cite this as: *BMJ* 2016;352:i1174

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Table 1

mHealth evidence reporting and assessment (mERA) guidelines, including mHealth essential criteria

Criteria	Item no	Notes
Infrastructure (population level)	1	Clearly presents the availability of infrastructure to support technology operations in the study location. This refers to physical infrastructure such as electricity, access to power, connectivity etc. in the local context. Reporting X% network coverage rate in the country is insufficient if the study is not being conducted at the country level
Technology platform	2	Describes and provides justification for the technology architecture. This includes a description of software and hardware and details of any modifications made to publicly available software
Interoperability/Health information systems (HIS) context	3	Describes how mHealth intervention can integrate into existing health information systems. Refers to whether the potential of technical and structural integration into existing HIS or programme has been described irrespective of whether such integration has been achieved by the existing system
Intervention delivery	4	The delivery of the mHealth intervention is clearly described. This should include frequency of mobile communication, mode of delivery of intervention (that is, SMS, face to face, interactive voice response), timing and duration over which delivery occurred
Intervention content	5	Details of the content of the intervention are described. Source and any modifications of the intervention content is described
Usability/content testing	6	Describe formative research and/or content and/or usability testing with target group(s) clearly identified, as appropriate
User feedback	7	Describes user feedback about the intervention or user satisfaction with the intervention. User feedback could include user opinions about content or user interface, their perceptions about usability, access, connectivity, etc
Access of individual participants	8	Mentions barriers or facilitators to the adoption of the intervention among study participants. Relates to individual-level structural, economic and social barriers or facilitators to access such as affordability, and other factors that may limit a user's ability to adopt the intervention
Cost assessment	9	Presents basic costs assessment of the mHealth intervention from varying perspectives. This criterion broadly refers to the reporting of some cost considerations for the mHealth intervention in lieu of a full economic analysis. If a formal economic evaluation has been undertaken, it should be mentioned with appropriate references. Separate reporting criterion are available to guide economic reporting
Adoption inputs/ programme entry	10	Describes how people are informed about the programme including training, if relevant. Includes description of promotional activities and/or training required to implement the mHealth solution among the user population of interest
Limitations for delivery at scale	11	Clearly presents mHealth solution limitations for delivery at scale
Contextual adaptability	12	Describes the adaptation, or not, of the solution to a different language, different population or context. Any tailoring or modification of the intervention that resulted from pilot testing/usability assessment is described
Replicability	13	Detailed intervention to support replicability. Clearly presents the source code/screenshots/ flowcharts of the algorithms or examples of messages to support replicability of the mHealth solution in another setting
Data security	14	Describes the data security procedures/ confidentiality protocols
Compliance with national guidelines or regulatory statutes	15	Mechanism used to assure that content or other guidance/information provided by the intervention is in alignment with existing national/regulatory guidelines and is described
Fidelity of the intervention	16	Was the intervention delivered as planned? Describe the strategies employed to assess the fidelity of the intervention. This may include assessment of participant engagement, use of backend data to track message delivery and other technological challenges in the delivery of the intervention

Creating and prescribing personalized apps

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AppScript™
The leading discovery and distribution platform for mobile health technologies.

Today, an increasing number of patients are asking healthcare professionals about mobile health. With over 100,000 mobile health apps and devices in the marketplace, recommending the best solution can be overwhelming.

AppScript™ is a simple and effective mobile health tool that lets you recommend apps, connected devices and content to improve patient engagement, satisfaction and outcomes.

1 Discover

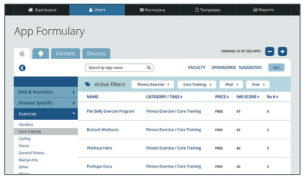
- Find the newest and best apps tailored for your patients
- Use the AppScript Score to ensure that each app is a fit for your practice and patient.

AppScript Score
With its proprietary algorithm, IMS Health has tested, rated and awarded a unique AppScript Score to over 100,000 mobile health apps. For every patient and every need, you can recommend the best resources with ease and confidence.

RATING AVERAGES ARE WEIGHTED TO CREATE OUR APPSCRIPT SCORES

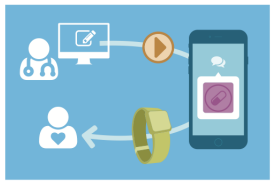
2 Manage

- Make your own mHealth formulary
- Customize each communication to reflect your institutions brand and experience
- Manage your users from a small practice to a large institution, Appscript can be customized to meet your needs.



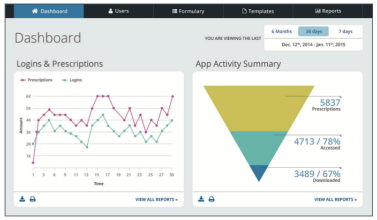
3 Prescribe

Send formalized app, device and content recommendations to your patients



4 Track

- See who opened their specialized AppScript prescription
- Send follow up messages to track patient satisfaction and usage
- Securely connect with users via surveys



imshealth™ APPSCRIPT
mHealth delivered.

Software

	Apple	Google	Cornell Tech	Samsung
DB smartphone	HealthKit	Google Fit		S Health
Apps for researchers	ResearchKit	Study Kit (Baseline)	Research Stack	
Apps for consumers	CareKit		OHMAGE-omh	

Software

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- ResearchKit (Apple) and ResearchStack (Android) are open source frameworks for researchers to inform and consent patients, and to collect personal health data from participants in trials.
- ResearchKit/ResearchStack have out-of-the box functionality for patient consent, surveys for Patient Reported Outcomes and collecting health data from sensors in the phone or devices connected to the phone.

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Data collection SQSs (wearables, mobile sensors, Quantified Self)

Collecting individual genome data

- Human Genome Project

  DNA Sequencer – designed to sequence the entire human genome in a day for $1,000

  DTC genomics – 23andMe, $100

  Microbiome

Benchtop Ion Proton™

Measuring the phenome (physiology, …)

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Measuring the Exposome (environmental risk)

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- Compilation of exposures experienced over an individual's lifetime (*Christopher Wild, 2005*)

- Industrial chemicals, combustion emissions, radiation, response to stress, physical activity levels – heat/cold, noise, food, microbiome

- Evaluating Personal Exposures
  - Phones: Light meters, GPS, Accelerometer
  - Senspod Monitor (Ozone, carbon monoxide, CO2, NO, Noise and UV)
  - Petroleum derived hydrocarbons (Benzene, Toluene)

Quantified Self: The concept

Quantified Self: The community

CALIFORNIA HEALTHCARE FOUNDATION

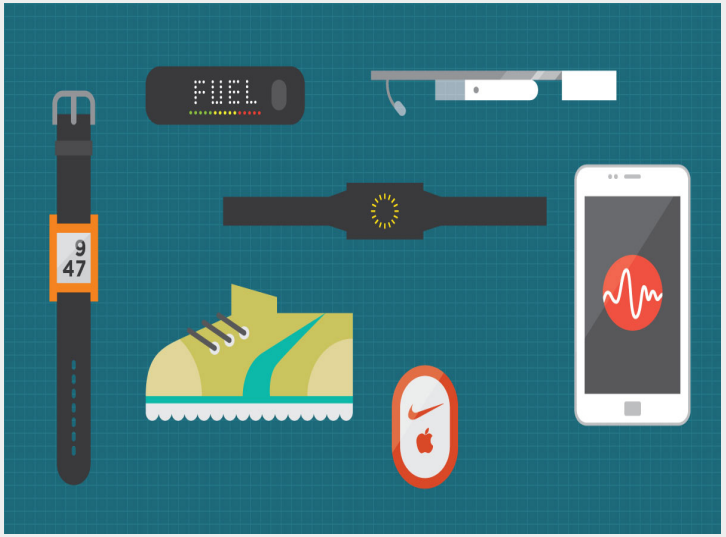
JANUARY 28, 2013

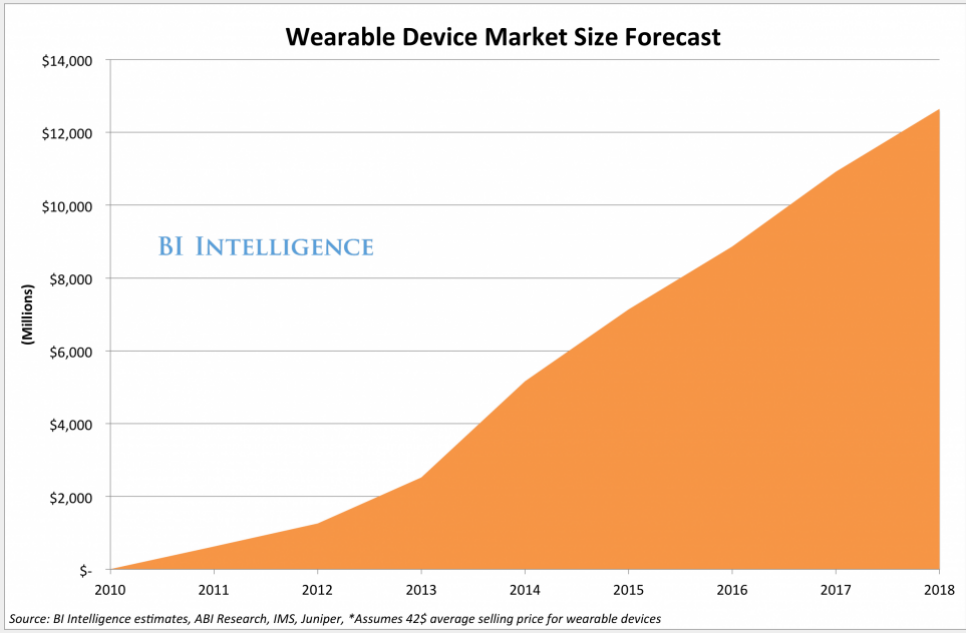
Tracking for Health

69% of U.S. adults track a health indicator like weight, diet, exercise routine, or symptom. Of those, half track "in their heads," one-third keep notes on paper, and one in five use technology to keep tabs on their health status.

New market

By 2018, 81.7 million users will own a wearable fitness device, according to eMarketer.





Quantified Self
self knowledge through numbers

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The Quantified Self community

- Quantified Self is a collaboration of users and tool makers who share an interest in self knowledge through self-tracking.
- We exchange information about our personal projects, the tools we use, tips we've gleaned, lessons we've learned. We blog, meet face to face, and collaborate online. There are three main "branches" to our work.
  - **The Quantified Self blog and community site.**
  - **Show and Tell meetings (Meetup groups) - Melbourne**
  - **Quantified Self Conferences (US and Europe)**
- Groups 228, **Members** 67,719, Cities 122, Countries 38

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Motivation

- You can't improve what you can't measure P. Drucker...
- *Using mobile and wearable digital devices to collect data on one's body function and everyday activities*
- *Self tracking through technology to improve health and medical conditions*
- To reveal patterns and correlations that can help you improve your life

The IBES SELF-OMICS Project

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- Addressing the information and communication needs of the 'quantified individual' for enabling participatory and personalised medicine
- Funded by IBES (Institute for a Broadband Enabled Society) - 2012-2013
- Resources:

http://www.broadband.unimelb.edu.au/health/monitoring/selfomics.html

http://www.scoop.it/t/selfomics

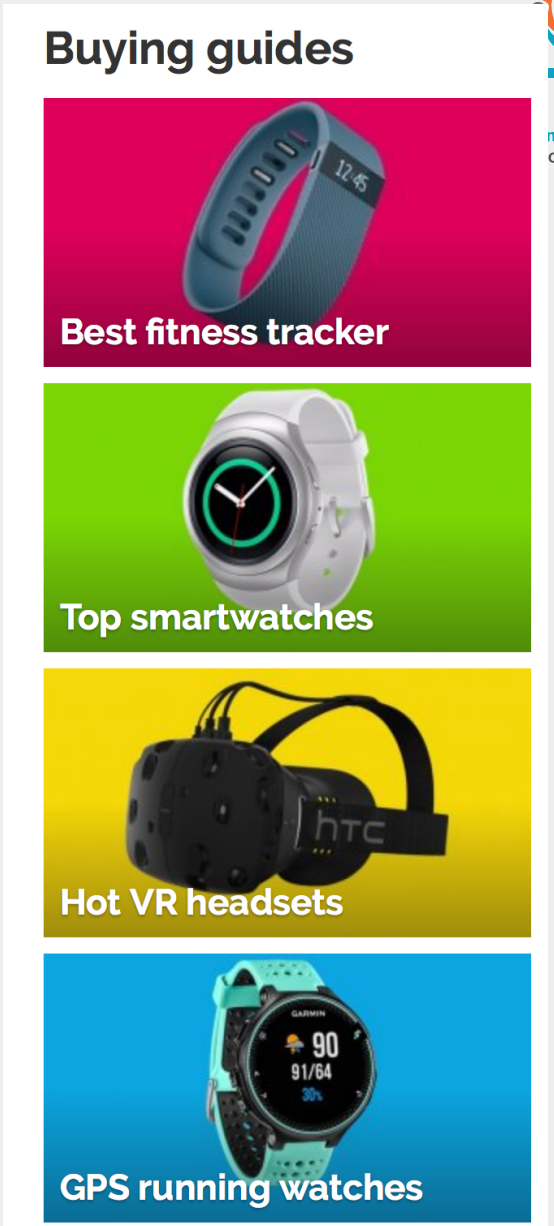
http://pinterest.com/hbir/self-omics-self-monitoring-quantified-self-omics/

QS Lab

How to find the best SQS…

- Wellocracy.com
- Wareable.com
- vandrico.com/wearables/

	Absalt EasyWakeup	Azumio Sleep Time	Basis Peak	Beddit
Price	$4.99	$0.00	$199.99	$149.00
Device or App	App	App	Device	Device
Tracks sleep duration	✓	✓	✓	✓
Tracks sleep	✗	✗	✓	✓
Tracks deep sleep/little	✓	✓	✓	✓
Tracks light sleep/more	✓	✓	✓	✓
Tracks awake	✗	✗	✓	✓
Has sleep score	✗	✓	✓	✓
Where to put it	On bed	On bed	Wrist	On bed



Samsung Welt

And other 437 devices from 304 companies

Grab File Edit Capture Window Help (100%) Wed 9:46 PM
DEVICES_INVENTORYBACKUP.xlsx
Home Layout Tables Charts SmartArt Formulas Data Review

SELF QUANTIFICATION DEVICES

CLASSIFICATION	MANUFACTURER	DESCRIPTION	MODEL	ORDER DATE	DELIVERY DATE	AMOUNT	PRIZE ($)	TOTAL PRIZE($)
Physical activity	FITBIT	Fitbit Zip Wireless Activity Tracker	Fitbit Zip	6/09/13	6/09/13	1	69.95	69.95
		Fitbit Zip Clip	charcoal-FB150ZC-CL	2/08/13	23/08//2013	1	10.95	10.95
		Fitbit One Wireless Activity and Sleep (TrackerSteps taken, calories burned, distance travelled and hours of sleep)	Burgundy-FB103BY	2/08/13	12/08/13	1	119.95	119.95
		Fitbit Flex Wireless Activity Wristband (Activity and sleep)	FB401SL	2/08/13	12/08/13	1	119.95	119.95
	JAWBONE	Jawbone Up	Jawbone Up	18/08/13	18/08/13	1	130	130
	MISFIT	Misfit Shine Activity Tracker	Shine	6/09/13	16/09/13	1	144.95	144.95
	LUMO BODYTECH	Lumoback Posture	Lumoback Posture	6/09/13	13/09/13	1	187.9	187.9
	BODYMEDIA	BodyMedia FIT + Armband Display (Diet, exercise and sleep efficiency)	BS100734	2/08/13	23/08//2013	1	279	279
		BodyMedia FIT Large Armband Strap	BS100628	2/08/13	12/08/13	1	24.95	24.95
		BodyMedia FIT Wearable Display	BS100735	2/08/13	12/08/13	1	129	129
		BodyMedia FIT Display Wristband	BS100179	2/08/13	12/08/13	1	24.95	24.95
Scales and weight	FITBIT	Fitbit Aria Wi-Fi Smart Scale	FB201B	8/02/13	23/08//2013	1	147	147
	WITHINGS	Withings WS-50 Smart Body Analyzer Wireless Scale	2388072	8/02/13	12/08/13	1	199.95	199.95
Sleep	ZEO	Zeo Mobile Sleep Management System (Weight, Body fat, Heart Rate, Air Quality)	ZEOMBL1	8/02/13	23/08//2013	1	149	149
	GEAR4	Renew SleepClock	GEA4	8/02/13	12/08/13	1	149	149
	INNOVATIVE SLEEP SOLUTIONS	SleepTracker	SleepTracker	6/09/13	9/09/13	1	195.9	195.9
Biochemical	SANOFI DIABETES	IBGstar (Blood glucose level)	IBGstar	6/09/13	10/09/13	1	99	99
Blood pressure and Cardiovascular health	IHEALTH	iHealth Wireless Blood Pressure Monitor Upper Arm Cuff (Blood pressure)	ZRYBP5	8/02/13	12/08/13	1	149	149
		iHealth Wireless Pulse Oximeter	ZRYPO3	8/02/13	12/08/13	1	79.95	79.95
	BEURER	Beurer Upper Arm Digital Blood Pressure Monitor	BM58	8/02/13	12/08/13	1	149	149
		Beurer Mobile ECG Device	ME80	8/02/13	12/08/13	1	399	399
	TINKE	Tinke Heart Rate Monitor	4/4S	8/02/13	12/08/13	1	129	129
TOTAL								3087.35

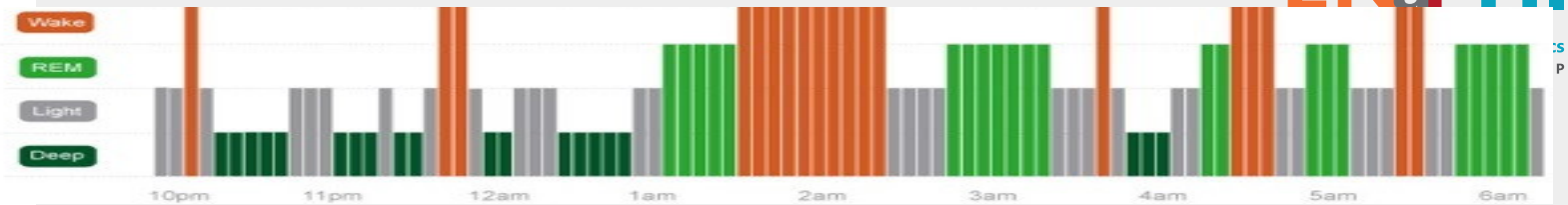
Hoja 1 - Tabla 1
Melbo... alias melbourne UniMelb alias

Comparison of five self-monitoring devices that measure physical activity

	FITBIT FLEX (Activity + Sleep Wristband)	FITBIT ZIP (Activity tracker)	FITBIT ONE Activity + Sleep tracker)	JAWBONE UP (Activity + Sleep Wristband)	NIKE FUELBAND (Activity Wristband)
STEPS	Yes	Yes	Yes	Yes	Yes
CALORIES BURNED	Yes	Yes	Yes	Yes	Yes
DISTANCE TRAVELLED	Yes	Yes	Yes	Yes	Yes
ACTIVE MINUTES	Yes	No	No	Yes	Fuel activity
SPEED	No	No	No	Yes	No
FLOORS CLIMBED	No	No	Yes (it has an altimeter)	No	No
SLEEP TIME	Yes	No	Yes	Yes	No
NUMBER OF TIMES AWOKEN	Yes	No	Yes	Yes	No
TIME SPENT IN DEEP VS. LIGHT SLEEP	No	No	No	Yes	No
QUALITY OF SLEEP	Yes	No	Yes	Yes	No
TO WAKE SILENTLY	Silent alarm	No	Silent alarm	Silent alarm. It vibrates the band up to 30 minutes ahead of your designated waking up time if it senses you are sleeping lightly around that time	No
POWER NAP	No	No	No	Yes. UP will wake you up at the optimal time (around 26.5 minutes) after you fall asleep	No
CLOCK	No	Yes	Yes	No	Yes
DISPLAY	5 LEDs that represent step progress for the day	There's an LCD (liquid crystal display) that shows the data when you touch it: steps, distance, calories burned, smiley and clock. The screen is not backlit	There's an OLED (organic light-emitting diode) display. Push button control: Each push cycles through one of six modes: steps, distance, calories burned, Floors climbed, Flower (grows and shrinks based on your recent activity)and Clock. The screen is backlit	Dual LEDs: it has a button to put the band into various modes. No data readouts on band itself	20 LEDs Push the single button on the band and you can see: steeps, calories, time and fuel
MOOD	No	No	No	Yes	Yes

HOW TO SYNC THE DEVICE WITH A COMPUTER OR PHONE	Wirelessly with a dongle plugged into your computer PC and select smartphones. Bluetooth 4.0. (within about 20 feet of the wireless sync dongle)	Wirelessly with a dongle plugged into your computer PC and select smartphones. Bluetooth 4.0. (within about 20 feet of the wireless sync dongle)	Wirelessly with a dongle plugged into your computer PC and select smartphones. Bluetooth 4.0. (within about 20 feet of the wireless sync dongle)	Just plug it in (you can do so by either plugging it directly into your USB port, or using the USB cable and dock provided with your FuelBand)	Bluetooth with a smartphone app (iOS-exclusive). Syncs are a little less tempting than with the Jawbone UP or Fitbit Flex
PC & MAC REQUIREMENTS	Windows XP/Vista/7/8, Mac OS X 10.5 and up, USB port and Internet connection	Windows XP/Vista/7/8, Mac OS X 10.5 and up, USB port and Internet connection	Windows XP/Vista/7/8, Mac OS X 10.5 and up, USB port and Internet connection	It doesn't work with personal computers	Windows XP/Vista/7/8, Mac OS X 10.5 and up, USB port and Internet connection
COMPATIBLE MOBILE PHONES	Last phones with either iOS-iPad, iPhone or iPod-or high-end Android Samsung 2012 and 2013	Phone 4S, 5,iPad 3, Retina,iPad mini, iPod touch, 5th generation, Samsung Galaxy S4,Samsung Galaxy S III, Samsung Galaxy Note II, Samsung Galaxy Note 10.1	iPhone 4S, 5,iPad 3, Retina, iPad mini, iPod touch, 5th generation, Samsung Galaxy S4,Samsung Galaxy S III, Samsung Galaxy Note II, Samsung Galaxy Note 10.1	iPhone and iPod: iOS 5.1 or greater and Android 4.0 (Ice Cream sandwich) or later	Only with iOS 5.0+
CHARGING THE DEVICE	Extra dongle that interface with USB (a proprietary docking port)	Extra dongle that interface with USB (a proprietary docking port)	Extra dongle that interface with USB (a proprietary docking port)	Extra dongle that interface with USB (a 3.5 mm-to-USB converter)	It plugs directly into a USB port, because it's a loose fit and lacks the external USB structure

zeo
8:32


Wake
REM
Light
Deep
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11pm
12am
1am
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3am
4am
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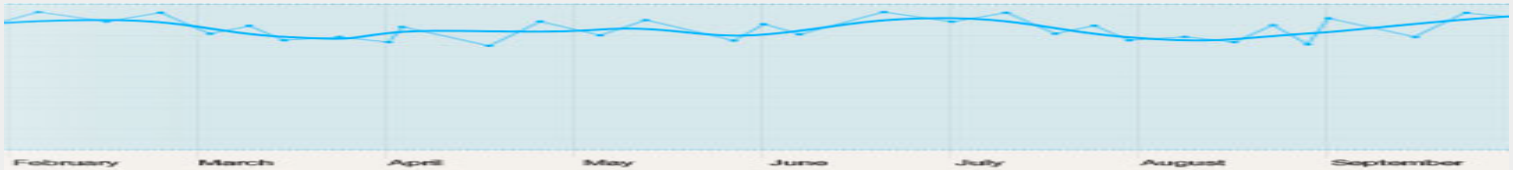
6am


February
March
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July
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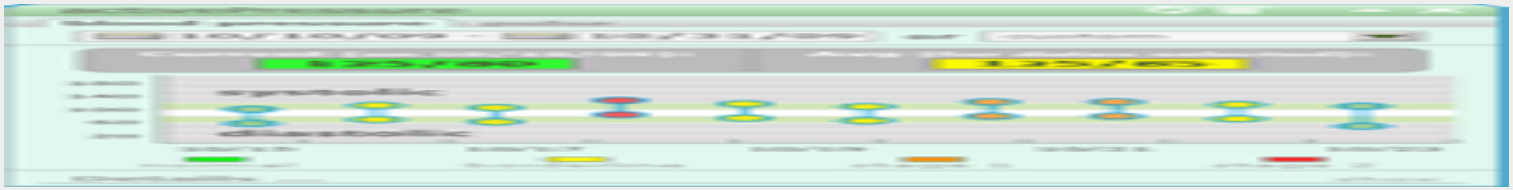
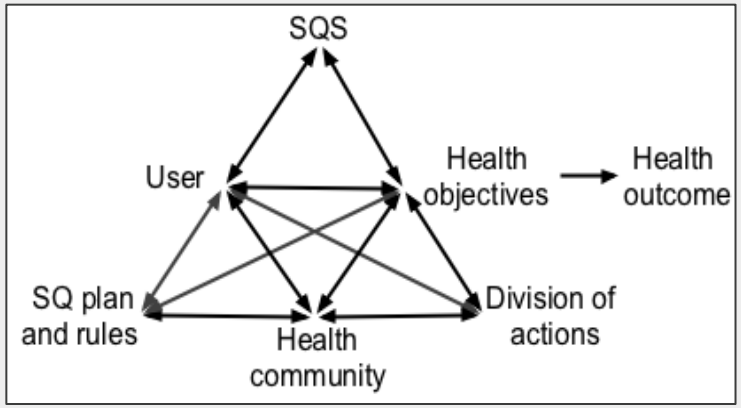
September

120
80
72



Sedentary
Lightly Active
Active
Fairly Active
Very Active
Athletic

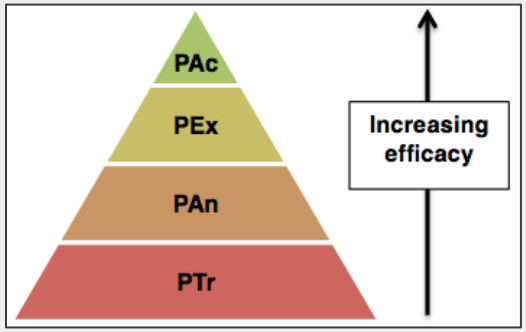
White Paper

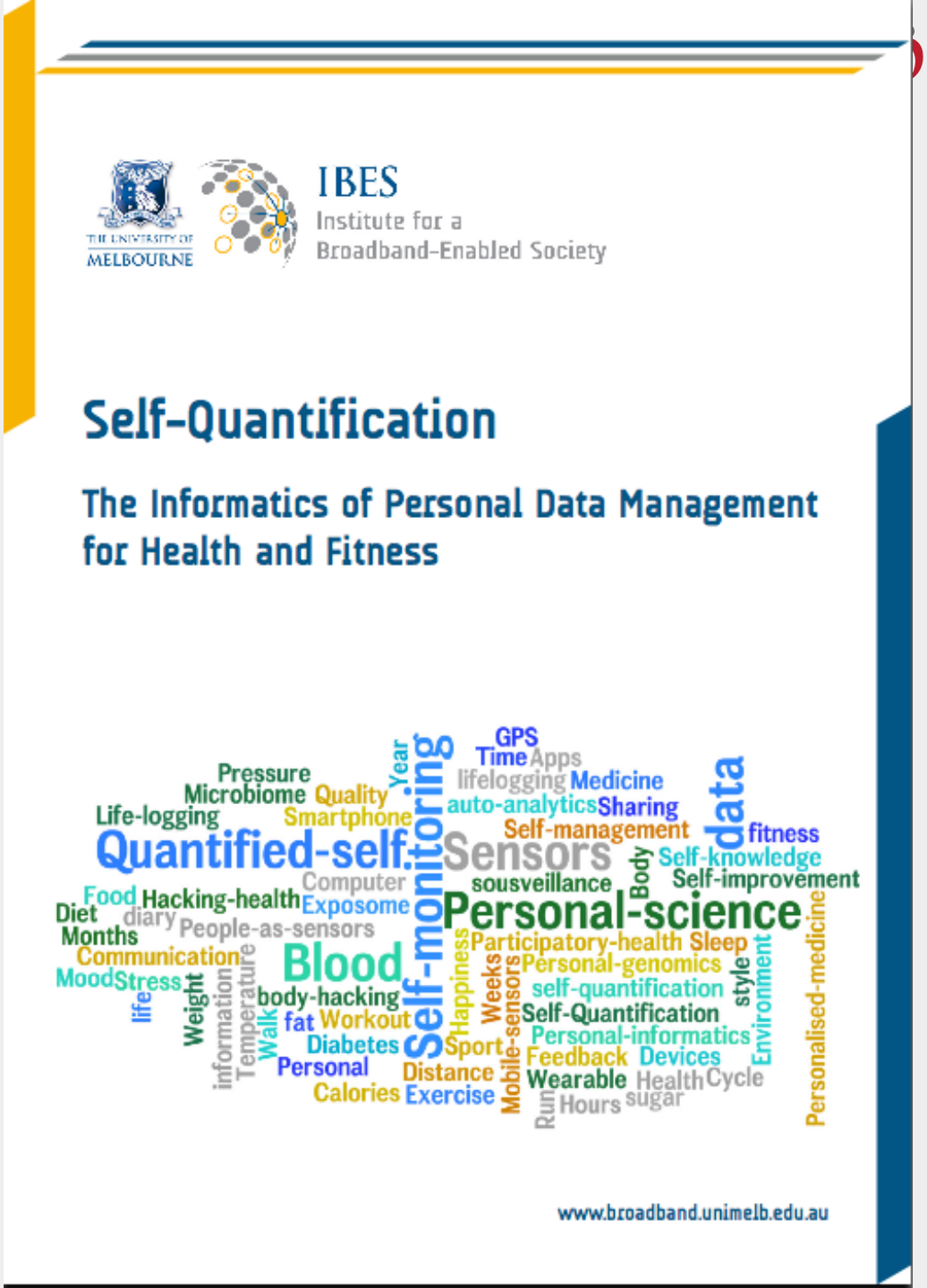


Activity Theory

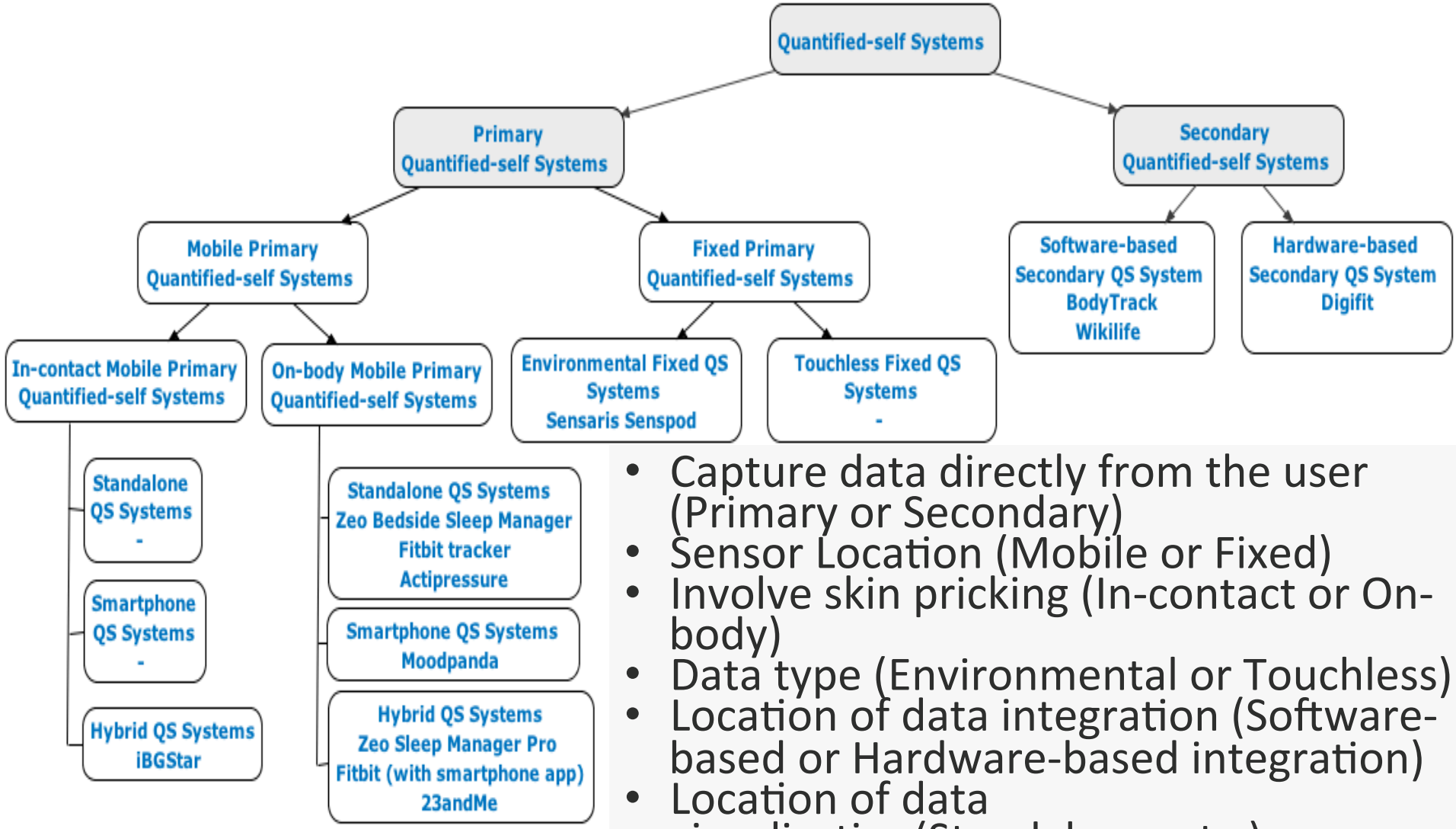
+

Patient Activation





Classification of self-quantification systems

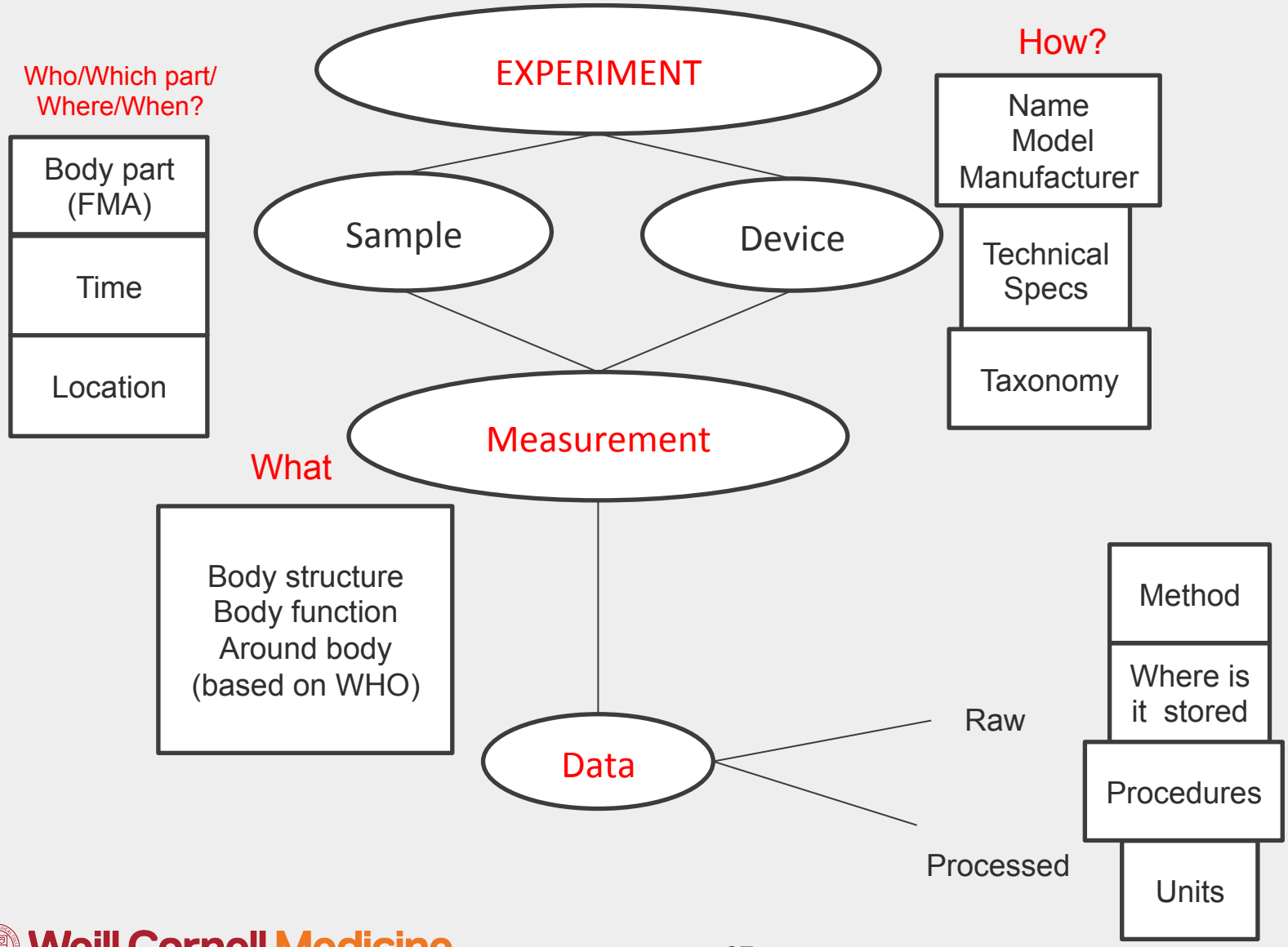


- Capture data directly from the user (Primary or Secondary)
- Sensor Location (Mobile or Fixed)
- Involve skin pricking (In-contact or On-body)
- Data type (Environmental or Touchless)
- Location of data integration (Software-based or Hardware-based integration)
- Location of data visualisation(Standalone, etc.)

Classification of Data and Activities

#	Body structures and functions	Body actions/activities	Around body
1	Mental functions	Learning and applying knowledge	Relationships and attitudes
2	Sensory functions	Communication	Products or substances for personal consumption
3	Sensation of pain	Mobility	Products and technology for use
4	Voice and speech functions	Self-care	Natural environment and human-made changes to environment
5	Cardiovascular system	Domestic life	
6	Haematological system	Interpersonal interactions	
7	Immunological system	Education	
8	Respiratory system	Work and employment	
9	Digestive system	Economic life	
10	Metabolic system	Recreation and leisure	
11	Endocrine system	Religion and spirituality	
12	Genitourinary functions		
13	Reproductive functions		
14	Body structures		
15	Skeletal system		
16	Muscular system		
17	Nervous system		
18	Skin		
19	Hair		
20	Nails		
21	Genome (DNA, RNA and genes)		
22	Microbes		

Minimum Information about a Self Monitoring Experiment (MISME)



Data integration methods

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iBGStar

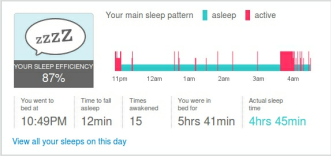
Glucose Meter integrated with iPhone

Zeo sleep monitor

FitBit

All-in-one-Platforms

PCEHR



Individual analysis

Integrated Analysis

Terminology

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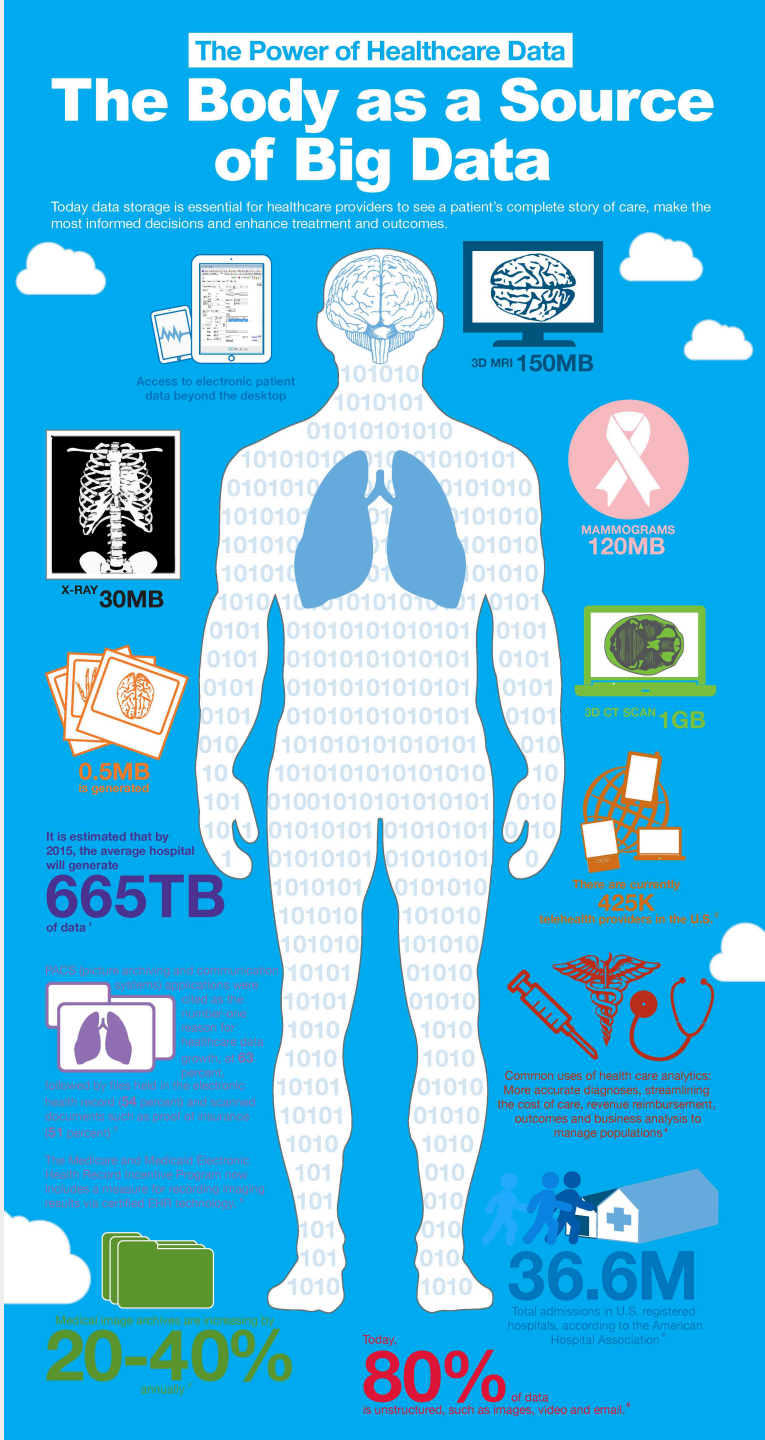
- Self-quantification, converting manually or automatically the collected data into numbers or categories.
- Self-monitoring, on the other hand, is more like watching a specific health factor to ensure keeping it at a satisfactory level and this requires regular medical interventions such as monitoring blood glucose.
- Self-tracking or life-logging can be described as continuous recording of one or more health factors for future use.
- For example, keeping diaries is a form of self-tracking while turning these unstructured data into numbers and categories is self-quantification.
- Self-tracking and self-quantification together could be described as self-monitoring.

Self-Omics

- QS as an interface to the Human Body
- How much information?
- Requirements for exchange, storage and processing of data
- People-as-sensors
- Making the personal public
- The transparent body
- From population surveillance to individual surveillance

Infography:
Institute for Health Technology Transformation

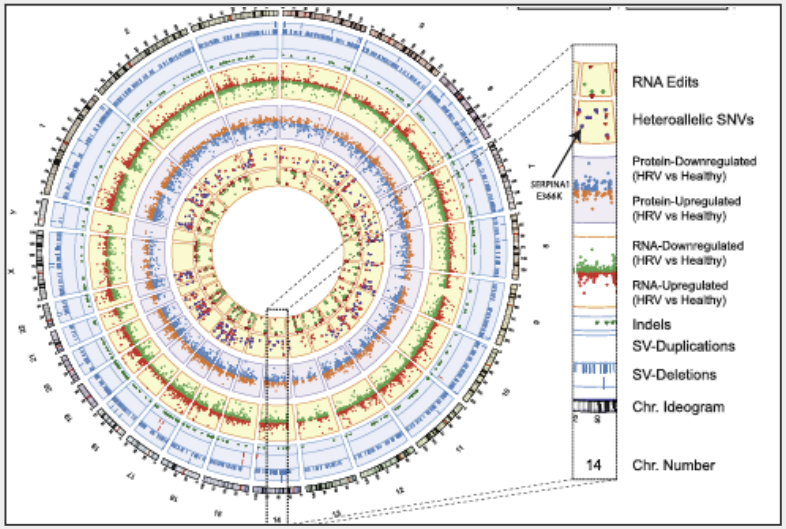


How much information

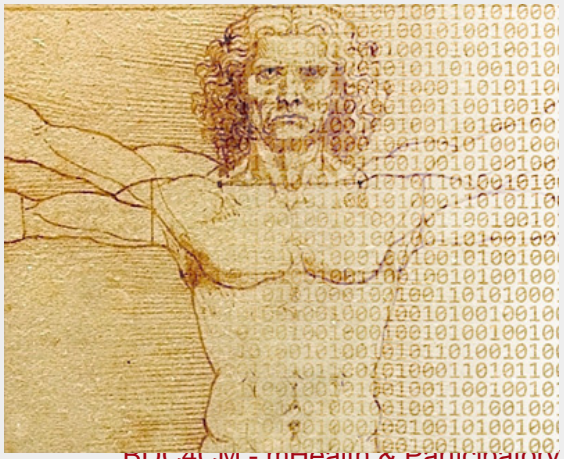
CR (computer radiography) 30 MB
DR (direct radiography) 54 MB
Computer Tomography (CT) - 32 MB
Multi-Slice CT - 630 MB
Magnetic Resonance 21 MB
Angio 15 MB

The project "Experimental Man" reports that one man has been collecting information about his exposure to toxins and has generated +100GB of data (only toxins)

Individual genome data:: from 20MB to 30 TB
3 Billion data points were collected along 20 time points during 14 months.
150 million data points per analysis.
Microbioma (gut) 35GB



(Chen et al, Cell 148, 1293-1307 March 16 2012)



BBC -

http://www.bbc.com/earth/story/the-making-of-me-and-you#/results/top

Data storage

Open mHealth

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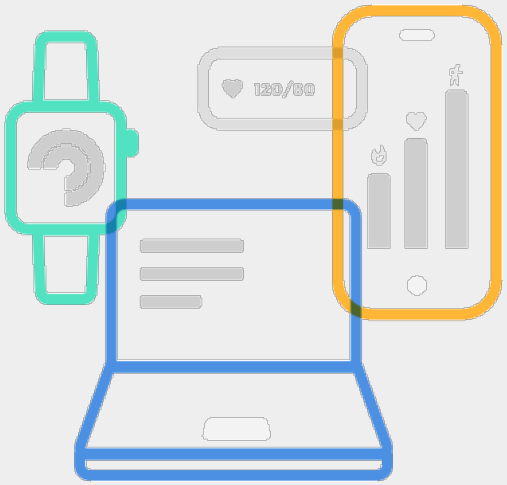
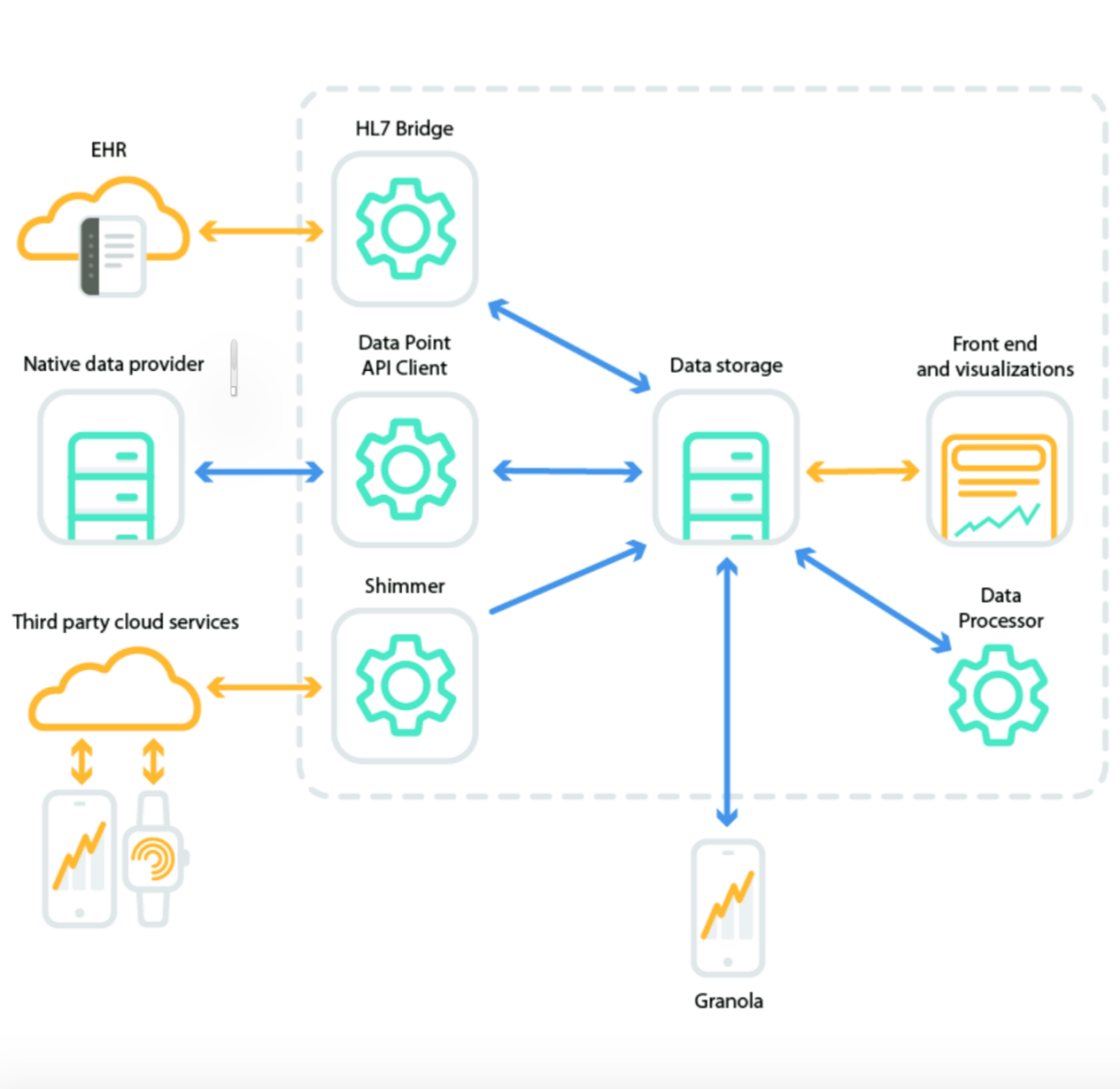
- Free, open-source code that makes it easy for developers to standardize, store, integrate, share, process and visualize mobile health data
  - Simple extensible and clinically valid schemas
  - RESTful API
    - Conforms to schemas
    - Authorizes access using Oauth 2.0
  - Open-source adapters linked to the APIs of large providers (e.g., RunKeeper, Fitbit, Google, Apple)
  - Library of visualization examples



Open mHealth

Open mHealth



Infinome – open science

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infinome

Connect a tracker:

Fitbit Jawbone Withings

Beddit

Connect with 23andMe

Share

#TRUTH

The obesity problem is killing most of us.

7 IN 10 AMERICANS WEIGH TOO MUCH

Synapse (SAGE)

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Mint a DOI for your work - and describe exactly what you did using Synapse provenance.

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Sage Bionetworks @Sagebio

Proud to announce @DR_E_A_M digital mammography challenge, part of our commitment to the #CancerMoonshot #CanServe synapse.org/#!Synapse:syn4…

29 Jun

HELP

Synapse Tutorial

Synapse is an open source software platform that data scientists can use to carry out, track, and communicate their research in real time.

This tutorial steps you through how to create your first Project, store your research data, share with your

Programmatic Clients

Synapse is designed to easily integrate into your current work. That's why we've created the following clients so that you can interact with all of Synapse's functionality programmatically. Create projects, upload & download files, generate provenance, query, create wikis and more all from the comfort of your own code.

Don't see your language of choice here? Check out our full REST API documentation

R client | Python client | Command line | Java client

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Data aggregation and integration

All-in-one platforms for digital health

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- WebMD - Healthy Target
- Philips Salesforce
- Samsung – S.A.M.I ARTIK cloud
- Apple – HealthKit
- Google – Google Fit
- Microsoft HealthVault
- Qualcomm Life – 2net
- Validic
- Open Humans
- Human API

PHILIPS salesforce
Philips and salesforce.com announce a global strategic alliance.

VALIDIC

Google Fit

Human API

SAMI
Samsung Architecture Multimodal Interactions

HealthKit

Microsoft HealthVault

2net™ by Qualcomm Life

WebMD Healthy Target

Shimmer (Cornell Tech)

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Integrations

Shimmer supports some of the best-in-breed apps and devices. To see the next set of tools we'll be supporting, check it out on Github.

Fitbit

Google Fit

Runkeeper

Misfit

UP by Jawbone

Withings

iHealth

Samsung ARTIK Cloud

https://artik.cloud/works-with

Wolfram Connected devices

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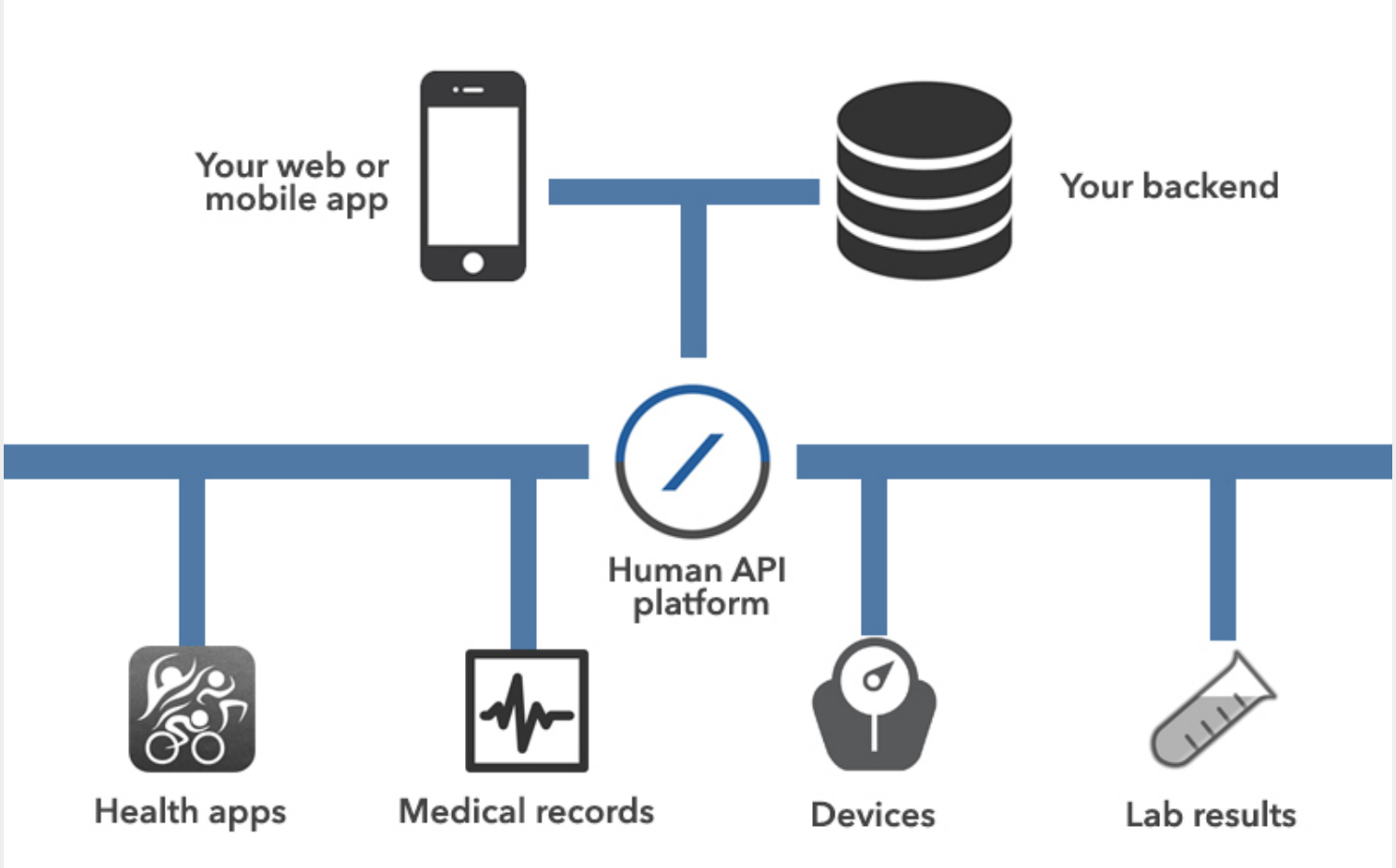
http://devices.wolfram.com

Validic

Named “de facto” standard

Human API


Your web or mobile app
Your backend
Human API platform
Health apps
Medical records
Devices
Lab results

Integration into PHR

- eClinicalWorks Announces Integration Between Wearable Devices and healow Platform
- Fitbit, iHealth, Jawbone and Withings

eClinicalWorks

"Improving Healthcare Together"

https://www.eclinicalworks.com/pr-eclinicalworks-announces-integration-between-wearable-devices-and-healow-platform/

Apple to add support for HL7 Continuity of Care Documents to iOS 10

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- iOS 10 will be available this fall.

- "Bloomfield (Duke): "It will enable any app to create and share a CCD with HealthKit, and another app can read that by using HealthKit."
- So a doctor can create a CCD, let her patients have that, and patients, in turn, can share that document with other caregivers and clinicians.
- Apple has not made an official announcement yet.

EHR integration with HealthKit

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- 2014 - Ochsner Health System in Louisiana
- 2015 - Deaconess Health System in Indiana integrates Fitbit into EHR portal
- 2015 - Duke is using HealthKit to get patient-generated data into the EHR.
- 2015 - Cerner with Validic
- 2015 - EPIC MyChart at Cornell Medicine has full HealthKit functionality

SMART on FHIR®

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- Medical apps that integrate into diverse EHR systems at the point of care.

- Open standards for healthcare data, authorization, and UI integration.

- Harvard Medical School and Boston Children's Hospital
- SMART Reference Platform, - custom set of data models and a corresponding RESTful API.
- *In 2014, FHIR® arrived: Fast Health Interoperability Resources.*
- FHIR is open healthcare data standard from HL7.
- Like SMART, FHIR provides for RESTful access to clean, granular data.
- FHIR specifically represents granular clinical concepts as a set of resources that may be addressed individually or in aggregate.

- **SMART on FHIR**
- SMART on FHIR, will provide a complete open standards-based technology stack.
- With SMART on FHIR, developers can integrate a vast array of clinical data with ease.

C3-PRO

The **C**onsent, **C**ontact and **C**ommunity framework for **P**atient **R**eported **O**utcomes

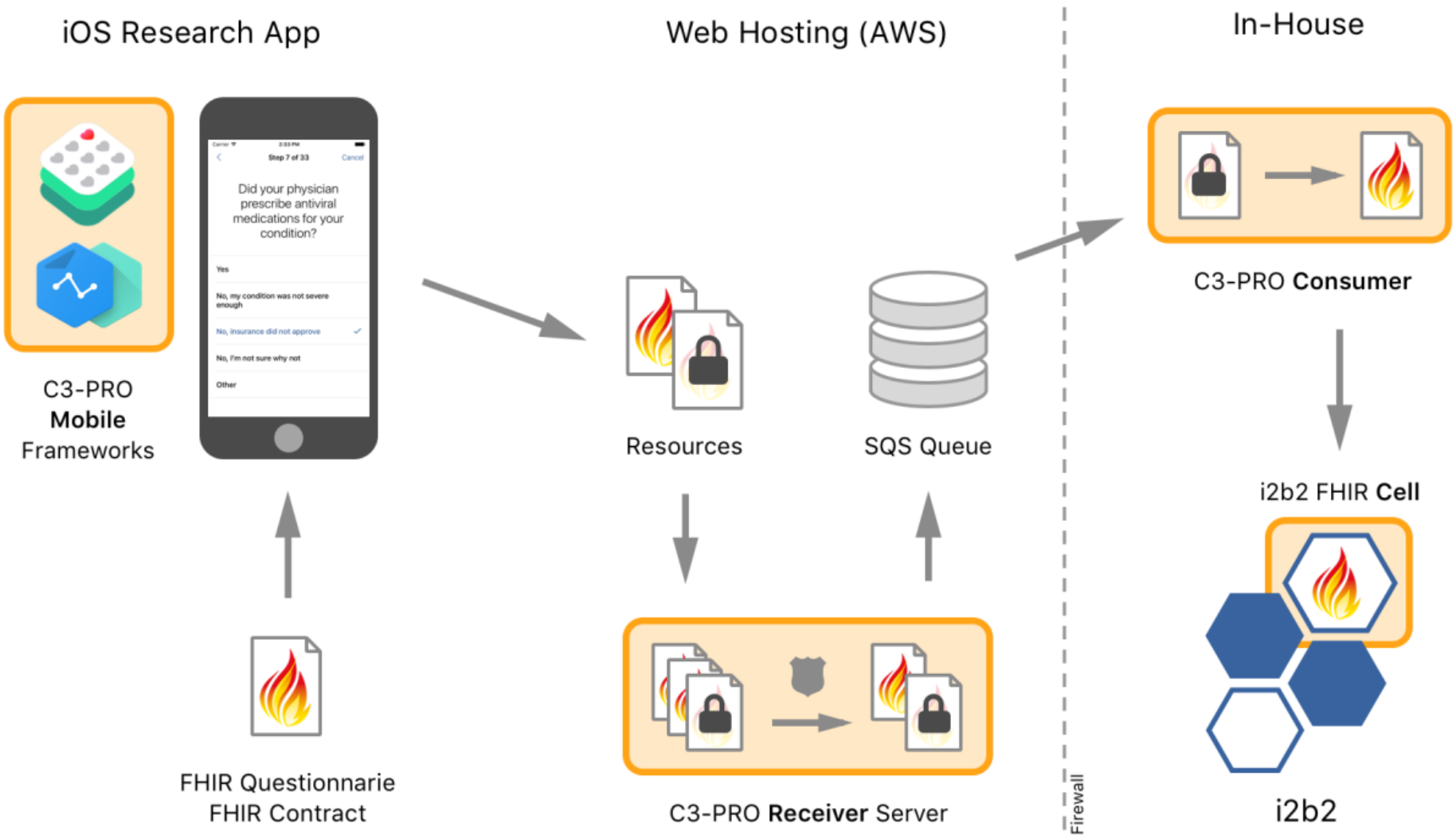
A set of FHIR® compliant research software tools for ResearchKit and ResearchStack

What is C3-PRO?

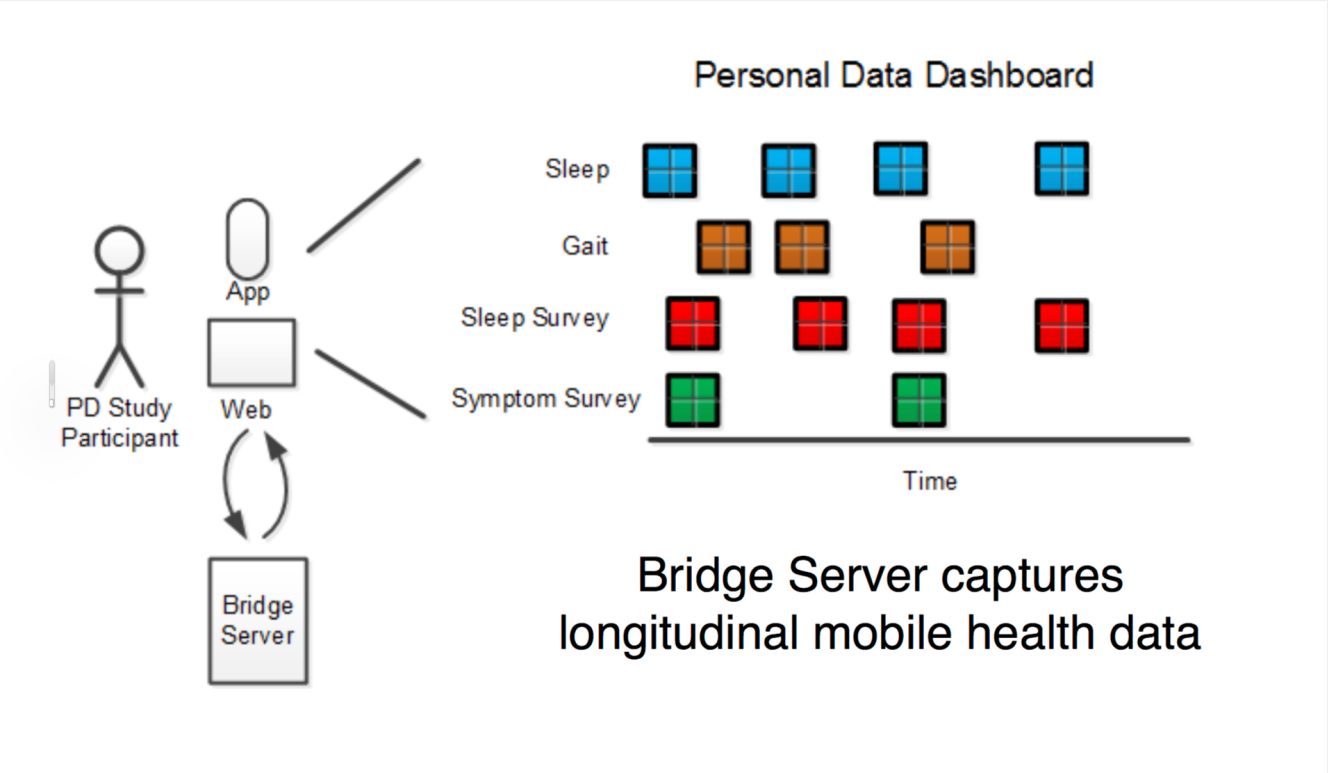
For Developers

Modules!

http://c3-pro.org


iOS Research App
Web Hosting (AWS)
In-House
C3-PRO
Mobile
Frameworks
Step 7 of 33
Cancel
Did your physician prescribe antiviral medications for your condition?
Yes
No, my condition was not severe enough
No, insurance did not approve
No, I'm not sure why not
Other
Resources
SQS Queue
C3-PRO Consumer
i2b2 FHIR Cell
FHIR Questionnarie
FHIR Contract
C3-PRO Receiver Server
Firewall
i2b2

SAGE Bionetworks Bridge + Synapse



OHMAGE-omh (Cornell Tech)

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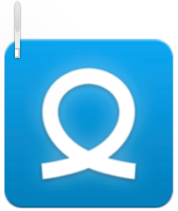
Downloadable Applications

Mobility-omh

Continuous passive measurement for activity and location

PAM-omh

Visual tool for affect/mood self-report



ohmage-mobile

Platform for distributing data collection surveys and acquiring survey responses

fitbit

Third Party Applications

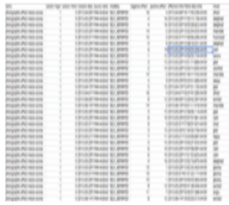
commercial applications such as Moves or Fitbit integrated through Open mHealth shims

Admin Dashboard

retrieve data from authorized participants of their studies

User Management

Data Visualization



Data Retrieval

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From information to knowledge

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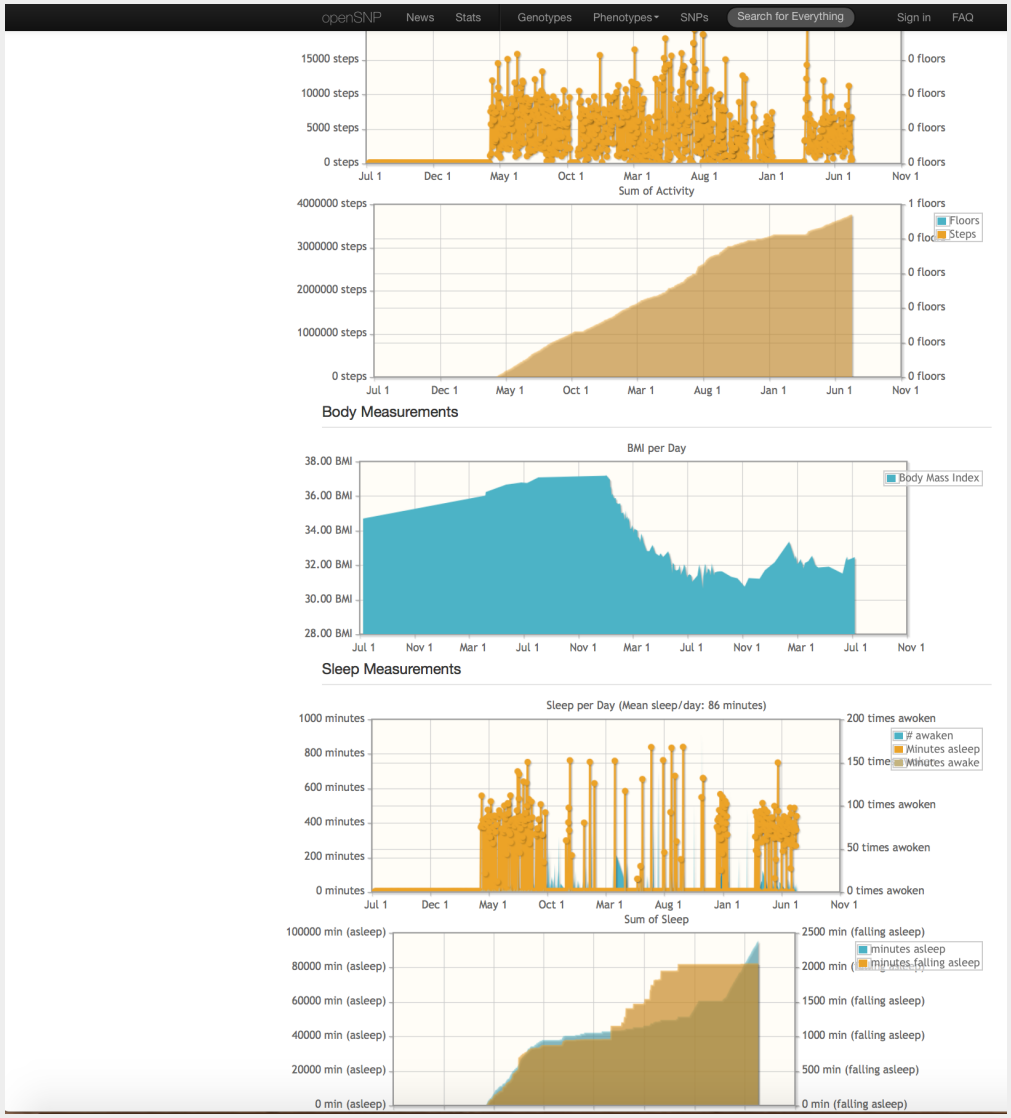
Data access

OpenSNP



https://opensnp.org/fitbit/

mPower

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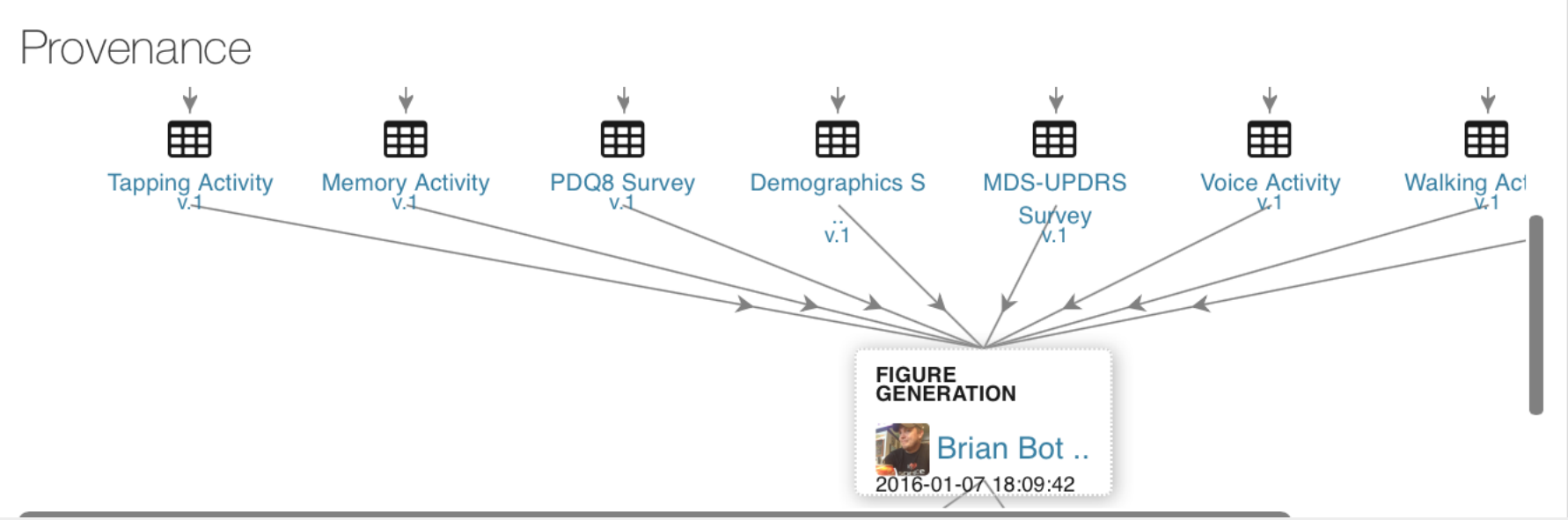
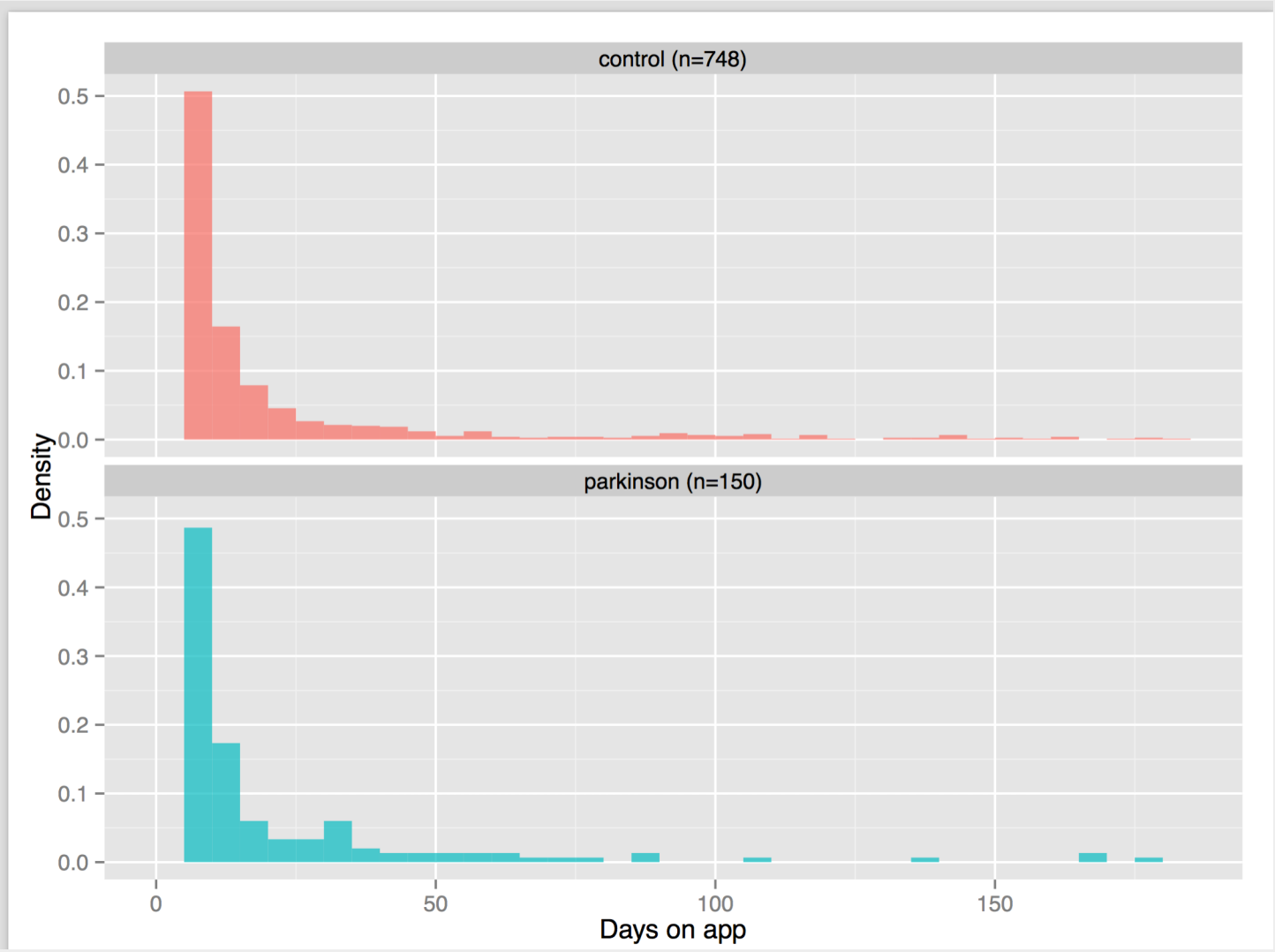
- First six months of data from the app. mPower, a Parkinson's-focused app, one of the first five Apple ResearchKit studies
- Of the 12,000 mPower study participants, about 9,500 participants chose to share their data with all researchers.
- mPower stands for "mobile Parkinson's observatory for worldwide, evidence-based research".
- The mPower app aims to help users track their symptoms using activities including a memory game, finger tapping, speaking, and walking. The app will also collect data from wearable devices

mPower


Provenance
Tapping Activity v.1
Memory Activity v.1
PDQ8 Survey v.1
Demographics S .. v.1
MDS-UPDRS Survey v.1
Voice Activity v.1
Walking Act v.1
FIGURE GENERATION
Brian Bot ..
2016-01-07 18:09:42

mPower


control (n=748)
parkinson (n=150)
Density
0.5
0.4
0.3
0.2
0.1
0.0
0
50
100
150
Days on app

Data analysis

Challenges

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- Comparative usage—how your consumption of a resource (for example, calories) compares with others in similar situations
- Understanding patterns and reasons for variation—developing statistical models that explain variation
- Predictive asset maintenance—using sensor data to detect potential problems in machinery (or your body) before they actually occur
- Optimization—using sensor data and analysis to optimize a process, as when a lumber mill optimizes the automated cutting of a log, or a poultry processor automates the preparation of a chicken, or when is the healthiest time to go to sleep or when in your sleep cycle to wake up
- Prescription—employing sensor and other types of data to tell the user what to do, as when an activity tracker nudges you to get off the couch or sit up straight
- Situational awareness—piecing together seemingly disconnected events and relating them to a larger repository of data to put together an explanation, as when a series of readings from activity trackers, glucose monitors, connected scales, and other devices tells you that you are in danger of contracting diabetes

http://dupress.com/articles/internet-of-things-wearable-technology/

Analyzing and interpreting smartphone data

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Preprint

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"*PeerJ Preprints*" is a venue for early communication or feedback before peer review. Data may be preliminary.
Learn more about preprints or browse peer-reviewed articles instead.

A framework for smartphone-enabled, patient-generated health data analysis

Evidence Based Medicine | Translational Medicine | Science and Medical Education | Human-Computer Interaction | Computational Science

Shreya S Gollamudi [1], Eric J Topol [1,2,3], Nathan E Wineinger [1]

March 30, 2016

Analyzing and interpreting smartphone data

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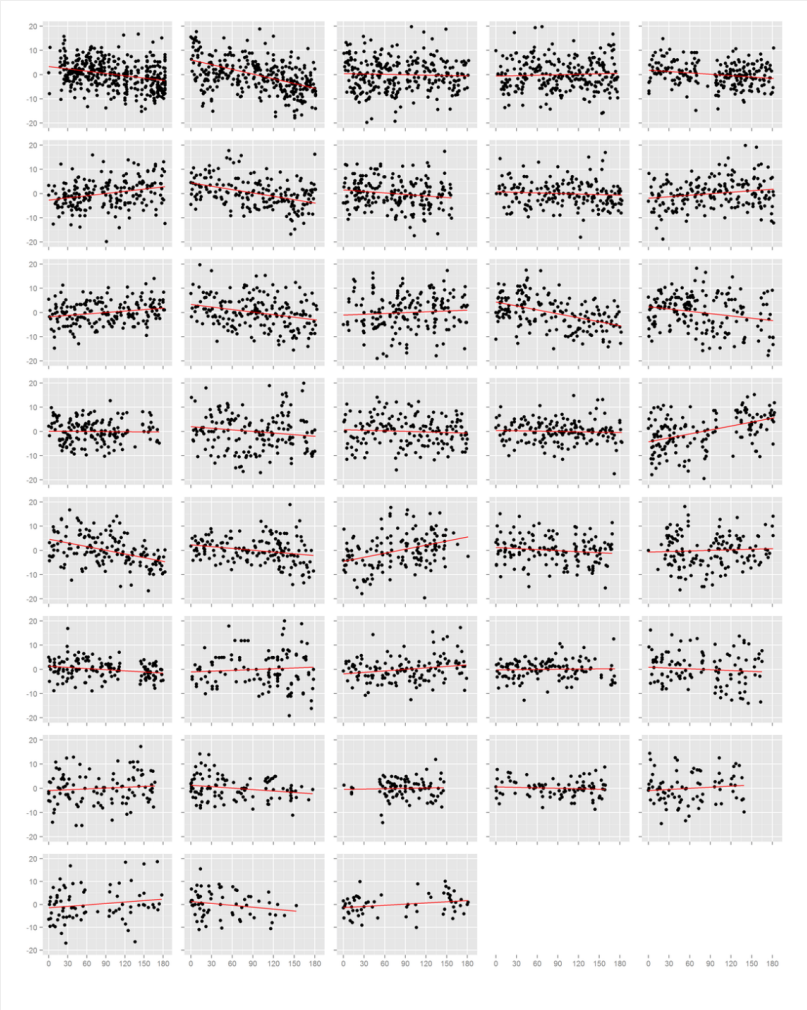
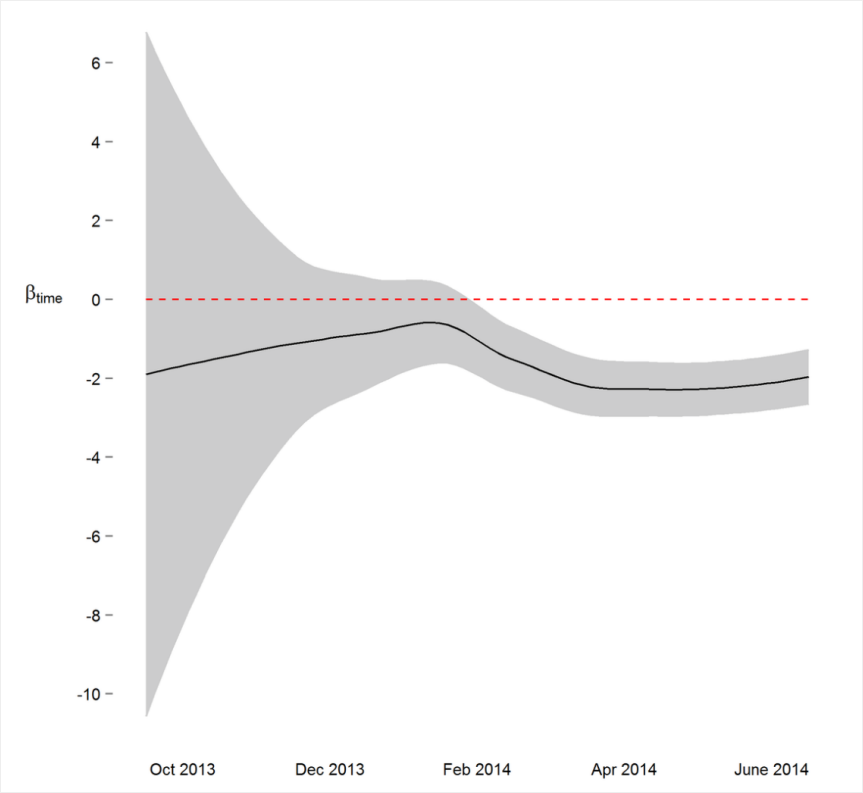
- 38 individuals, 6290 blood pressure readings over a 11-month trial
- Withings BP monitor, iphone app, HealthyCircles account and app. Qualcomm Life Health HealthyCircles server.
- Hypothesis testing framework for unstructured time series data.
- Mixed model approach using autoregressive models
  - Multiple n-of-1 (analysis of individual data)
  - Combination of all individuals data
- 2mmHg decrease in both systolic and diastolic
- Sequential analysis approach allowed them to observ results three months prior to the official study end.

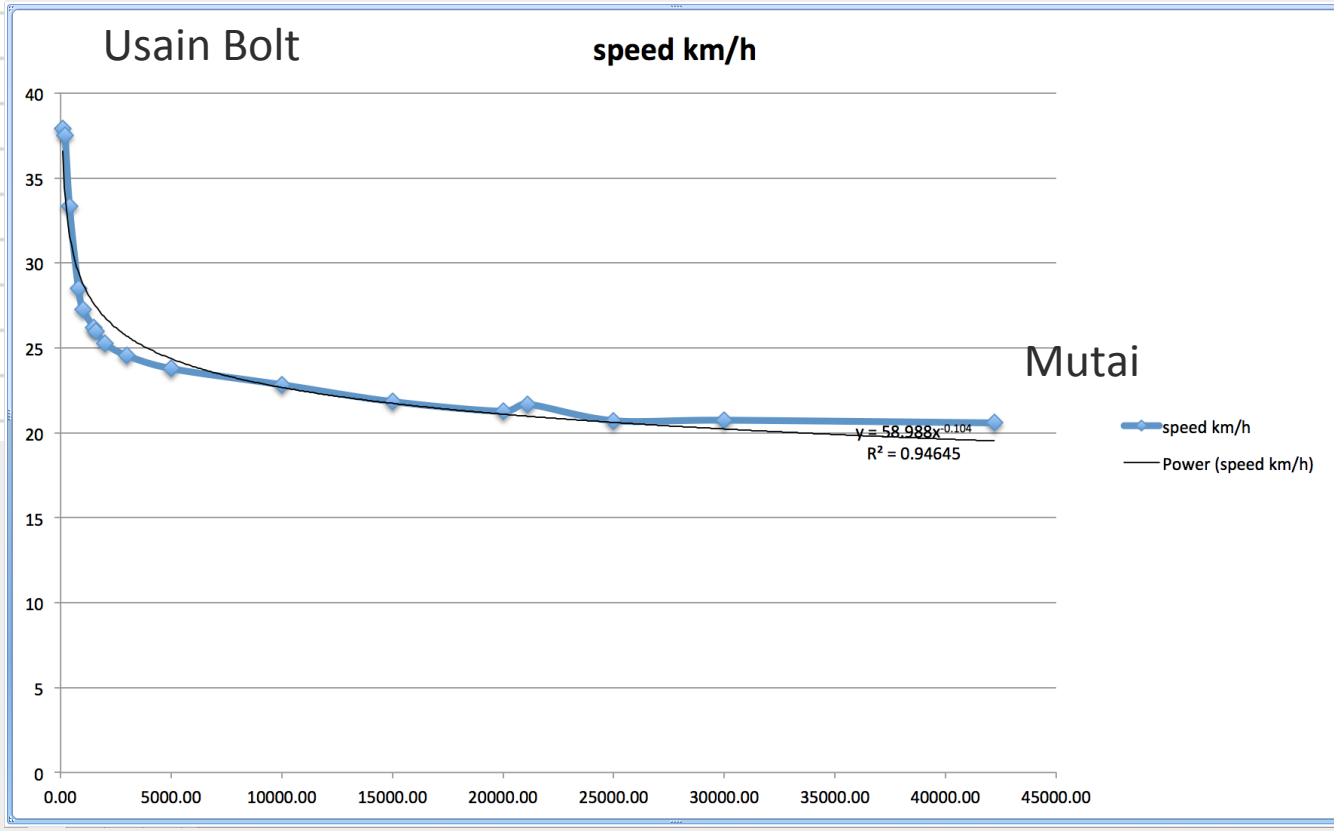
Analyzing and interpreting smartphone data



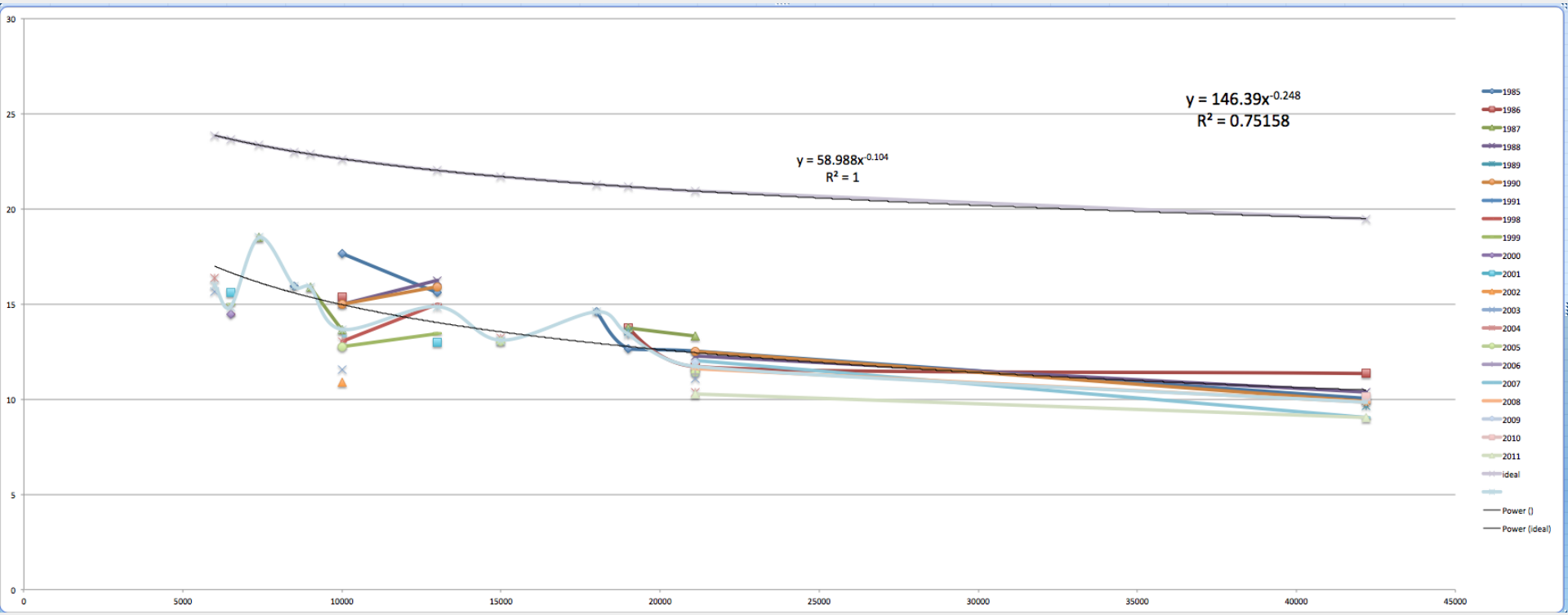


Athletics World Records

distance	t	speed
100.00	9.5	10.5263158
200.00	19.2	10.4166667
400.00	43.2	9.25925926
800.00	101	7.92079208
1000.00	132	7.57575758
1500.00	206	7.2815534
1609.00	223	7.21524664
2000.00	285	7.01754386
3000.00	440	6.81818182
5000.00	757	6.60501982
10000.00	1577	6.34115409
15000.00	2473	6.06550748
20000.00	3386	5.90667454
21095.00	3503	6.02198116
25000.00	4345	5.75373993
30000.00	5207	5.76147494
42195.00	7380	5.71747967



PREDICTIVE MODEL



IF distance=6km and time=25.30 (speed=14km/h)
THEN 42.195km → 4h 10m

Results

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- More than 80 races completed, including 12 Marathons and 21 Half-Marathons
- No injuries

- No competitive goal or performance improvement
- Decision making tool (whether to run or not to prevent damage and ensure having a good time – less than 5 hours)

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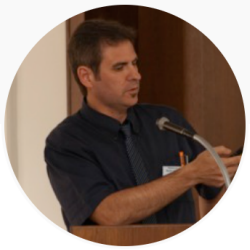
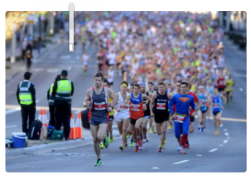
THE CONVERSATION US PILOT



Fernando Martin-Sanchez

Director, Health and Biomedical Informatics Centre (HaBIC), University of Melbourne

Profile | **Articles** | Activity



September 4, 2013

How can big data go the distance for runners (and the rest of us)?

Fernando Martin-Sanchez, *University of Melbourne*

The number of Australians running or jogging has almost doubled since 2005-06 and - with the rise of smartphones - running and fitness app development has also exploded. So how many of these runners have…

EMORY | news center

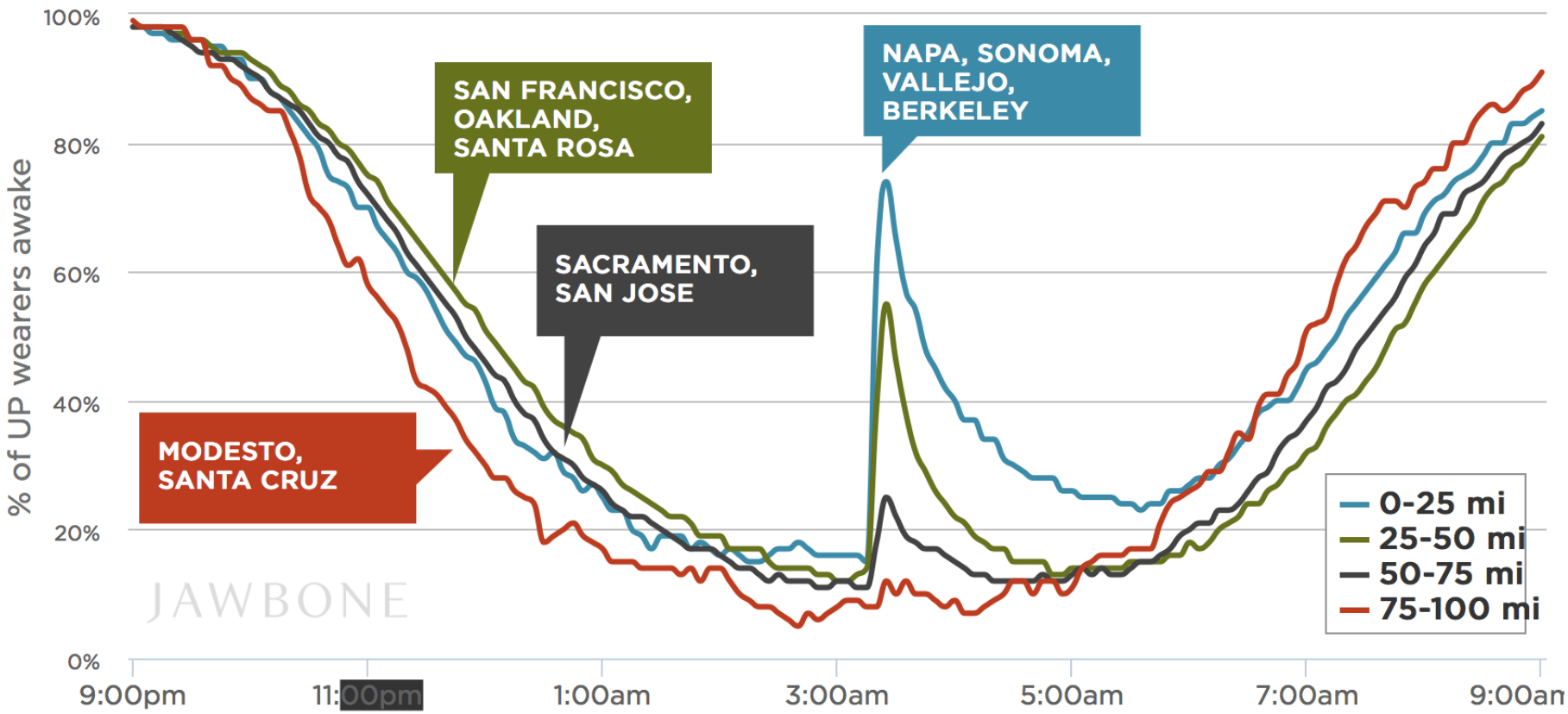
CONTACT US | NEWS

Emory study focuses on heart health of AJC Peachtree Road Race runners

Woodruff Health Sciences Center | June 26, 2015

Data visualization

Jawbone and Bay Area Earthquake Sept 2014



https://jawbone.com/blog/napa-earthquake-effect-on-sleep/

Mashing data – HeadsUp Health

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headsuphealth | Dashboard | My Data | Analyzer | File | Profile | Add Data | Connect Data | Dave Korsunsky

Weight (Withings)
Average: 192.9 pounds

191.5	192.1	192.2	195.1	193.6

Goal 185
Avg this month: --
Avg last month: 192.9
Avg YTD: 190.3

Body Fat (Withings)
05/14/15, 07:11 AM

15.5
Goal 15 %

Heart Rate (Withings)
05/14/15, 07:11 AM

59
Goal 55 bpm

Sleep (Misfit)
Average: 7.7 hours

Steps (Misfit)
Average: 12286 steps

Calories (Misfit)
06/03/15

Meditation Time (Manual)
06/03/15, 06:54 AM

20.0
minutes

Total Cholesterol
Average: 202.0 mg/dL

177	209	218	228	178

Avg this month: --
Avg last month: --
Avg YTD: 178.0

Blood Pressure (Manual)
04/25/15, 09:13 AM

124/83
Goal 120/80 mmHg

Food log data – Shanonn Conners

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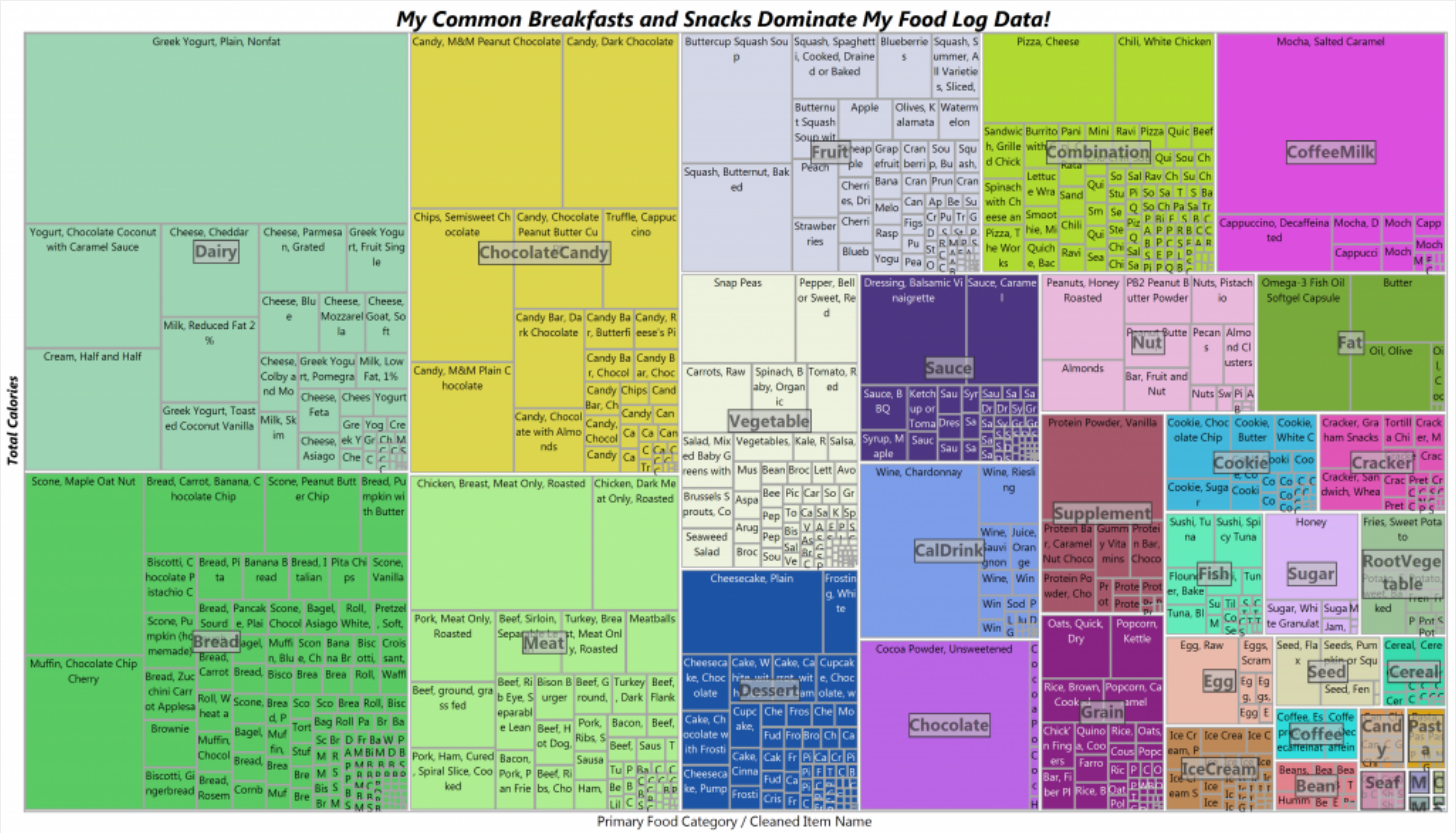

SAS - JMP

Quantified Weight Loss – Julian Parris

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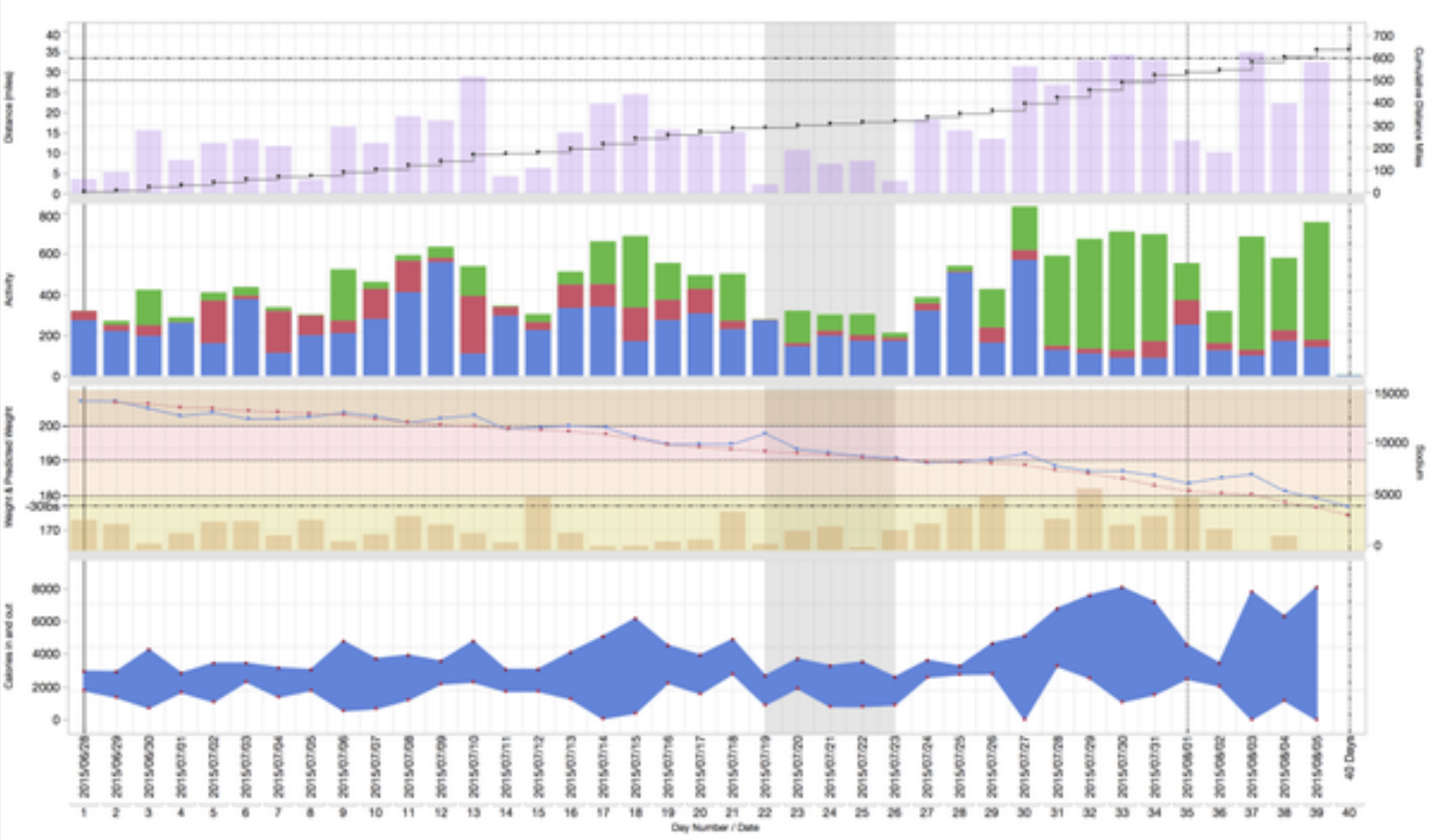

EHDVIZ

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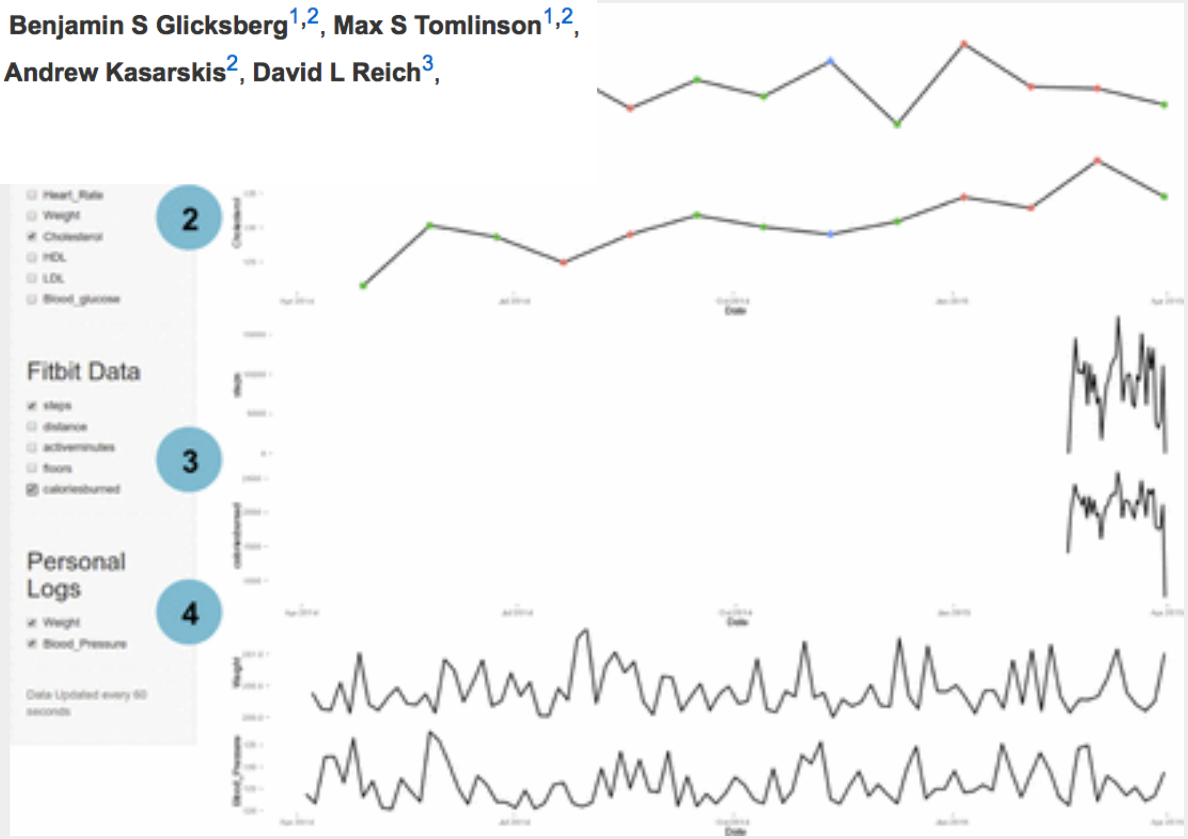
BMJ Open 2016;**6**:e010579 doi:10.1136/bmjopen-2015-010579

Health informatics

EHDViz: clinical dashboard development using open-source technologies

Marcus A Badgeley[1,2], Khader Shameer[1,2], Benjamin S Glicksberg[1,2], Max S Tomlinson[1,2], Matthew A Levin[2,3], Patrick J McCormick[3], Andrew Kasarskis[2], David L Reich[3], Joel T Dudley[1,2,4]



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From knowledge to application (relevant initiatives)

Health eHeart study, Google Baseline, 100K Wellness Project, Precision Medicine Initiative, Health Data Exploration and Network, mPower study, Open Humans, N-of-1 (single subject) studies, BD2K Centers of Excellence (emobilize, MD2K)

Clinical Benefits

The JAMA Network | Journals > | Specialties & Topics | Store | Physician Jobs | About Mobile

JAMA The Journal of the American Medical Association

Home | Current Issue | All Issues | Online First | Specialties & Topics | CME | Multim

November 21, 2007, Vol 298, No. 19 >

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Review | November 21, 2007

CLINICIAN'S CORNER

Using Pedometers to Increase Physical Activity and Improve Health

A Systematic Review FREE

Dena M. Bravata, MD, MS; Crystal Smith-Spangler, MD; Vandana Sundaram, MPH; Allison L. Gienger, BA; Nancy Lin, ScD; Robyn Lewis, MA; Christopher D. Stave, MLS; Ingram Olkin, PhD; John R. Sirard, PhD

[+] Author Affiliations

JAMA. 2007;298(19):2296-2304. doi:10.1001/jama.29

THE ANNALS OF THORACIC SURGERY

Official Journal of The Society of Thoracic Surgeons and the Southern Thoracic Surgical Association

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Functional Recovery in the Elderly After Major Surgery: Assessment of Mobility Recovery Using Wireless Technology

David J. Cook, MD, Jeffrey E. Thompson, MHA, Sharon K. Prinsen, RN, Joseph A. Dearani, MD, Claude Deschamps, MD

Accepted 21 May 2013.

Abstract | Full Text | PDF | Images | References

Purpose

Hospitalization and surgery in older patients often leads to a loss of strength, mobility, and functional capacity. We tested the be used to measure mobility during hospital recovery after cardiac surgery.

asure daily mobility in patients after surgery. Data were transmitted wirelessly, iewable dashboard.

gery was easy and practical. There was a significant relationship between the eriod, length of stay, and dismissal disposition.

ACP American College of Physicians Internal Medicine | Doctors for Adults

Annals of Internal Medicine

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6 August 2013, Vol 159, No. 3>

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Reviews | 6 August 2013

Self-Measured Blood Pressure Monitoring in the Management of Hypertension: A Systematic Review and Meta-analysis

Katrin Uhlig, MD, MS; Kamal Patel, MPH, MBA; Stanley Ip, MD; Georgios D. Kitsios, MD, MS, PhD; and Ethan M. Balk, MD, MPH

[+] Article and Author Information

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RESEARCH ARTICLE | SLEEP RESEARCH

A global quantification of "normal" sleep schedules using smartphone data

Olivia J. Walch[1], Amy Cochran[1] and Daniel B. Forger[1,2,*]

+ Author Affiliations

*Corresponding author. Email: forger@umich.edu

Science Advances 06 May 2016:
Vol. 2, no. 5, e1501705
DOI: 10.1126/sciadv.1501705

PRE Peer Reviewed
← see details

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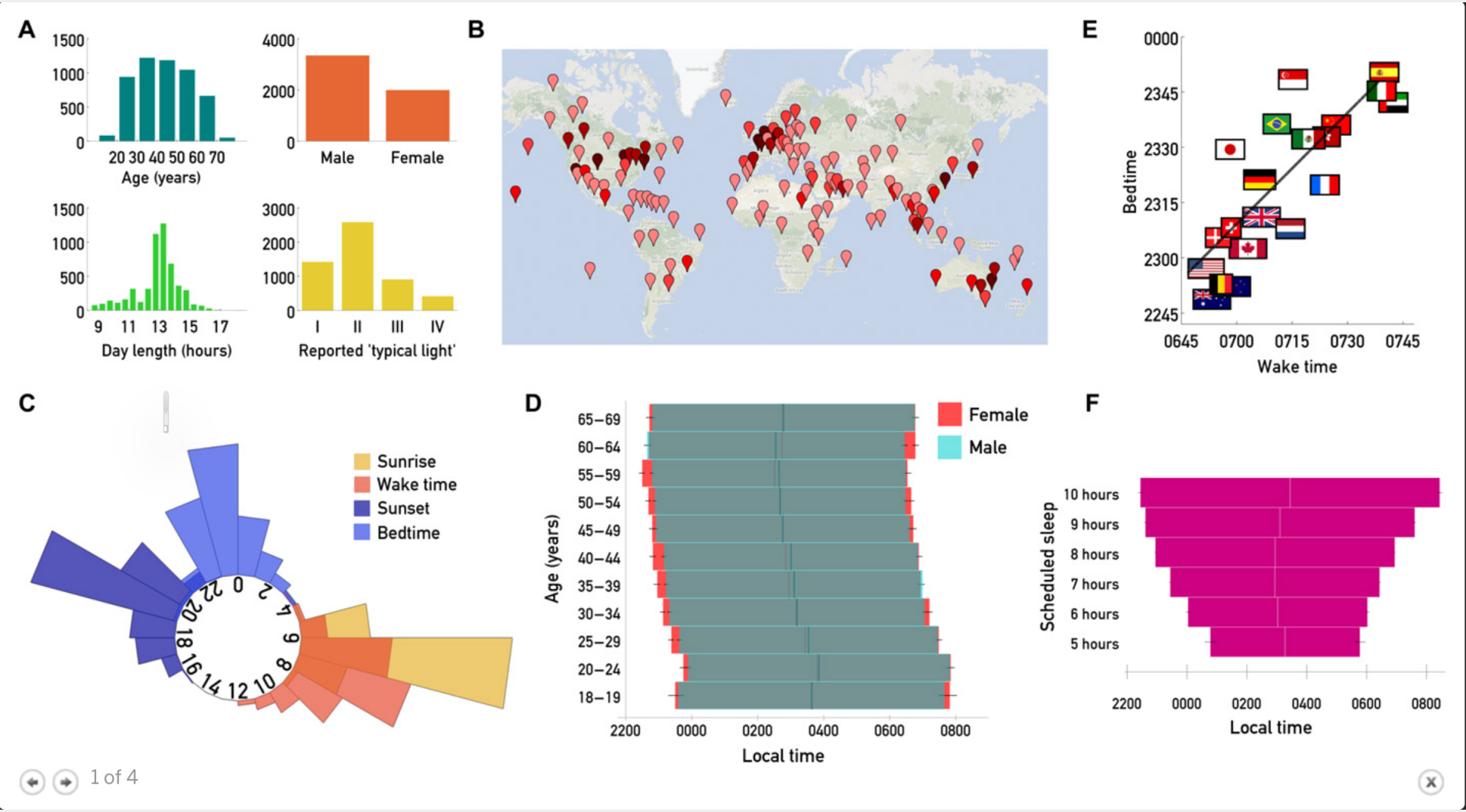
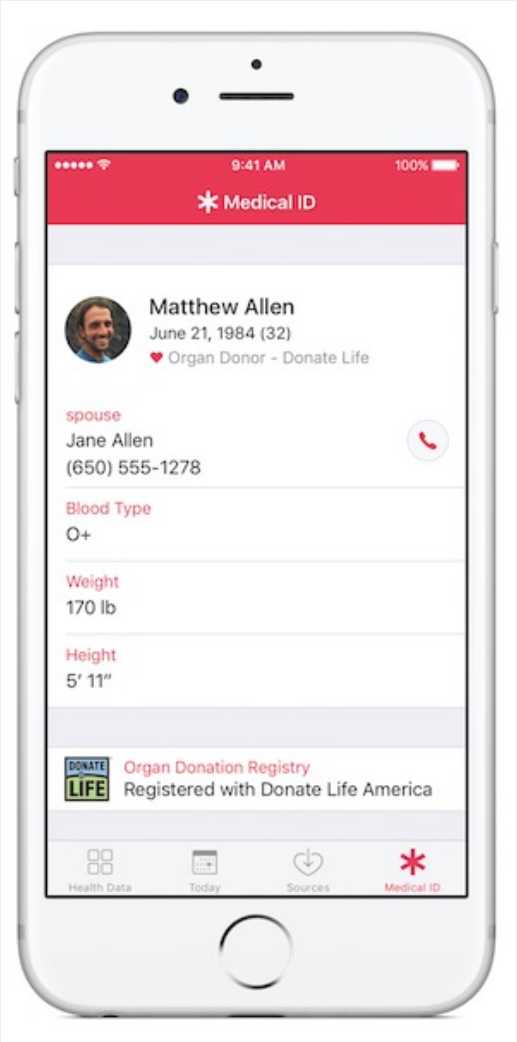


With iOS 10, iPhone users can become organ donors via Health app

When iOS 10 is released, the Apple Health app will include a new feature, allowing iPhone users across the United States to become organ, eye, and/or tissue donors with just a few taps.



Health eHeart

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Health eHeart™

Home Study Community

Join the study to end heart disease.

Be a part of an ambitious study to end heart disease. It only takes a few minutes to make a big difference. Anyone can join — whether you have heart disease or not.

Join the Study

Brought to you by UCSF in collaboration with American Heart Association. life is why

Google Baseline

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KEYWORDS

Startups Try to Spread Outside of Silicon Valley

TECH

Google's New Moonshot Project: the Human Body

Baseline Study to Try to Create Picture From the Project's Findings

100K Wellness Project

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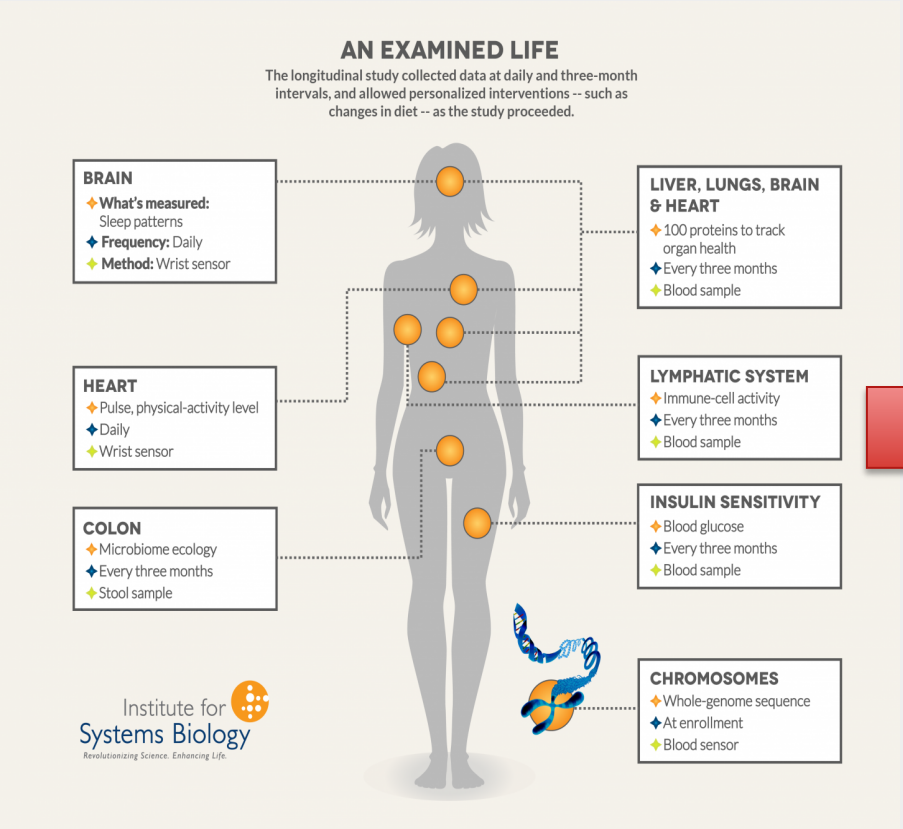

Human Longevity, Inc. Launches the Health Nucleus, a Comprehensive and Personalized Health Platform for Individuals

(SAN DIEGO, CA) OCTOBER 13, 2015 – Human Longevity, Inc. (HLI), the genomics-based, technology-driven company working to revolutionize the practice of medicine, announced today the launch of the company's first Health Nucleus™, a genomic powered clinical research project that has the potential to transform healthcare. The inaugural Health Nucleus is located in San Diego, CA, at HLI's headquarters facility. More Health Nucleus facilities are slated to open in 2016 in other US and International cities.

The Health Nucleus platform uses whole genome sequence analysis, advanced clinical imaging and innovative machine learning – combined with a comprehensive curation of personal health history – to deliver the most complete picture of individual health.

The Health Nucleus provides a novel approach devoted to exploring, quantifying and beginning to understand as much as possible about individual health and disease risk. Supported by the world's largest genome sequencing center and the leading experts in translating genomics data into clinically relevant information, this platform embodies HLI's philosophies and ideas on how individuals can better understand their health. It is the first center to combine genomics with a complete array of other clinical and biological measures, including:

- Whole human genome sequencing, spanning all 6 billion base pairs of DNA (most DNA tests examine less than 2% of the full genetic code);
- Microbiome sequencing which quantifies the collective genomes of the microorganisms that live inside and on the human body (it is estimated that there are 10 times more microbial cells than human cells in our bodies);
- Metabolome characterization which enables us to measure the unique chemical fingerprints that cellular processes leave behind;
- A comprehensive body MRI scan to screen for any abnormalities and provide a baseline for the future;
- Customized laboratory tests and screenings.

Precision Medicine Initiative

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- Precision medicine is an approach to disease treatment and prevention that seeks to maximize effectiveness by taking into account individual variability in genes, **environment**, and **lifestyle**. Precision medicine seeks to redefine our understanding of disease onset and progression, treatment response, and health outcomes through the more precise measurement of molecular, **environmental**, and **behavioral** factors that contribute to health and disease. This understanding will lead to more accurate diagnoses, more rational disease prevention strategies, better treatment selection, and the development of novel therapies.

- Coincident with advancing the science of medicine is a changing culture of medical practice and medical research that **engages individuals as active partners** – not just as patients or research subjects. We believe the combination of a highly engaged population and rich biological, health, **behavioral**, and **environmental** data will usher in a new and more effective era of American healthcare.

Why now?

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	Ten Years Ago	Now – 2014 (most recent data)
Cost of sequencing a human genome	$22,000,000	$1,000 - $5,000
Amount of Time to Sequence a Human Genome	2 years	<1 day
Number of smart phones in the United States	1 million (<2%)	160 million (58%)
EHR Adoption (% hospitals)	20-30%	>90%
Computing Power	n	n x 16 Deep Learning

NIH awards $120M to Scripps, others, to enroll 350K participants in Precision Medicine Initiative via mobile apps

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- **Scripps Research Institute, Vibrent Health, PatientsLikeMe, Sage Bionetworks, and Walgreens will help build apps and enroll participants**
- The National Institutes of Health announced a number of partners today who will receive a total of $55 million in grant money for 2016 to build the foundational structures of the White House's Precision Medicine Initiative (PMI). The PMI Cohort Program includes five companies that make up the Participant Technologies Center, which will be responsible for creating mobile apps to enroll, consent, collect data from and communicate with PMI Cohort Program participants.
- In addition to Scripps and Vibrent, NIH has designated several sub-awardees which will share the $20 million award and work together on the Participant Technologies Center: Cambridge, Massachusetts-based online patient community platform PatientsLikeMe, Seattle-based Sage Bionetworks, which is best known for its work on Apple's ResearchKit, and Walgreens. According to its own statement, Walgreens will allow its customers to enroll in the program at its stores, at Walgreens Healthcare Clinics, online through Walgreens.com and through the Walgreens mobile app.
- Sage Bionetworks, meanwhile, "will be responsible for the patient consent and data governance related to the PMI Cohort Program's software products, as well as the community outreach and participant engagement efforts of the Participant Technologies Center", Sage said in a statement. They'll also develop new ways of monitoring health factors using smartphones and wearable devices.

Health Data Exploration and Network

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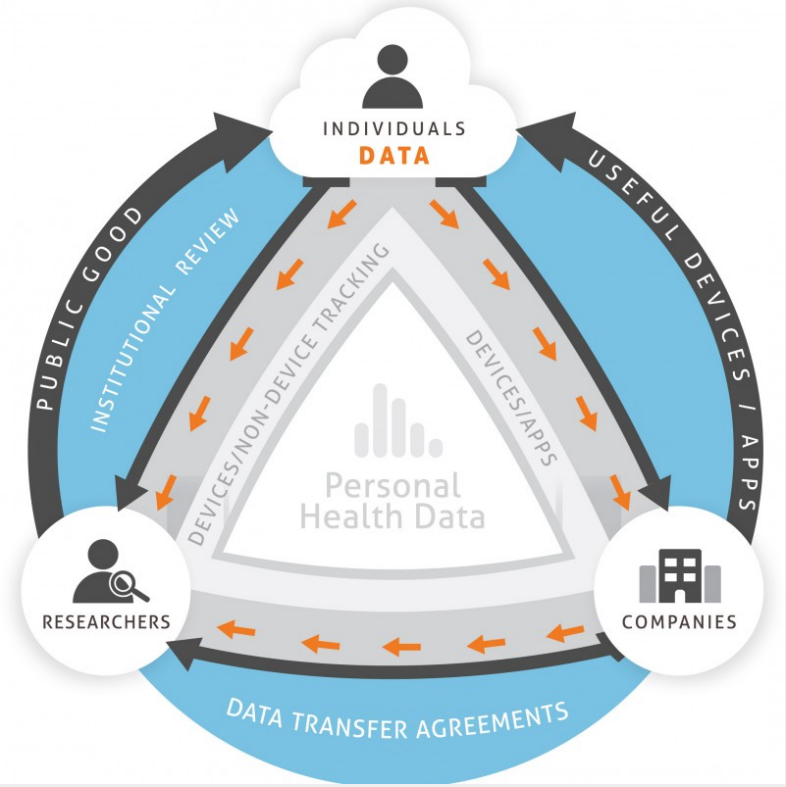
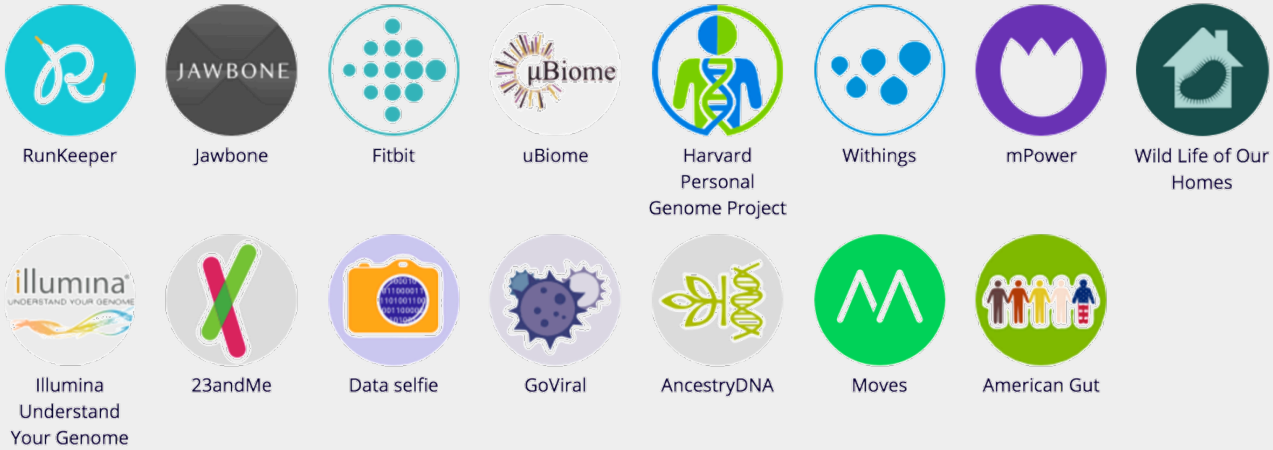


PERSONAL HEALTH DATA FOR THE PUBLIC GOOD

A California Institute for Telecommunications and Information Technology project with support from the Robert Wood Johnson Foundation

Open Humans

- Project of PersonalGenomes.org funded by Knight Foundation and the Robert Wood Johnson Foundation
- Objectives
  - Break down data silos in human health and research
  - Public data sharing
    - Connect individuals willing to share data about themselves



N-of-1 studies

- https://www.theguardian.com/science/2016/jul/03/citizen-science-how-internet-changing-amateur-research?CMP=share_btn_fb

Quantified Self

METHODS of Information in Medicine

CALL FOR PAPERS

N-OF-1

METHODS OF INFORMATION IN MEDICINE

FOCUS THEME: SINGLE SUBJECT RESEARCH DESIGN AND DATA PROCESSING

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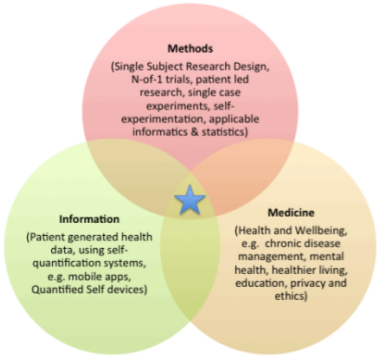
Scientific progress in medicine and public health during the last century has been dominated by studies performed with groups of people. Today, thanks in part to advances in computing and information technology, many people collect data to help investigate a health problem, make progress towards a goal, or simply because we are curious. Such investigations need not be conducted on groups. Often, they involve just a single person who is both the subject and the investigator. They are "N-of-1" trials, where data are generated by the individual, normally making use of self-quantification systems, including mobile apps and portable monitoring devices. This focus theme of "Methods of Information in Medicine" on single subject research encourages submission of original articles describing data processing and research methods using a "N-of-1" design where the questions and analysis are guided by the interests and participation of the subject. We encourage submissions that focus on challenges and questions involving data collection, processing, integration, analysis and visualization in the context of single subject research.

AREAS OF FOCUS MAY INCLUDE, BUT ARE NOT LIMITED TO:

Personal health and well-being * Chronic disease management * Mental health * Autonomous self-experimentation in the context of health and well-being * Health education and autodidactic learning * Privacy, ethics and regulation issues



SUBMISSION DEADLINE
NOVEMBER 1, 2016

High quality, original manuscripts will be subject to a rigorous peer review process.

Submissions must follow the submission guidelines of Methods of Information in Medicine, available at:

http://methods.schattauer.de/en/authors/manuscript-submission.html

EXAMPLE METHODS AND TECHNOLOGIES THAT ARE RELEVANT INCLUDE, BUT ARE NOT LIMITED TO:

IT infrastructures for Single-Subject-Research trials * Aggregating data from multiple sensors * Ontologies and knowledge representation * Integrating N-of-1 data with other clinical information systems (health records, decision support) * Data analysis and visualization * Data quality, metadata and annotation aspects

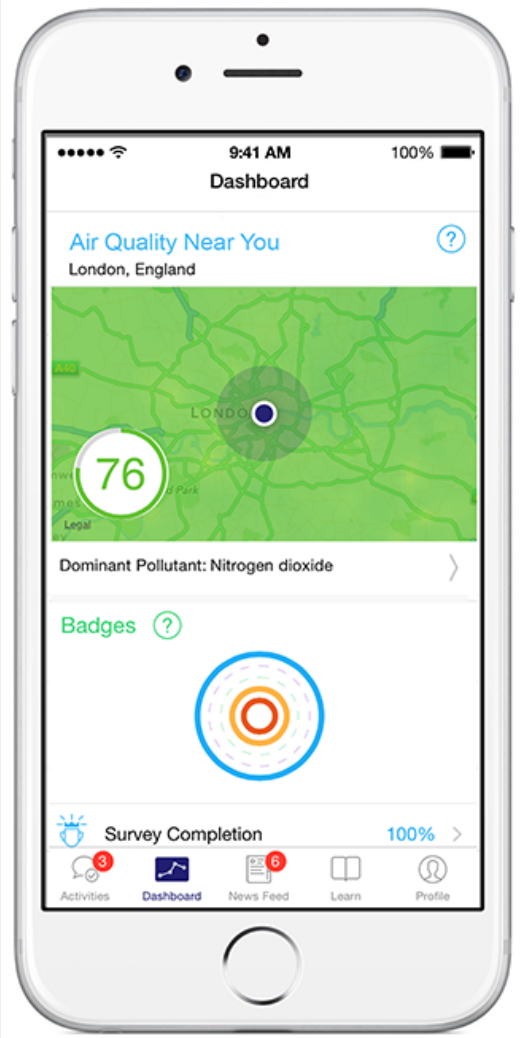
WE ENCOURAGE SUBMISSIONS IN THE FORM OF:

- Original contributions of individual or a series of N-of-1 trials.
- Original contributions with Single Subject Research Design, Single Case Experimental Design or Patient Led Research Design
- Original contributions on methodological aspects of informatics and statistics applied to N-of-1 trials.
- Reviews in the field of Single Subject Research Design and data processing of patient generated data
- Perspective and opinion papers

Research studies: Asthma Health

Icahn School of Medicine at Mount Sinai

23andMe integrates with Apple's ResearchKit app



Research studies: GlucoSuccess

Massachusetts General Hospital (MGH) in Boston.

To keep track of health behaviors important for people with type 2 diabetes, such as physical activity, diet, and taking your medicines

Research studies: mPower

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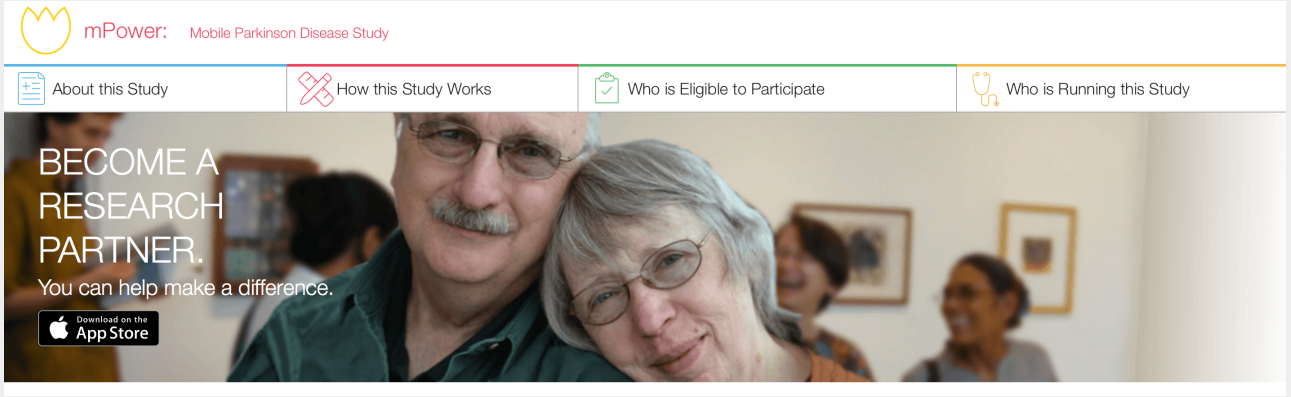
SAGE BioNetworks



Download the mobile app

The mobile app will help you log your symptoms.

Give consent to enroll

Understand the risks and benefits of participating.

Read the consent form.

Perform simple tasks

We'll ask you to do a few tasks and answer some questions about your health.

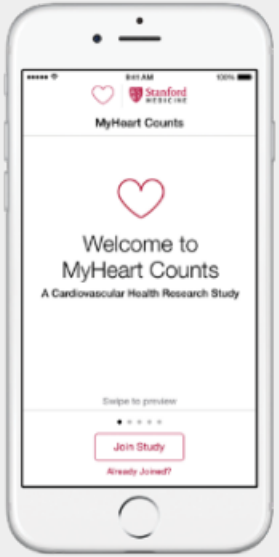
Track your health

You can use the health dashboard to track your health data.

Scientists make discoveries

Scientists will use your data to make breakthroughs in medical research and treatments.

Research studies: MyHeart Counts



Make *your* heart count!

What keeps your heart its healthiest? Help us find out.

New version of MyHeart Counts App now available for download at the App Store

Research study: Share the Journey

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- Mind, Body and Wellness after breast cancer is a clinical study that aims to understand the symptoms after breast cancer treatment, why these symptoms vary over time, and what can be done to improve them.
- SAGE Bionetworks
- Dana Farber Cancer Institue

Research study: MoleMapper

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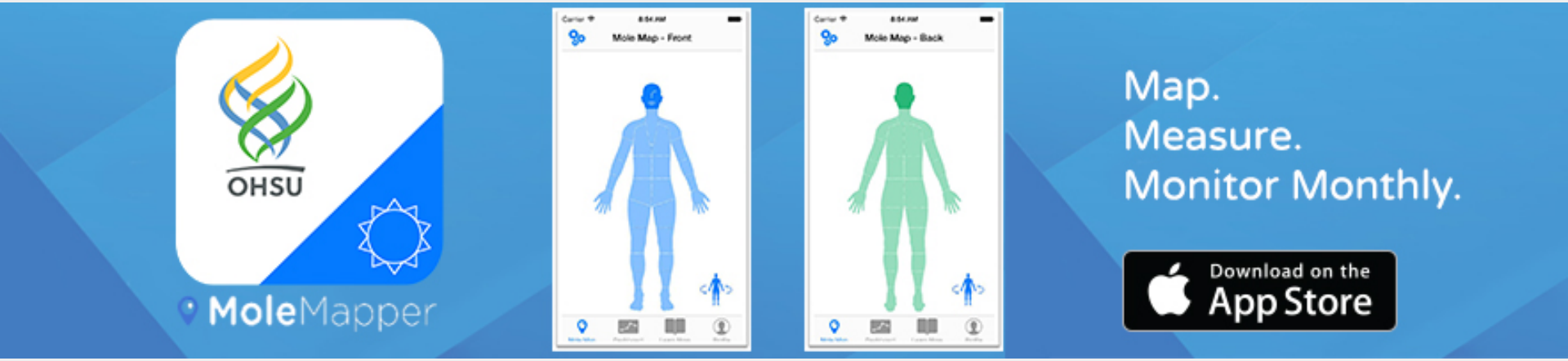
OHSU Dermatology



Using your iPhone camera, Mole Mapper tracks moles and how they change and grow over time. Rapid change or growth may indicate malignancy. Mole Mapper also reminds you to re-check your moles regularly. By sharing mole images over time, researchers can develop new ways of evaluating moles and may (at some point in the future) be able to tell whether you need to see a doctor or have a mole removed based upon a cell phone picture.

More research studies:

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- http://mobihealthnews.com/47611/apple-researchkit-is-a-pipeline-for-future-diagnostic-medical-apps/
- Duke – Autism and Beyond – Recording children reactions to videos
- Johns Hopkins – EpiWatch – Seizure detector
- USC - Biogram 2– Biometrics and personal/social
- uBiome – Microbiome and weight management
- U Nebraska Med Center – Hand in Hand – HIV-neurocognitive disorders
- Boston Children's – C Tracker. Chronic Hep C - PROs
- Yale – Cardiomyopathy Index –
- UCSF – PRIDE – LGBTQ sexuality and health

- Over 100,000 participants

Training

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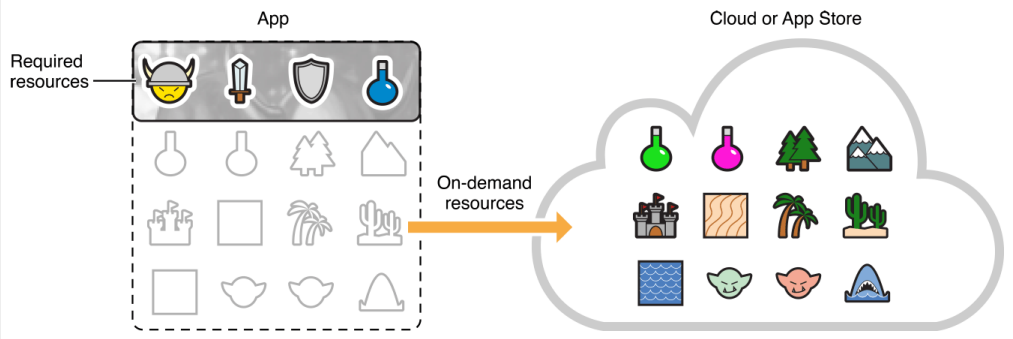
The Future

Future without apps

- Problem with apps: Delivery and Discoverability
- Solutions:
  - App linking (apps automatically linked to content)
  - App indexing (apps through search queries)

  "I don't want to maintain a walled garden of apps. I want to consume and create content."
  - App streaming from Google: you tap a link to the content and Google will stream the right parts of the app to you on-demand.
  - On-demand resources from Apple (ODR): technology released with iOS 9 that downloads a small core application only on installation, and then downloads extra parts and content as needed

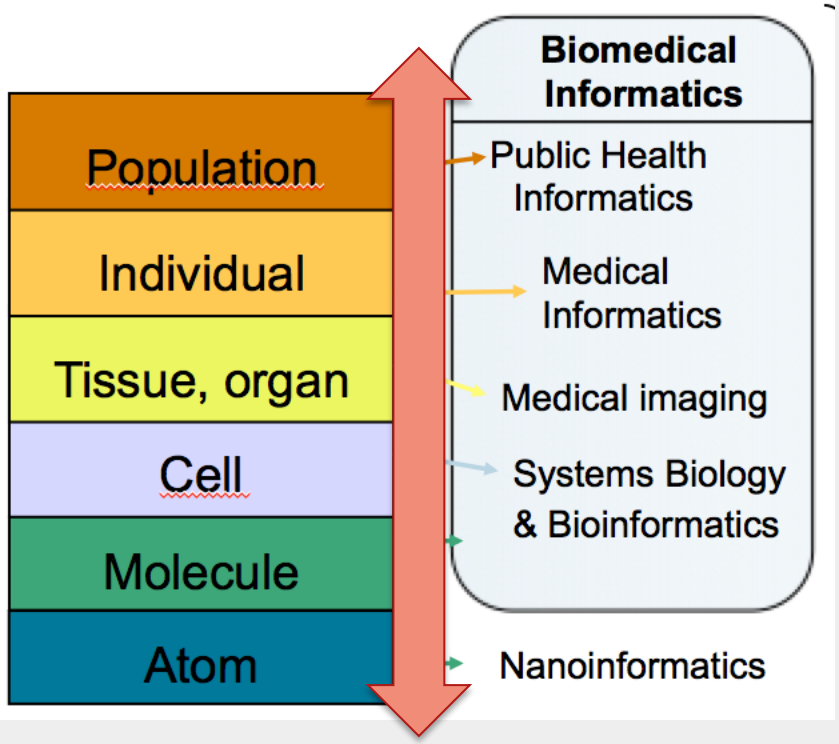


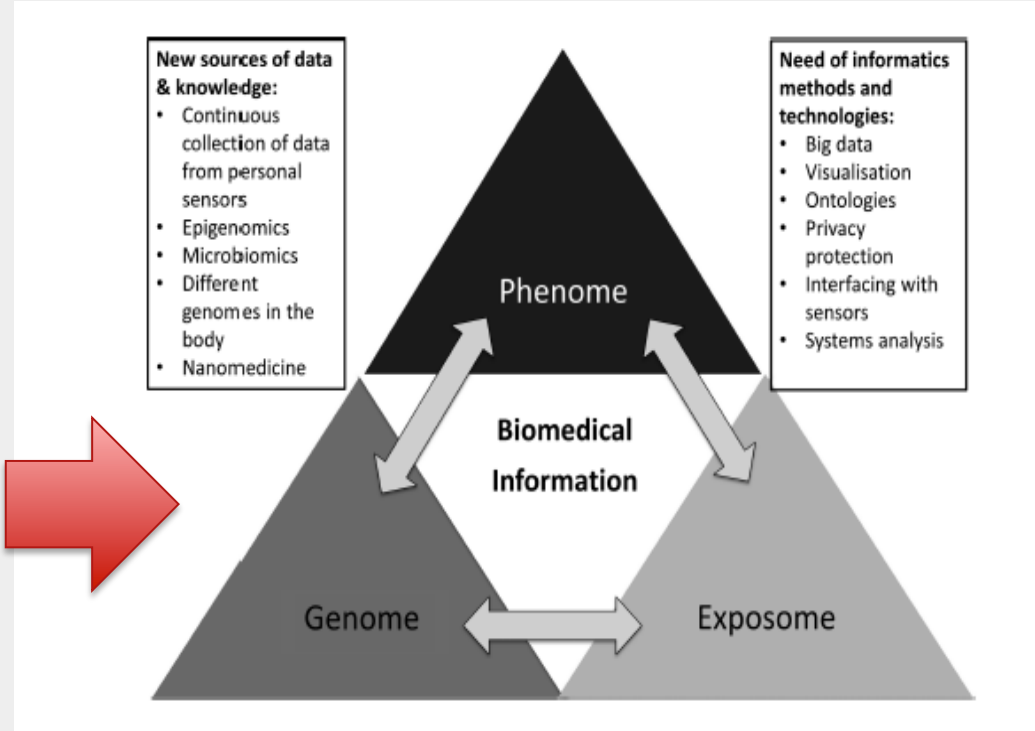
Java applets on mobile?

https://medium.com/fwd-thoughts/the-future-is-without-apps-ddf43ec52aab#.127sqwf61

Pokemon Go

Biomedical Informatics





Environment

Martin-Sanchez et al, JAMIA 2015

Integrating patient data with clinical data for a learning healthcare system

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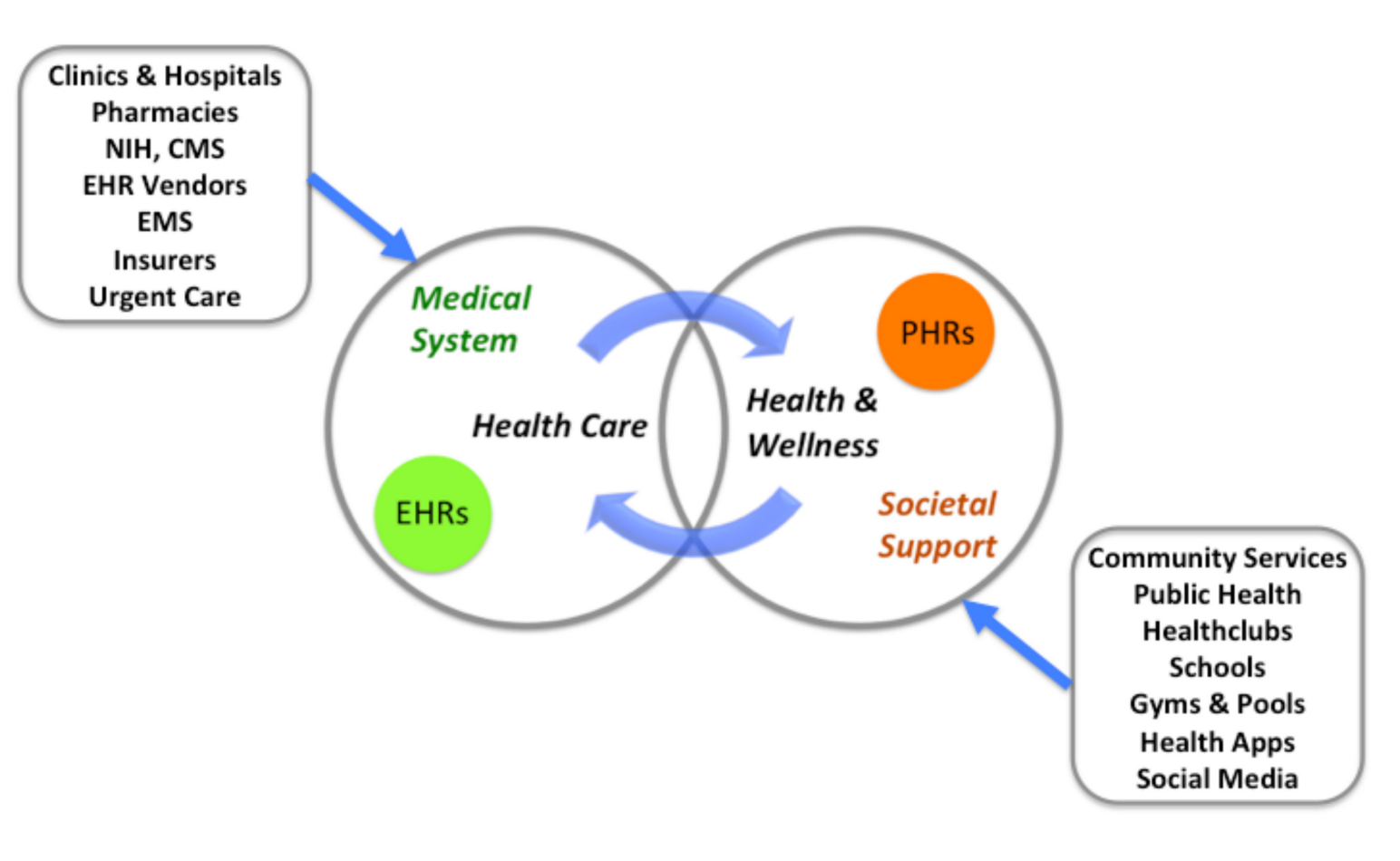
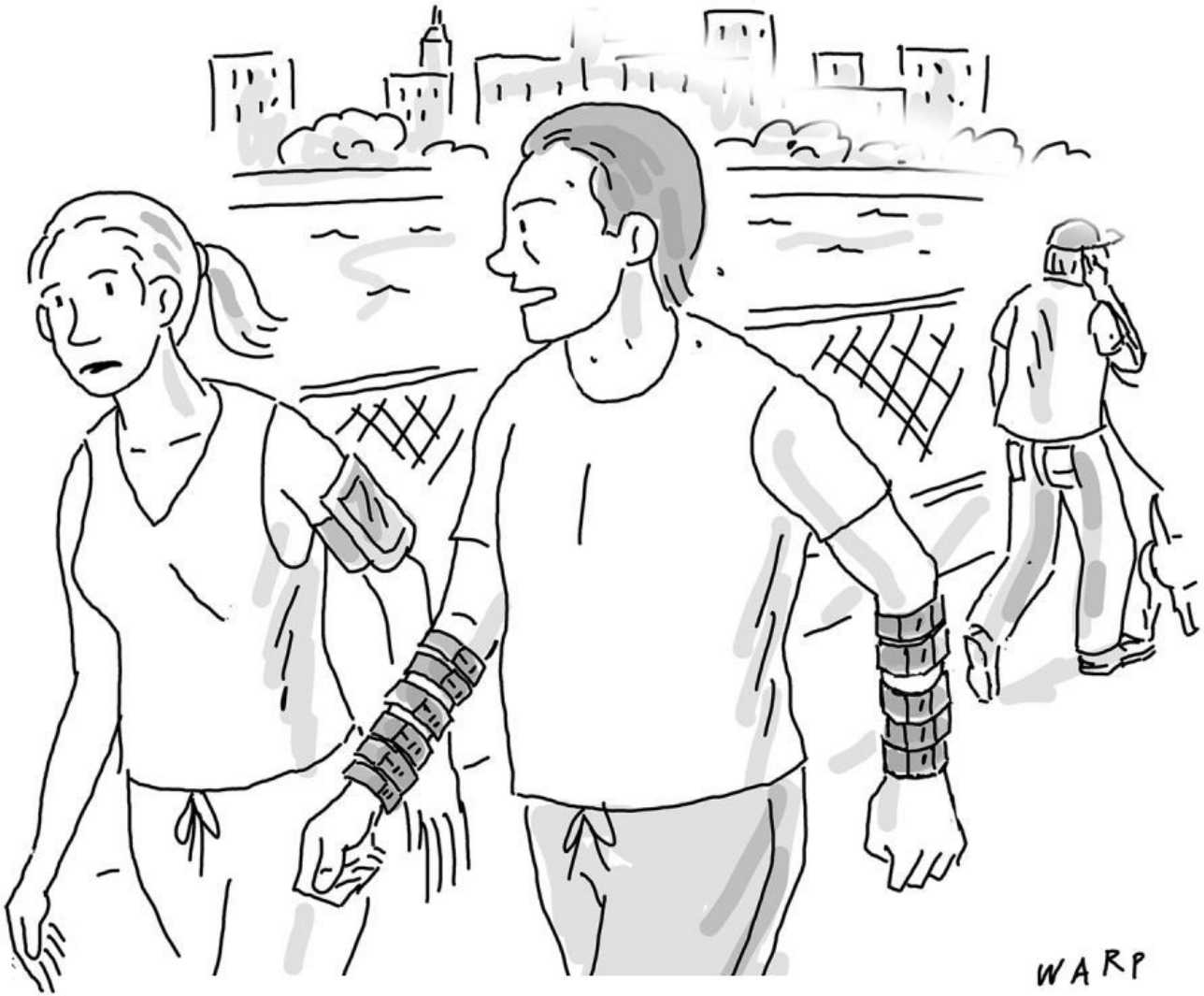


JASON, MITRE Corp. November 2014. Data for individual health. Agency for Healthcare Research and Quality. http://healthit.ahrq.gov/sites/default/files/docs/publication/2014-jason-data-for-individual-health.pdf



"People pay me to put steps on their Fitbits."

New jobs?

Summary

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- Understand the concept and importance of Participatory Health and PGHD
- Identify opportunities for biomedical and clinical research using participatory technologies
- Discern the quality of mobile apps
- Find the most appropriate wearable sensor for your project
- Understand how information flows from sensors to information systems
- Identify methods for aggregating and integrating data from multiple sensors
- Understand methods to analyze and visualize participatory health data
- Learn from the most relevant initiatives in this area
- Appreciate challenges for biomedical informatics research and education derived from the use of digital health technologies and participatory health

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