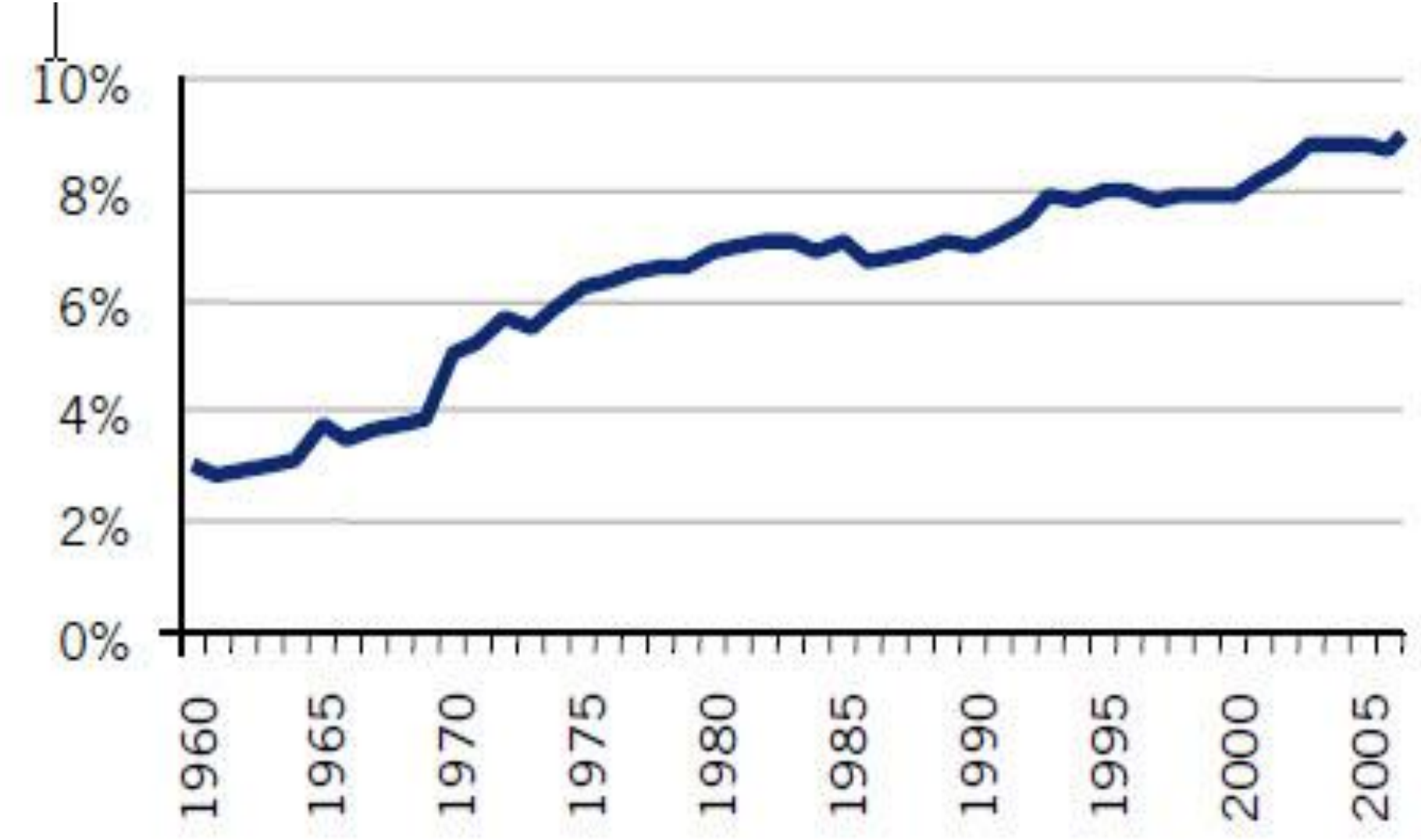
m-Health as an important step towards personalized medicine

Prof. Oleg Medvedev
Moscow State University
Moscow Technical University

Average cost of healthcare in 6 European countries as % of their GDP



Gartner report, 2009

Health Care Costs in the United States, 2006-2021

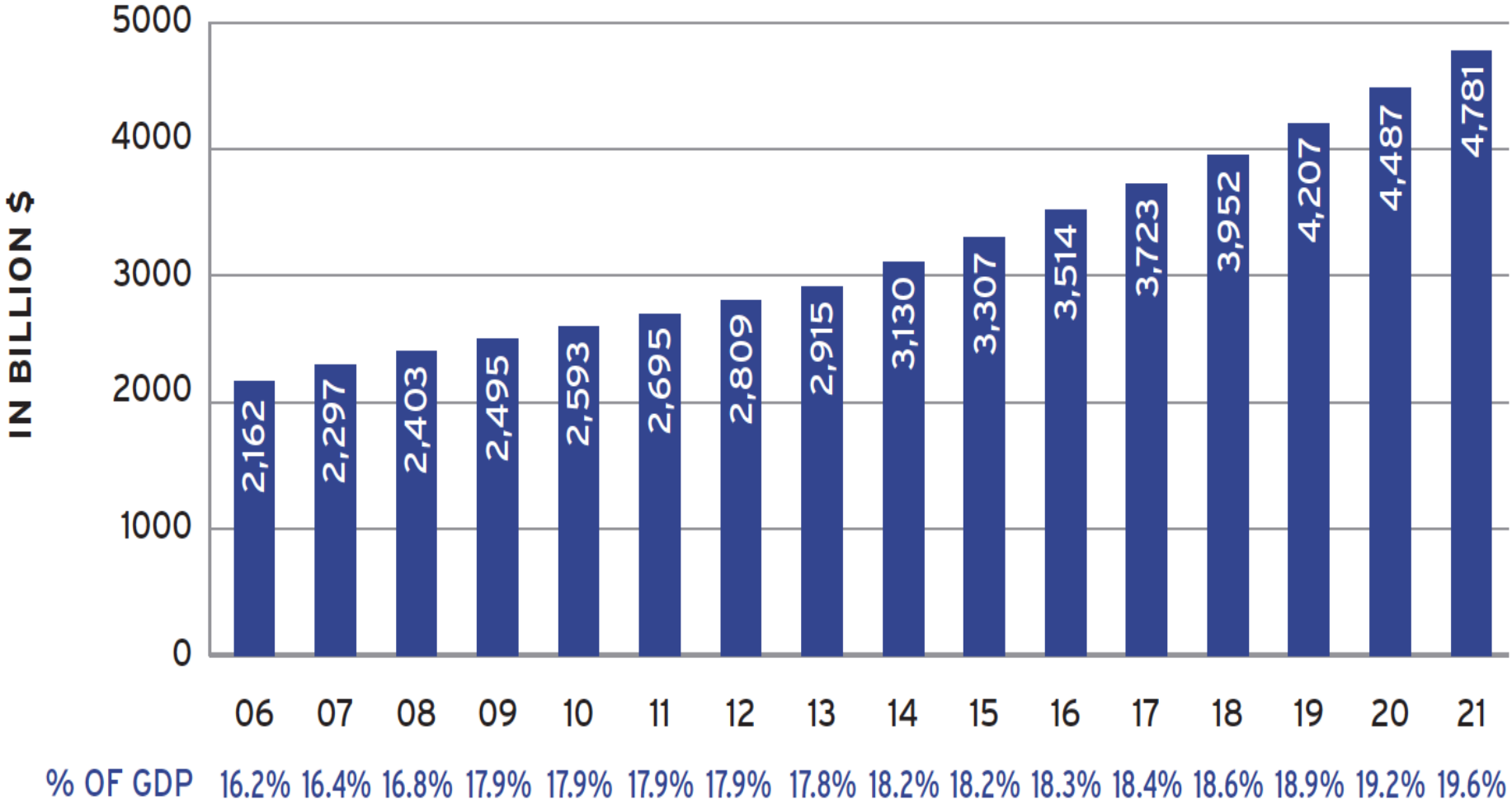
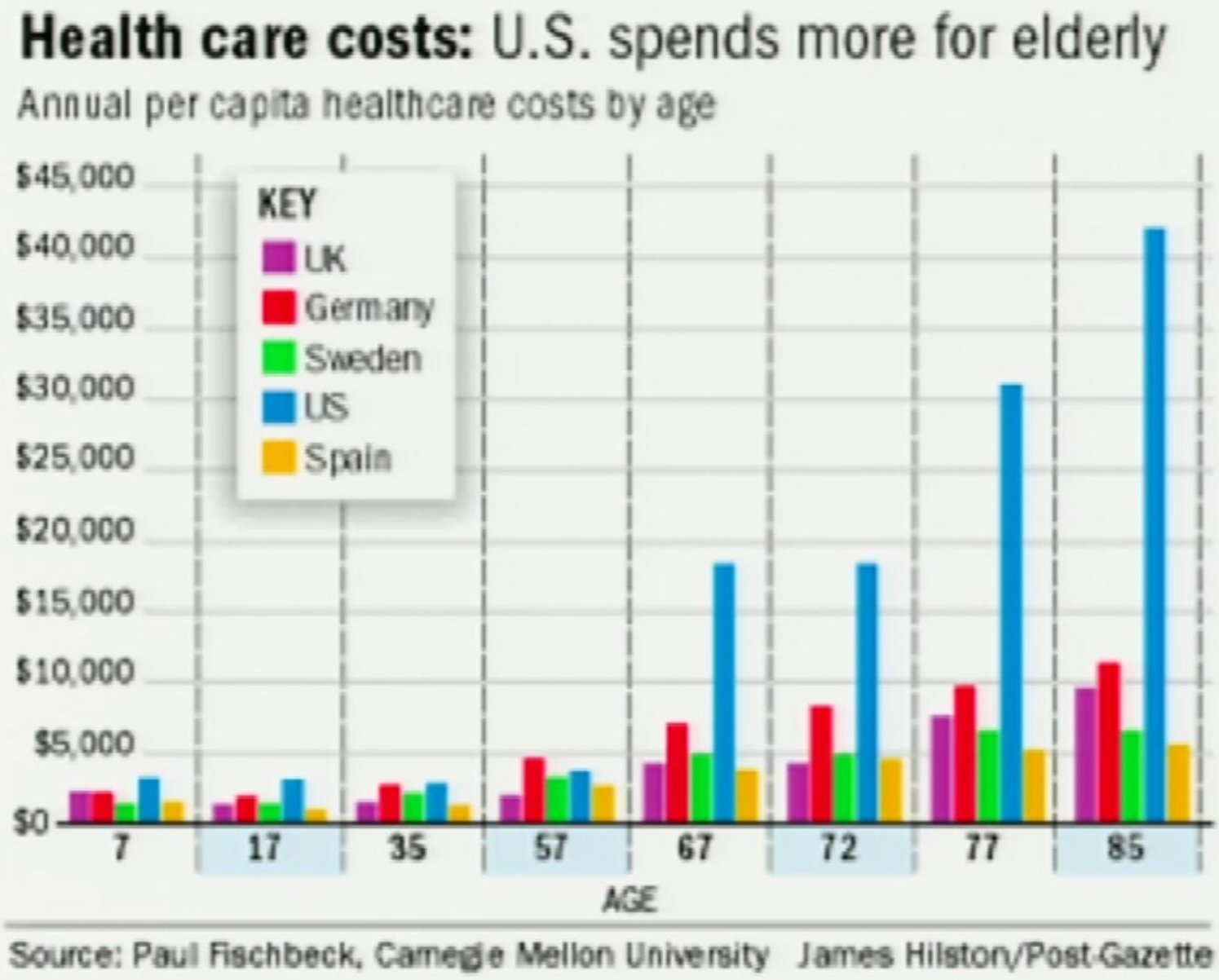


Table 1

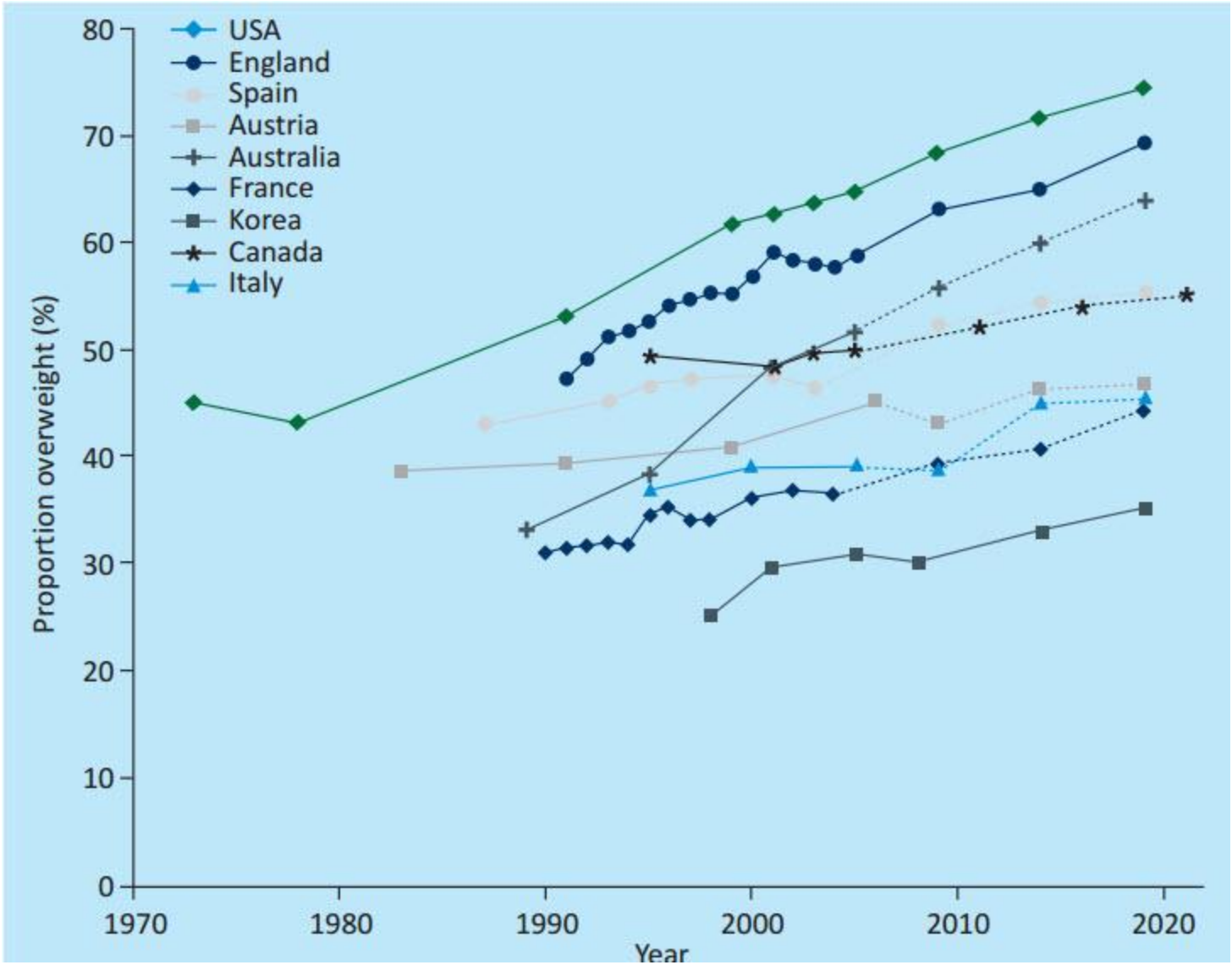
Number of People Over 65 Years in United States, 2010-2050

YEAR	2010	2020	2030	2040	2050
Total Number (million)	310	341	373	405	439
Number Over 65 (million)	40	55	72	81	88
Percent Over 65	13.0%	16.1%	19.3%	20.0%	20.0%

Does it have to be this way?



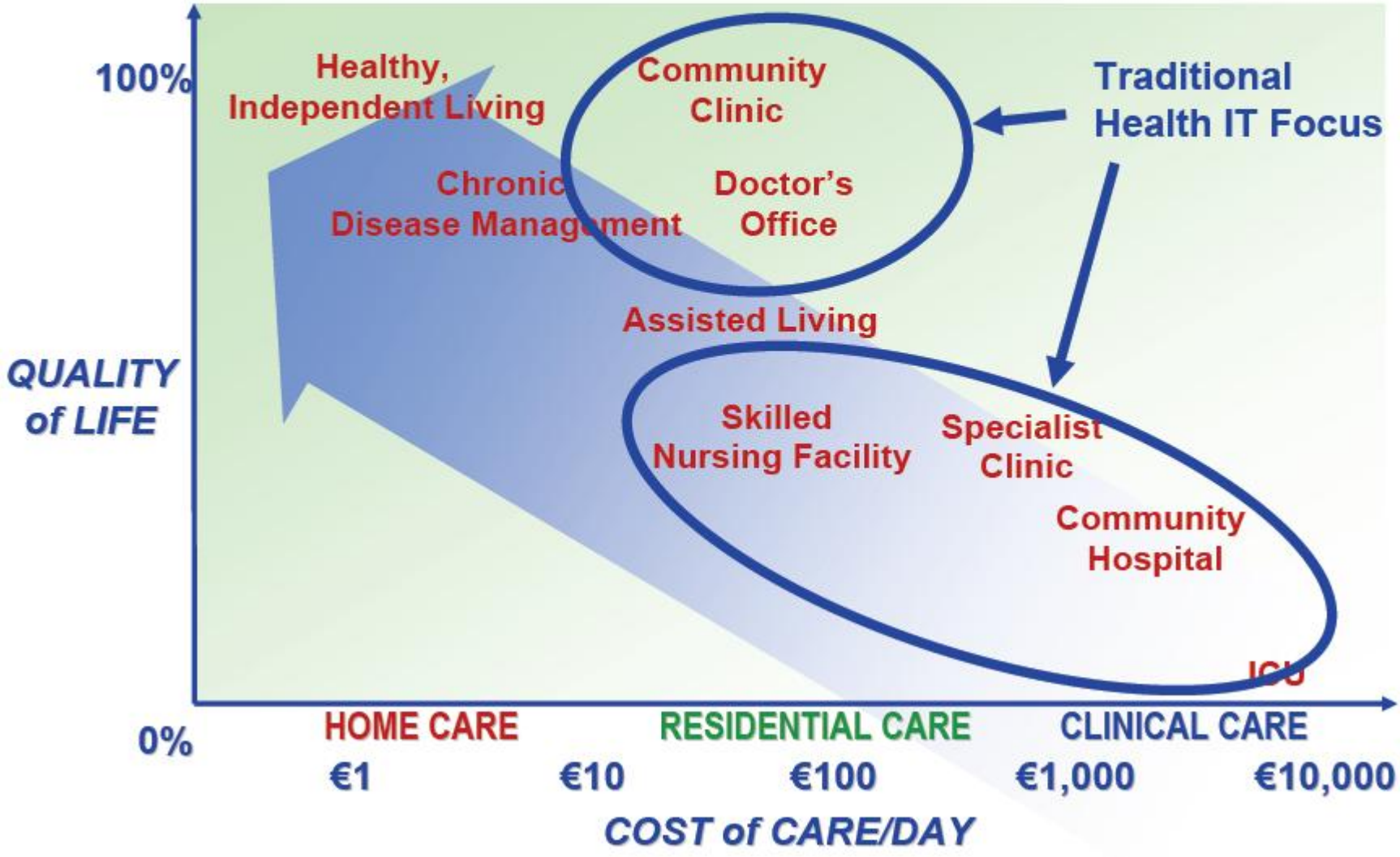
Доля жителей с повышенным весом в разных странах



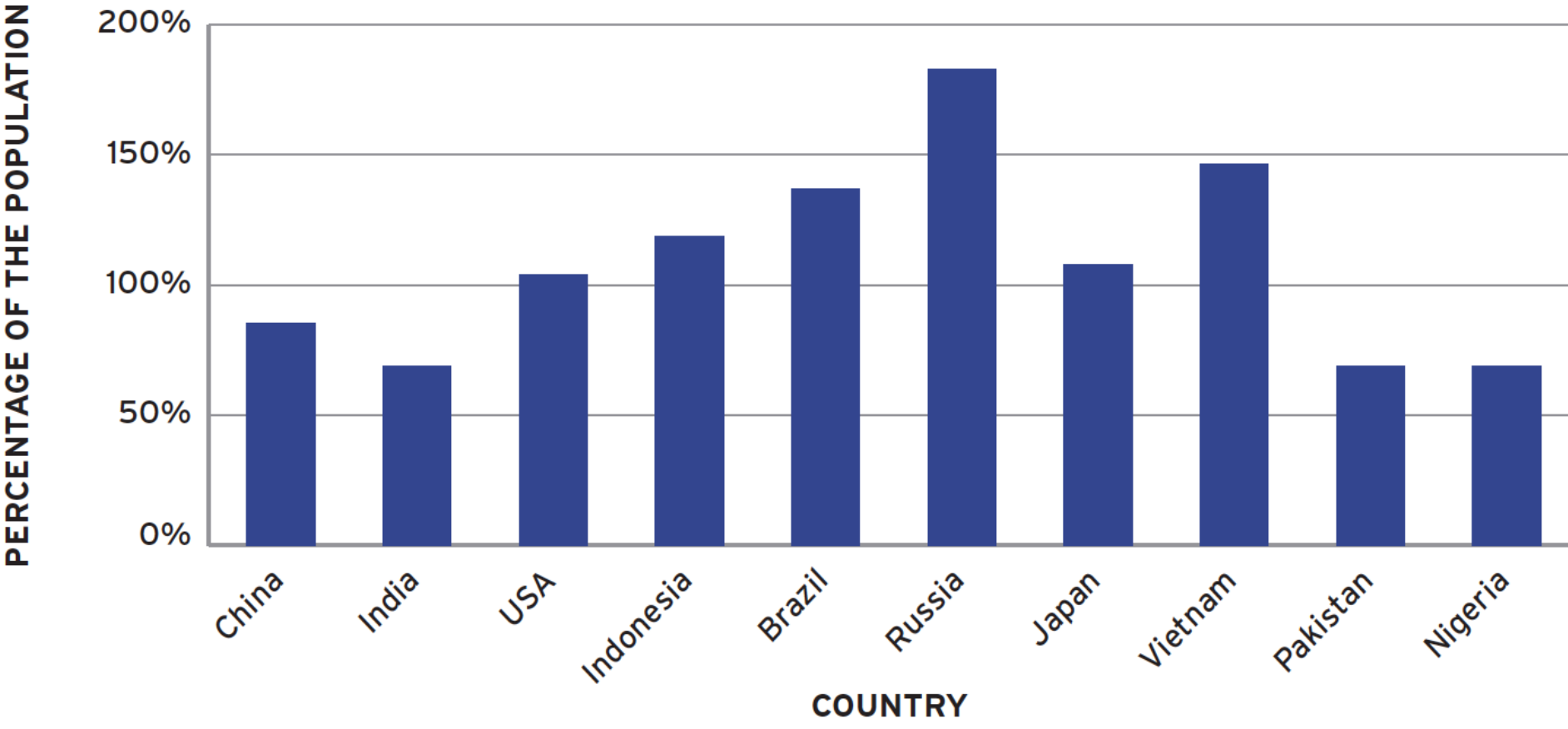
Clinical Medicine 2012, Vol 12, No 5: 456–60

Health and Social Care Costs

NHS
Connecting for Health

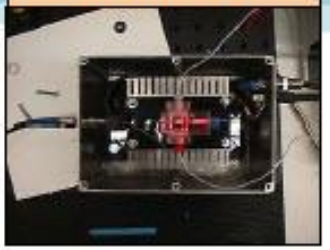


Mobile Phone Users' Percentage of the Population, 2013*

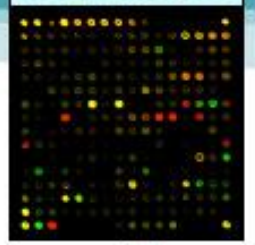


Step 3: Invest in research
Towards full picture of individual's health status

Biosensors



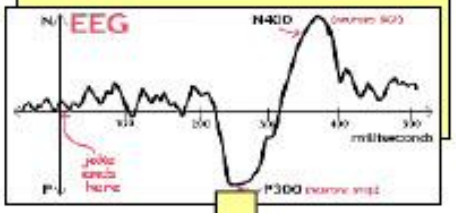
Biochips



Environmental Data

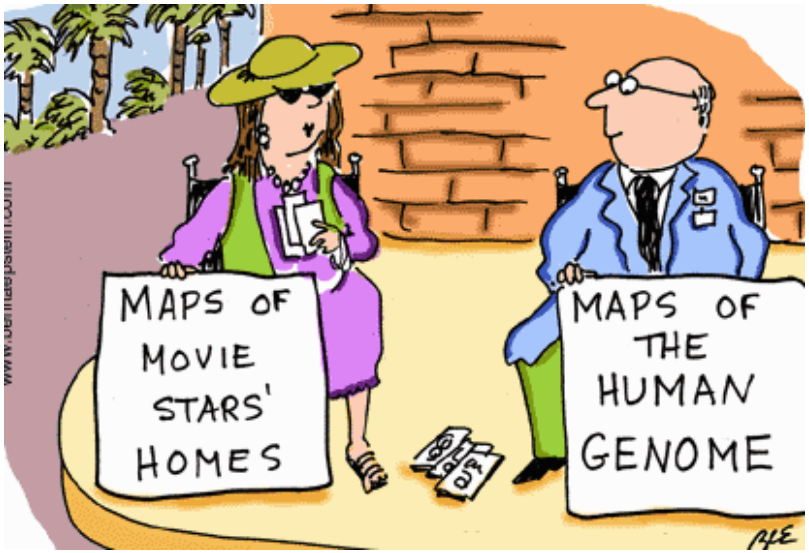
Genomic data

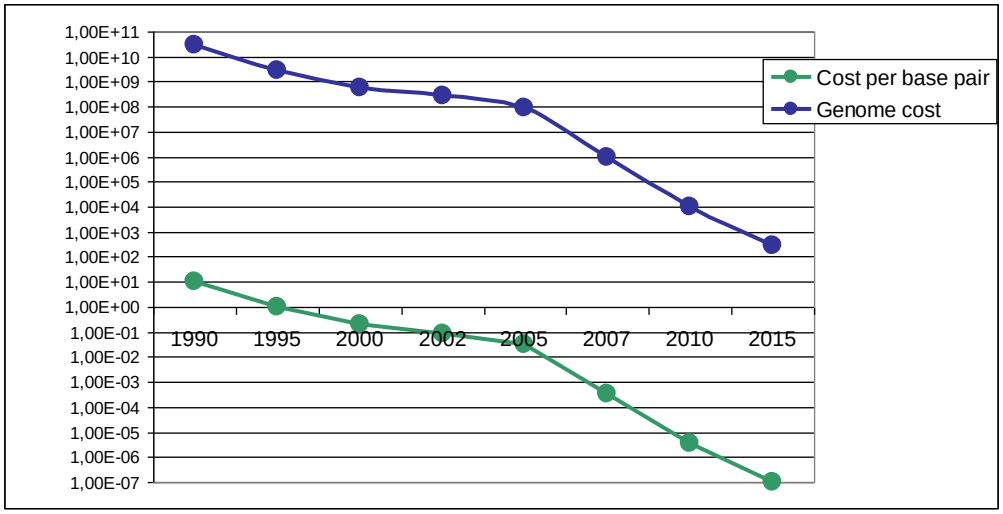
Phenomic data



Integrated Health Records

European Commission
Information Society and Media





- **Human genome project. June 2000**
  - **Final draft: April 2003**
  - **13 year project**
  - **$300 million value with 2002 technology**
- **Personal genome. June 1, 2007**
  - **Genome of James Watson, co-discoverer of DNA double helix, is sequenced ($1.000.000 - Two months)**
- **€1000-genome expected 2012-2020**

Year	Cost per base pair	Genome cost
1990	10	3E+10
1995	1	3.000.000.000
2000	0.2	600.000.000
2002	0.09	270.000.000
2005	0.03	90.000.000
2007	0.000333333	1.000.000
2010	3.33333E-06	10000
2015	0.0000001	300

CNS diseases	Potassium	Sodium	Calcium	Chloride
Epileptic syndromes	*KCNA1* *KCNA2* *KCNQ2/3* *KCNMA1* *KCNT1* *KCND2* *KCNH5* *KCNJ10* *KCNJ11*	*SCN1A* *SCN1B* *SCN2A* *SCN3A* *SCN8A*	*CACNA1H*	*CLCN2* *GLIALCAM*
Ataxia syndromes	*KCNA1* *KCNC3* *KCND3*		*CACNA1A*	
Familial Hemiplegic Migraine		*SCN1A*	*CACNA1A*	

Heart diseases	Potassium	Sodium	Calcium
Long QT and Short QT syndromes	*KCNQ1* *KCNH2* *KCNE1* *KCNJ2*	*SCN5A*	*CACNA1C*
Brugada syndromes	*KCNE3* *HCN4*	*SCN5A* *SCN1B* *SCN3B*	*CACNA1C*
Catecholaminergic polymorphic ventricular tachycardia			*RYR2*

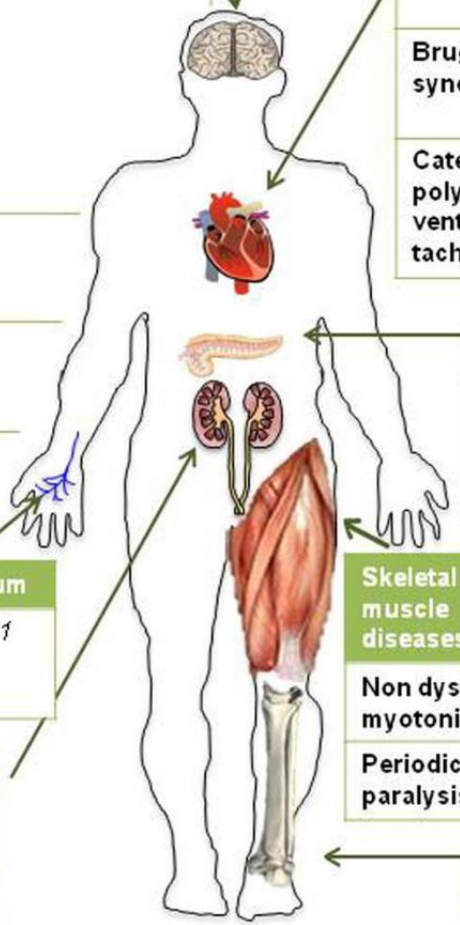
Pancreas diseases	Potassium
Familial Congenital hyperinsulinism and neonatal diabetes mellitus	*KCNJ11* *ABCC8*

PNS diseases	Sodium	Potassium	Calcium
Pain syndromes and neuropathies	*SCN9A* *SCN10A* *SCN11A*	*KCNQ2*	*TRPA1*

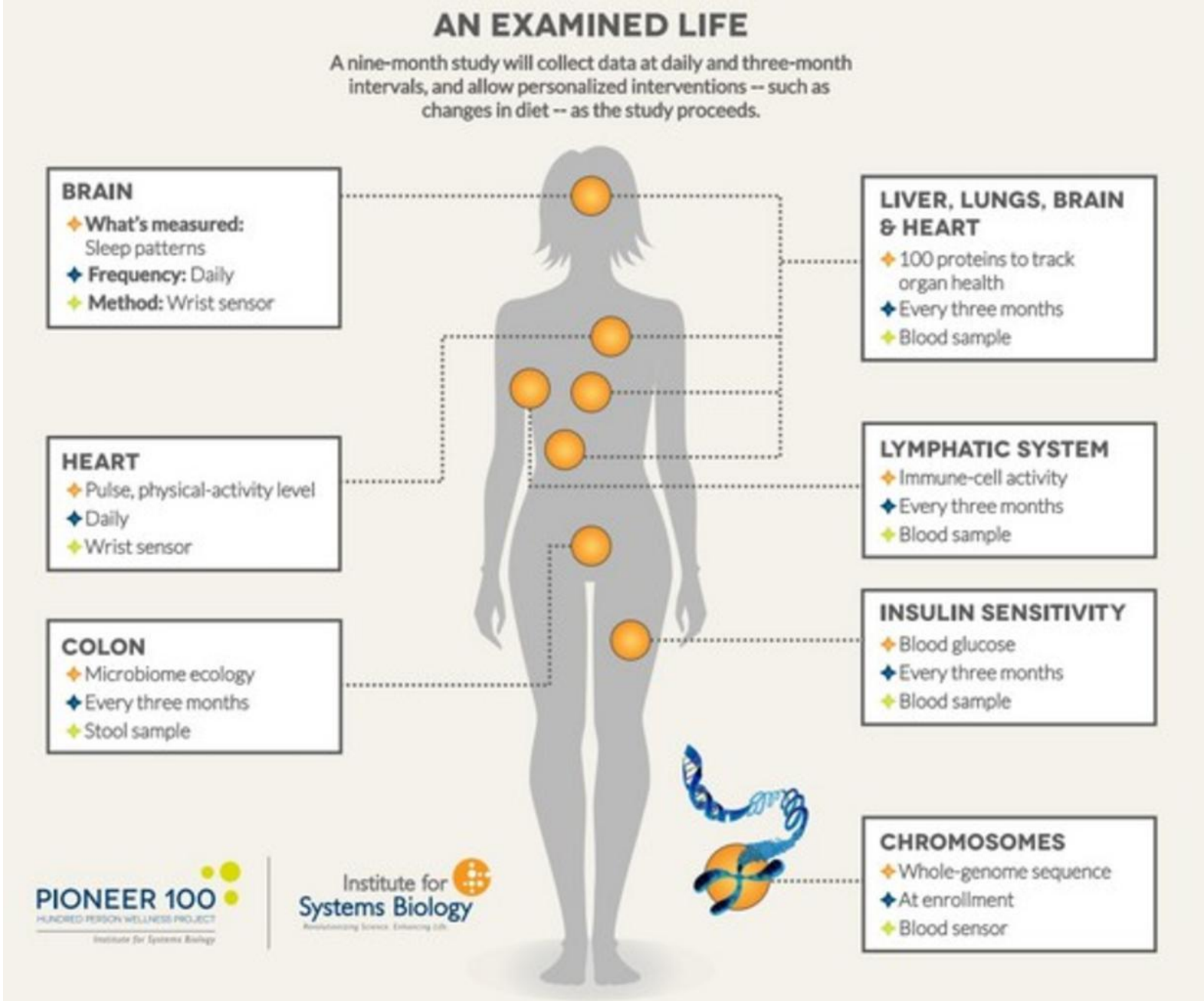
Skeletal muscle diseases	Potassium	Sodium	Calcium	Chloride
Non dystrophic myotonias		*SCN4A*		*CLCN1*
Periodic paralysis	*KCNJ2* *KCNJ18*	*SCN4A*	*CACNA1S*	

Kidney diseases	Potassium	Chloride
Bartter's syndrome	*ROMK1*	*CLCNKB* *BSDN*
Dent disease		*CLCN5*
EAST/SESAME syndrome	*KCNJ11*	

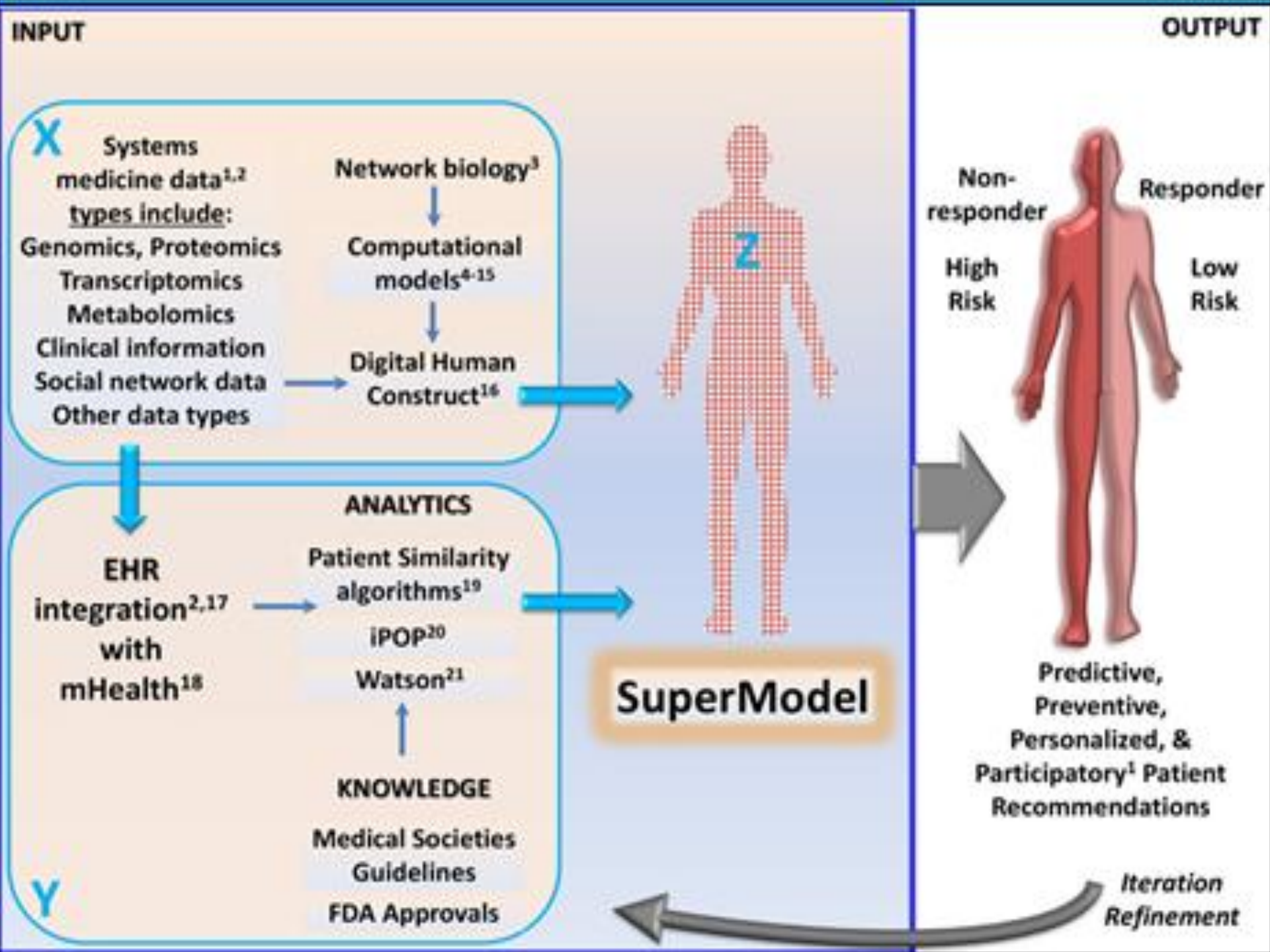
Bone diseases	Chloride
Osteopetrosis	*CLCN7* *OSTM1*



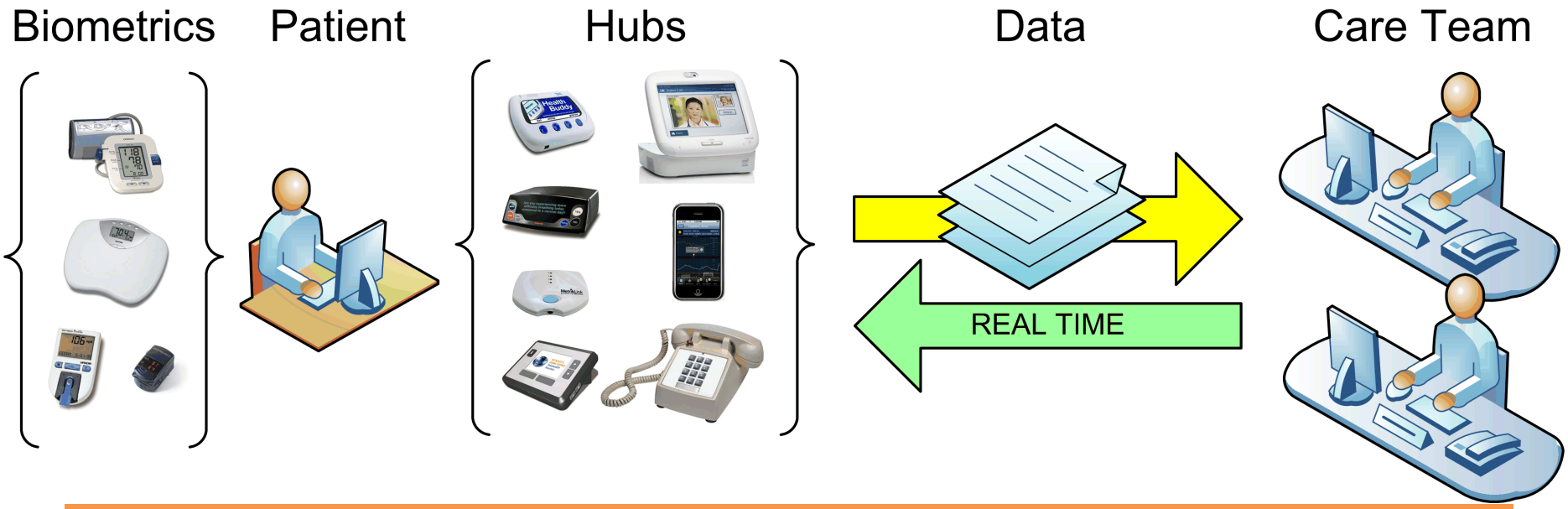
Front. Pharmacol., 10 May 2016, p 1-50



Source: Institute for Systems Biology


INPUT
OUTPUT
X
Systems medicine data[1,2] types include:
Genomics, Proteomics
Transcriptomics
Metabolomics
Clinical information
Social network data
Other data types
Network biology[3]
Computational models[4-15]
Digital Human Construct[16]
Z
Non-responder
Responder
High Risk
Low Risk
EHR integration[2,17] with mHealth[18]
ANALYTICS
Patient Similarity algorithms[19]
iPOP[20]
Watson[21]
KNOWLEDGE
Medical Societies Guidelines
FDA Approvals
Y
SuperModel
Predictive, Preventive, Personalized, & Participatory[1] Patient Recommendations
Iteration
Refinement

Remote Patient Monitoring



Modality	Pros	Cons	Comments
Telemonitoring	Better access 'Personalization' Early detection Fewer visits and hospitalizations Members love it	Data issues Integration issues Rules engine issues	Multimodal by population Team-based care Requires initial in-person visit

mHealth

What it covers

mobile devices

Personal Digital Assistant (PDA)

smart watches & other body-worn devices or implants

With these devices it is possible to **collect big amounts of data** such as

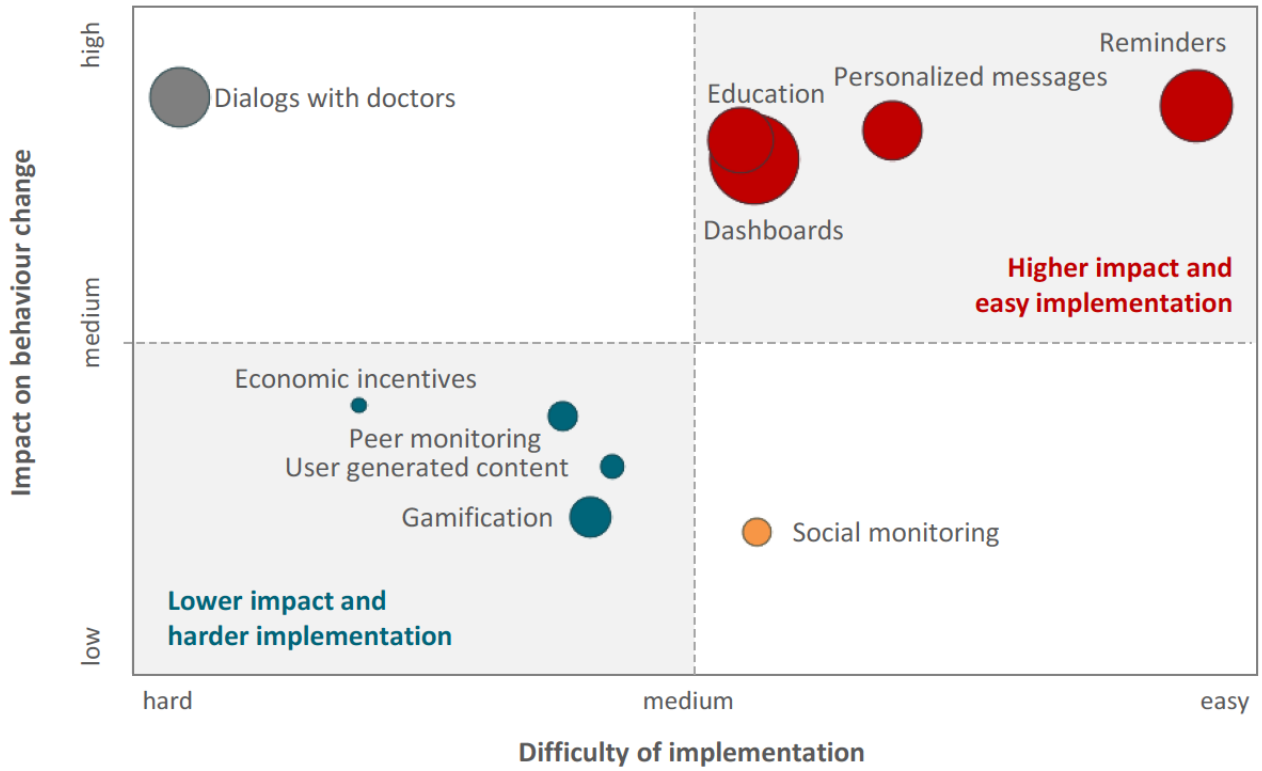
health monitoring

lifestyle

daily activity

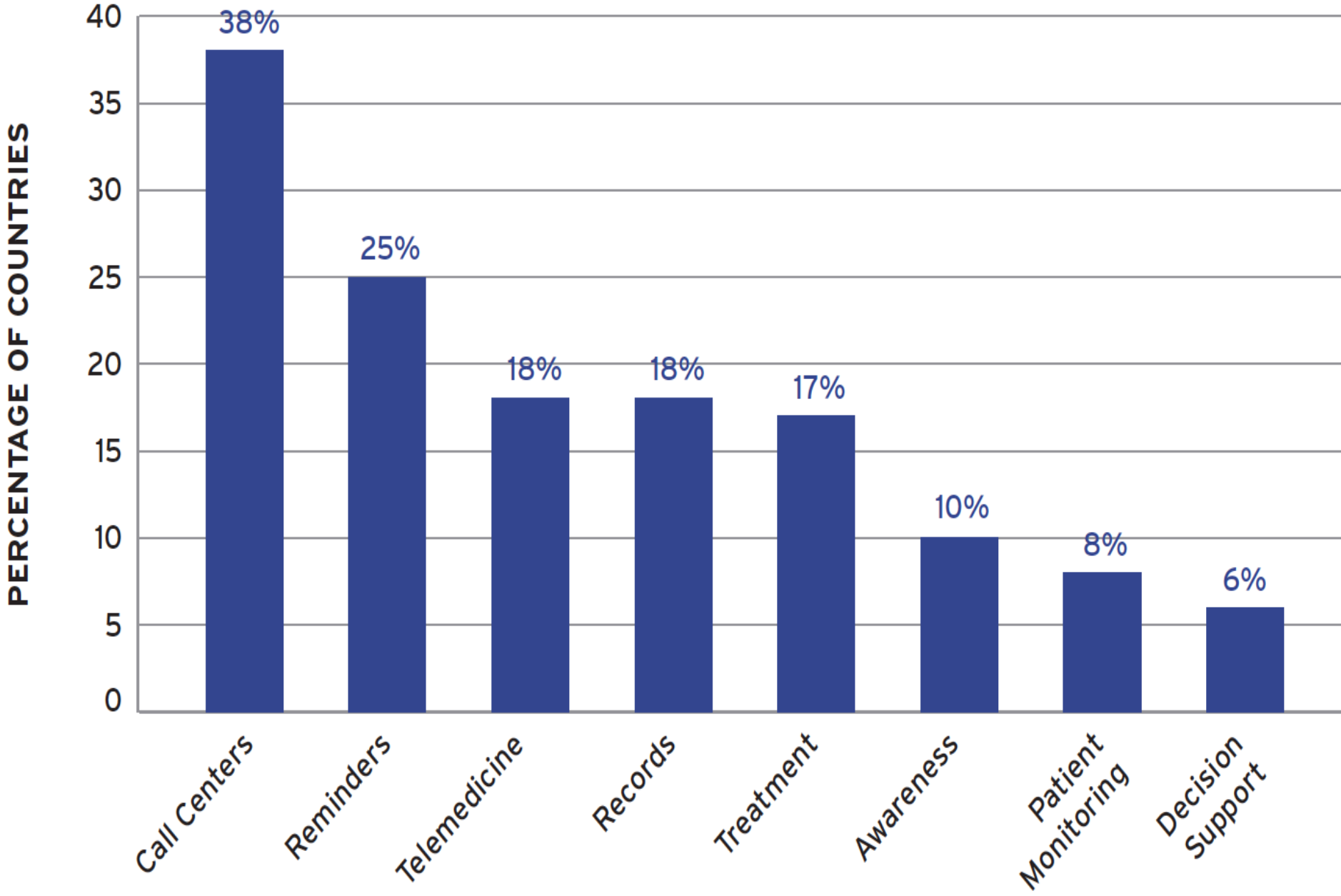
REMINDERS ARE SEEN AS THE MOST EASILY IMPLEMENTED AND MOST EFFECTIVE IN CHANGING PATIENT BEHAVIOR

Impact and implementation of behavior changing app features

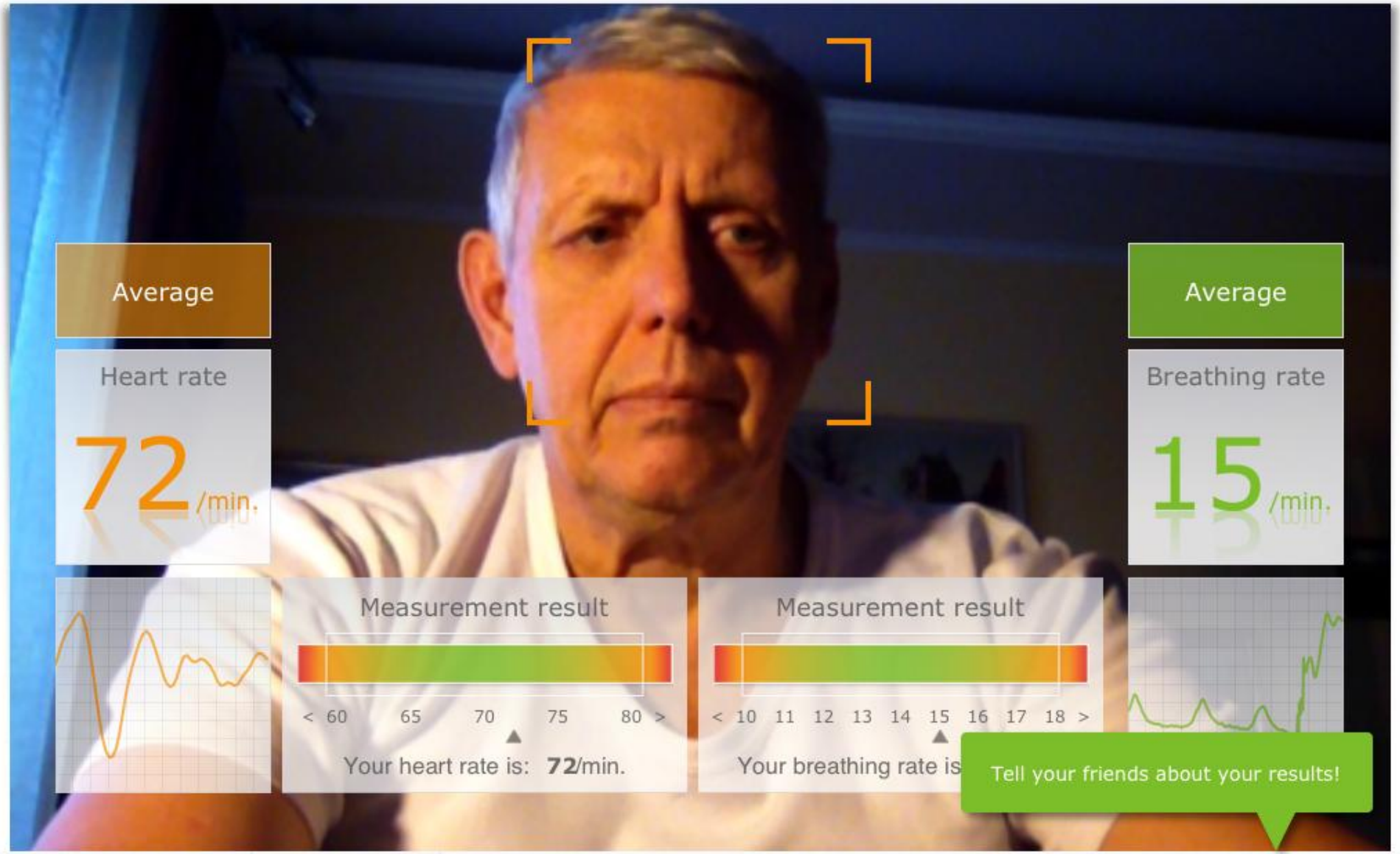


Note: Size of circle shows usage of the feature by app publishers

Countries Reported Use of mHealth Initiatives



Contactless monitoring of heart rate and breath rate

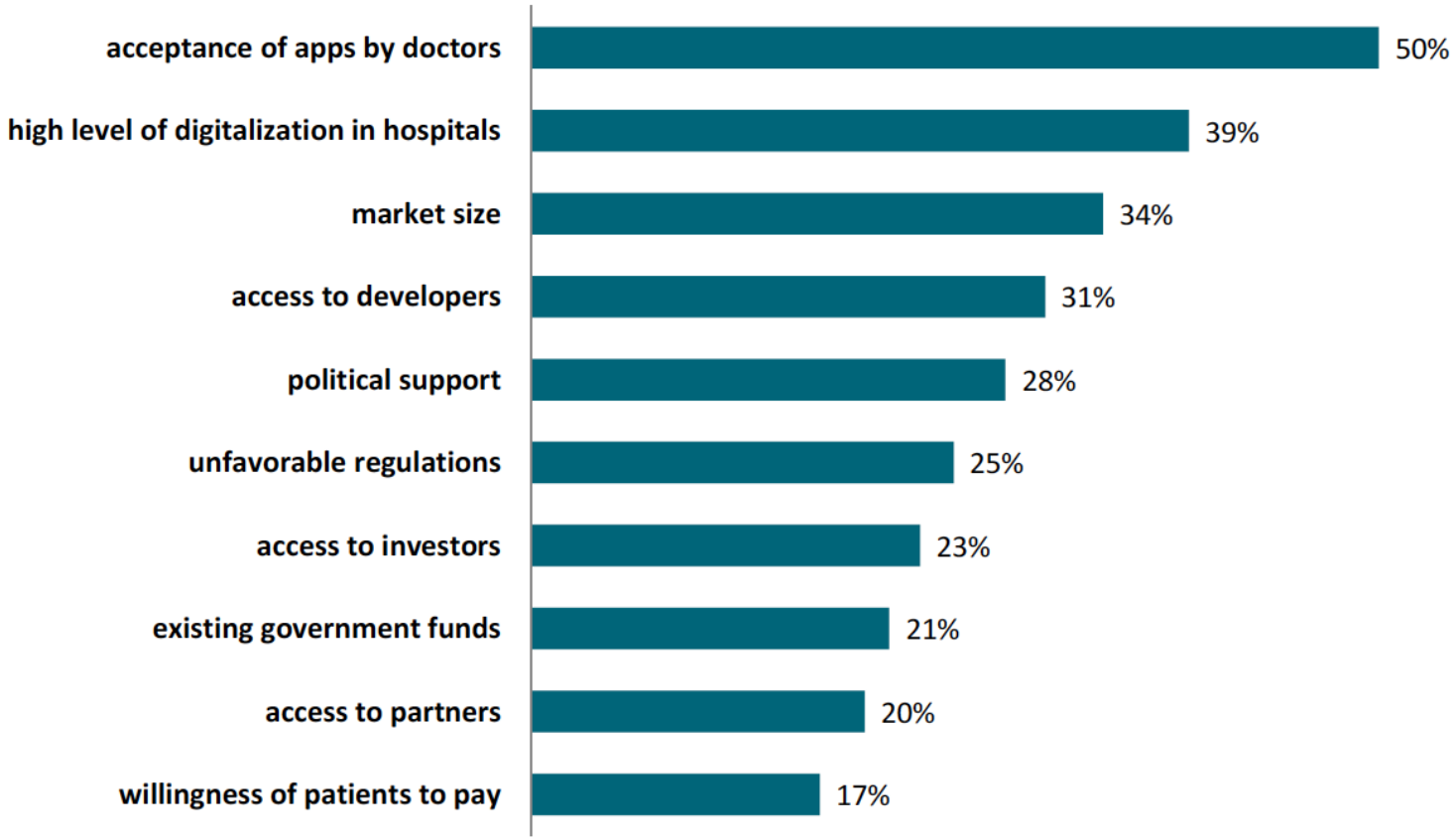



ARE SNCF / PARIS PAR TRAIN
NCF STATION / PARIS BY TRAIN
TACIÓN SNCF / PARIS VIA TRENO
BIENVENUE
WELCOME
BIENVENIDOS
TGV
SNCF

Human-powered Carousel (Spain)

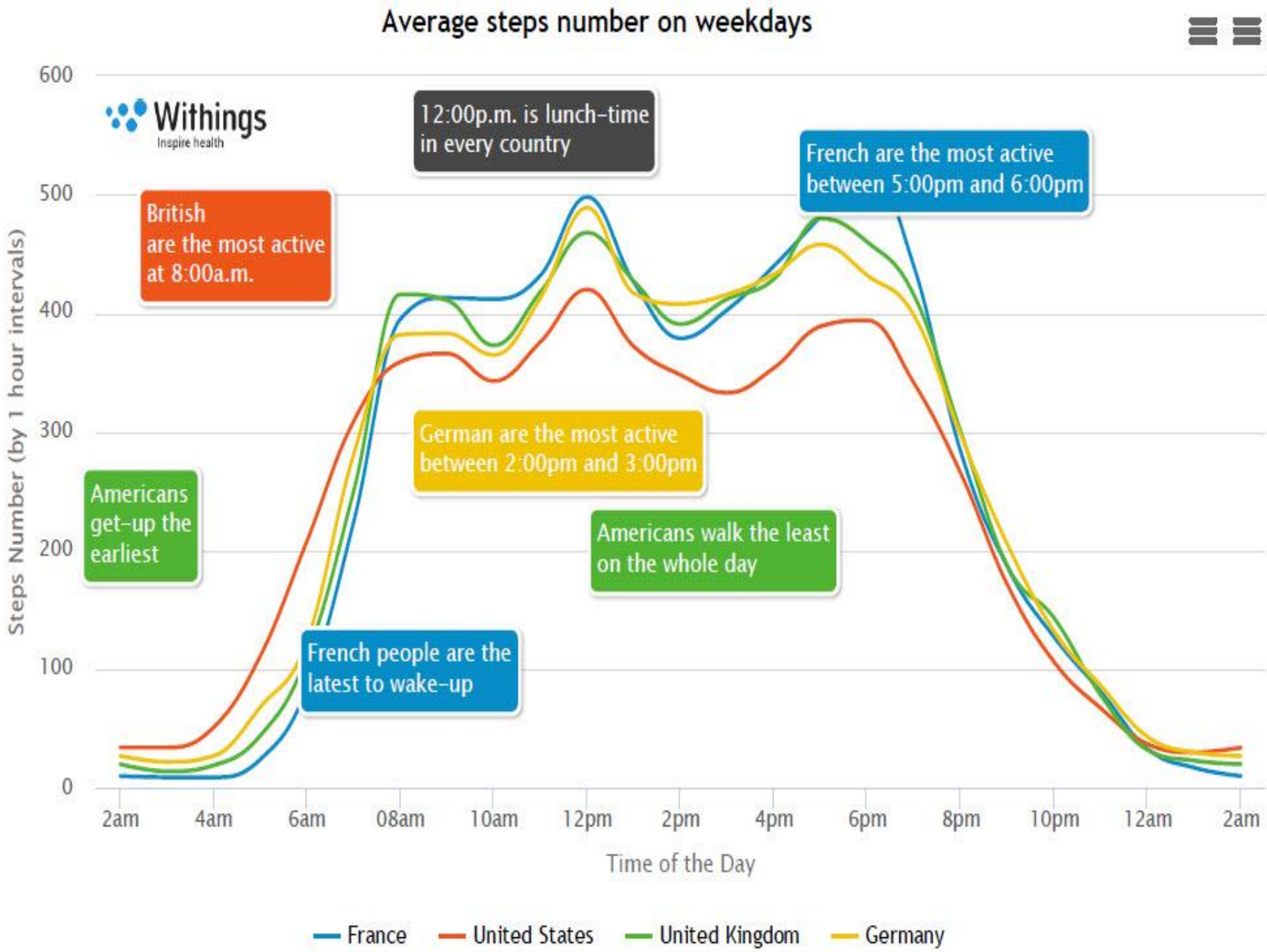
50 % OF PARTICIPANTS STATED DOCTORS' ACCEPTANCE OF APPS AS MOST IMPORTANT FOR MHEALTH BUSINESS

Top 10 reasons why country offers favorable market conditions



Share of participants stating reason in 3 most important for country offering poor market conditions

Source: research2guidance - EU countries' mHealth app market ranking 2015, n = 4,471


Average steps number on weekdays
Withings
Inspire health
12:00p.m. is lunch-time in every country
British are the most active at 8:00a.m.
French are the most active between 5:00pm and 6:00pm
German are the most active between 2:00pm and 3:00pm
Americans get-up the earliest
Americans walk the least on the whole day
French people are the latest to wake-up
Steps Number (by 1 hour intervals)
600
500
400
300
200
100
0
2am
4am
6am
08am
10am
12pm
2pm
4pm
6pm
8pm
10pm
12am
2am
Time of the Day
France
United States
United Kingdom
Germany

How It Works

Life insurance with the John Hancock Vitality Program rewards the every day steps you take to stay healthy and inspires you to do even more.

It's easy to participate:

Step 1. Accumulate Vitality Points: Members earn Vitality points by completing simple everyday activities to stay healthy - like going to the gym, getting annual health screenings, staying tobacco-free, and more.

Step 2. Earn a Vitality Status: Each year, you'll earn a Vitality Status – Bronze, Silver, Gold, or Platinum - based on the number of Vitality Points you accumulate.

Step 3. Enjoy Savings and Rewards: The higher your Vitality Status the more you can save on premiums and the greater your rewards and discounts.

We'll even send you a free Fitbit to track your progress toward a healthy life!

Gartner Reveals Top Predictions for IT Organizations and Users for 2016 and Beyond

- **8) By 2018, two million employees will be required to wear health and fitness tracking devices as a condition of employment.**

- The health and fitness of people employed in jobs that can be dangerous or physically demanding will increasingly be tracked by employers via wearable devices.
- Emergency responders, such as police officers, firefighters and paramedics, will likely comprise the largest group of employees required to monitor their health or fitness with wearables.
- The primary reason for wearing them is for their own safety. Their heart rates and respiration, and potentially their stress levels, could be remotely monitored and help could be sent immediately if needed.
- In addition to emergency responders, a portion of employees in other critical roles will be required to wear health and fitness monitors, including professional athletes, political leaders, airline pilots, industrial workers and remote field workers.

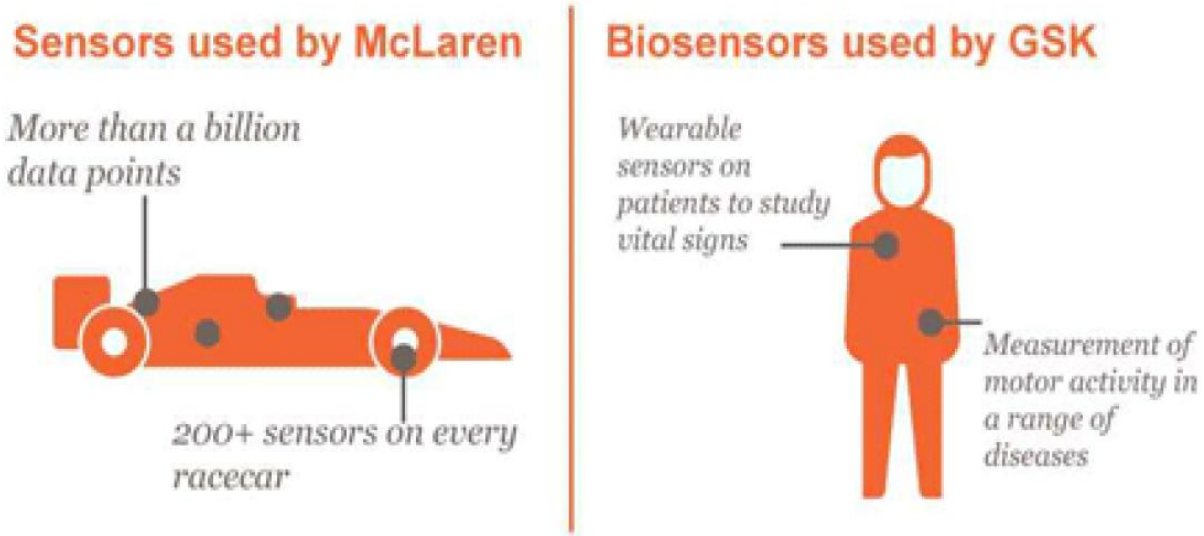
Glaxo Mulling $1B Deal with Qualcomm

Posted in Medical Device Business (/medical-device-business) by Qmed Staff (/users/qmed-staff) on January 21, 2016

British drug giant GlaxoSmithKline may be looking to look beyond the humble pill by considering a merger with chipmaker and digital health pioneer Qualcomm.

Nancy Crotti

GSK is looking for ways to develop medical technology, according to Bloomberg, which reported



GSK has been announcing a growing number of partnerships in recent years. For instance, a partnership with the McClaren racing team has helped the company refine how it performs clinical trials.

Importance of BIG DATA analysis for evidence-based medicine (big groups of people)

Psychological Science OnlineFirst, published on January 20, 2015 as doi:10.1177/0956797614557867

Research Article

Psychological Science
1–11

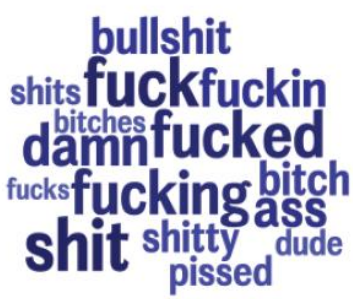
DOI: 10.1177/0956797614557867
pss.sagepub.com

Psychological Language on Twitter Predicts County-Level Heart Disease Mortality

Johannes C. Eichstaedt[1], Hansen Andrew Schwartz[1,2], Margaret L. Kern[1,3], Gregory Park[1], Darwin R. Labarthe[4], Raina M. Merchant[5], Sneha Jha[2], Megha Agrawal[2], Lukasz A. Dziurzynski[1], Maarten Sap[1], Christopher Weeg[1], Emily E. Larson[1], Lyle H. Ungar[1,2], and Martin E. P. Seligman[1]

Twitter Topics Positively Correlated With County-Level AHD Mortality

Hostility, Aggression



$r = .18$

$r = .21$

$r = .27$

Hate, Interpersonal Tension

$r = .16$

$r = .17$

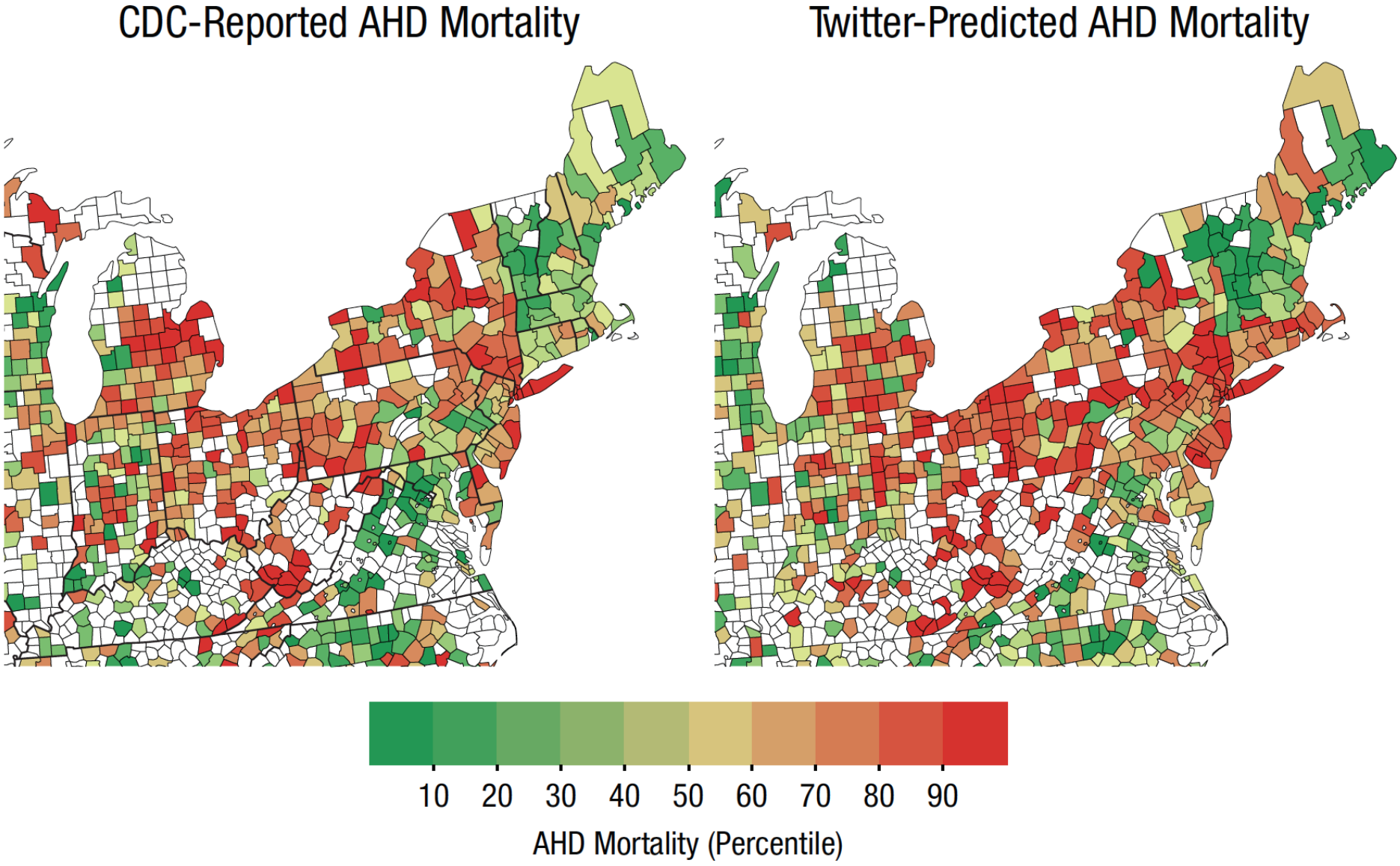
$r = .21$

Boredom, Fatigue

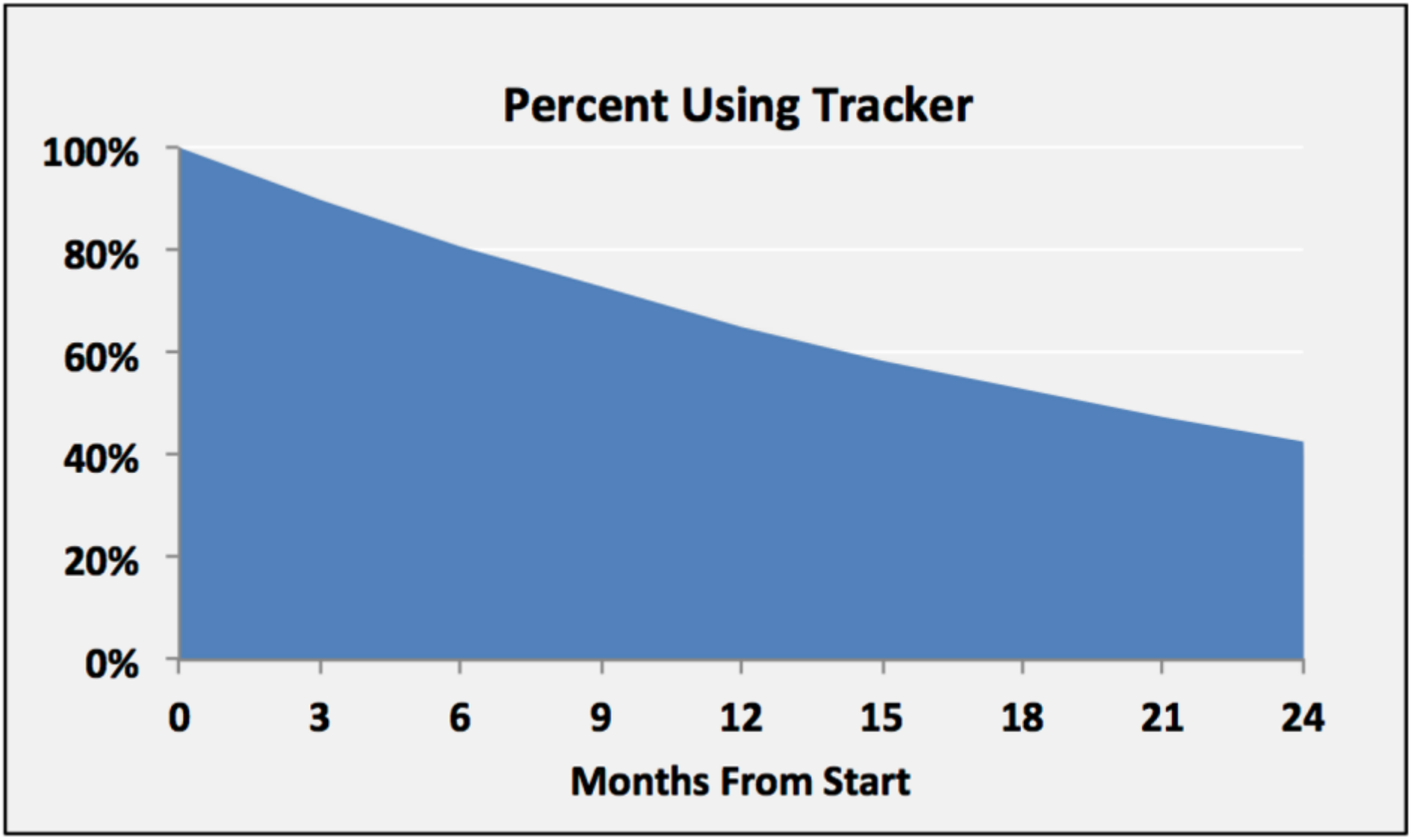
$r = .18$

$r = .18$

$r = .20$


CDC-Reported AHD Mortality
Twitter-Predicted AHD Mortality
10
20
30
40
50
60
70
80
90
AHD Mortality (Percentile)

https://www.youtube.com/watch?v=hZWLy7FLvZ4&feature=youtu.be



Data via Endeavor Partners, LLC, September 2013.

Keeping the wearable commitment

Our survey shows the initial buzz doesn't always translate to long-term commitment, most likely for one of these reasons:

1. Consumers don't perceive a pressing need for them; use-case unclear
2. Easy to lose
3. Unattractive or uncomfortable
4. Short-lived battery life
5. Does not sync seamlessly with a smartphone

While full abandonment was less severe, our survey did indicate a correlation between frequency of usage and time of purchase.

Over time, the newness wears off and fewer consumers use their wearables daily. Regardless of device type, wearables purchased over a year ago are used less often than those purchased more recently (within the last six months). Smart clothing experienced the largest daily drop-off, while smart glasses experienced the smallest.

- Glasses: 16% decrease
- Fitness: 18% decrease
- Watches: 22% decrease
- Clothing: 33% decrease

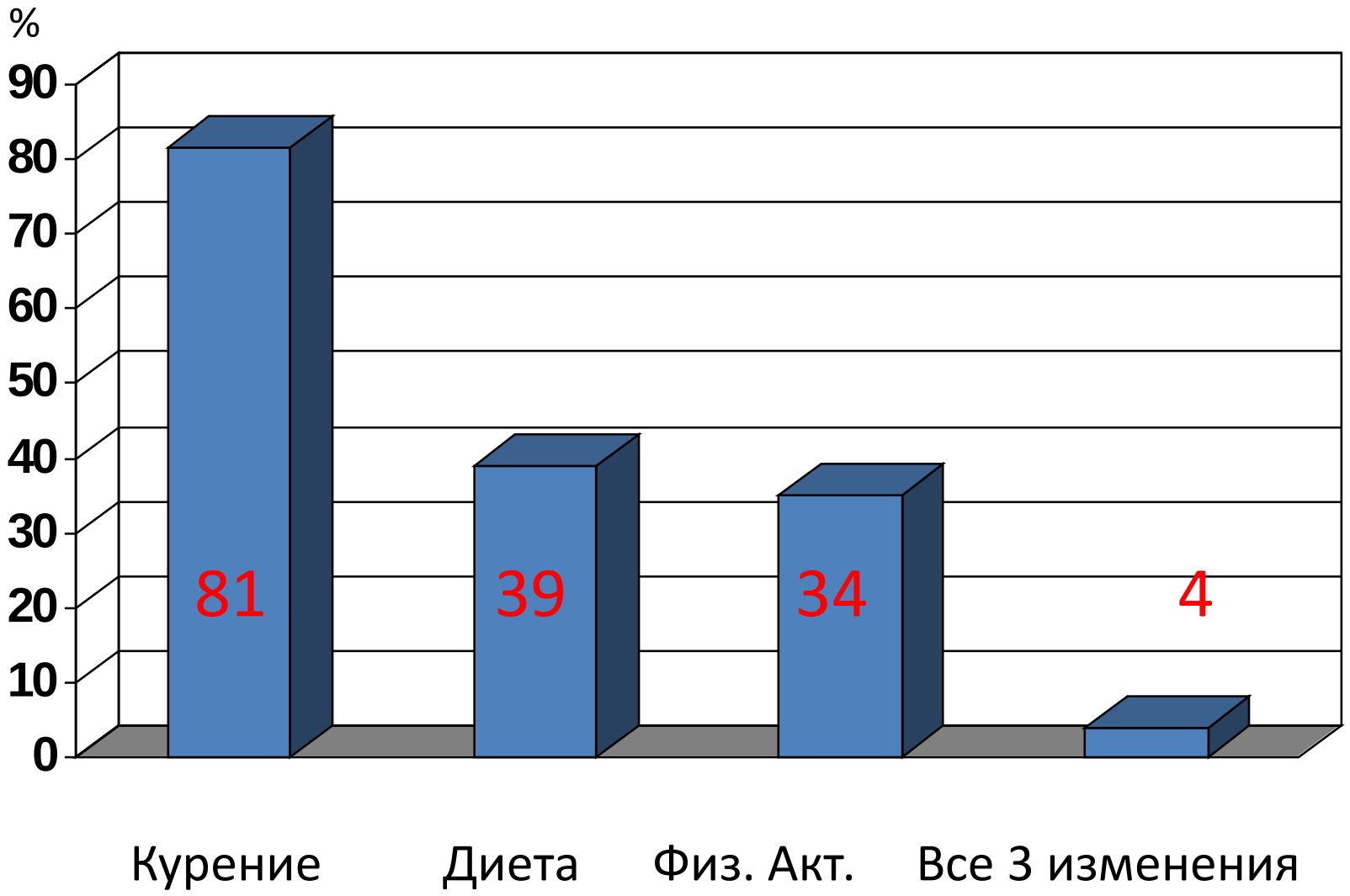
For consumers to commit to wearables for the long term, a device should not

"Honestly, I forget it most of the time."

– Male, 31

https://www.pwc.se/sv/Publications/cis-wearables.pdf

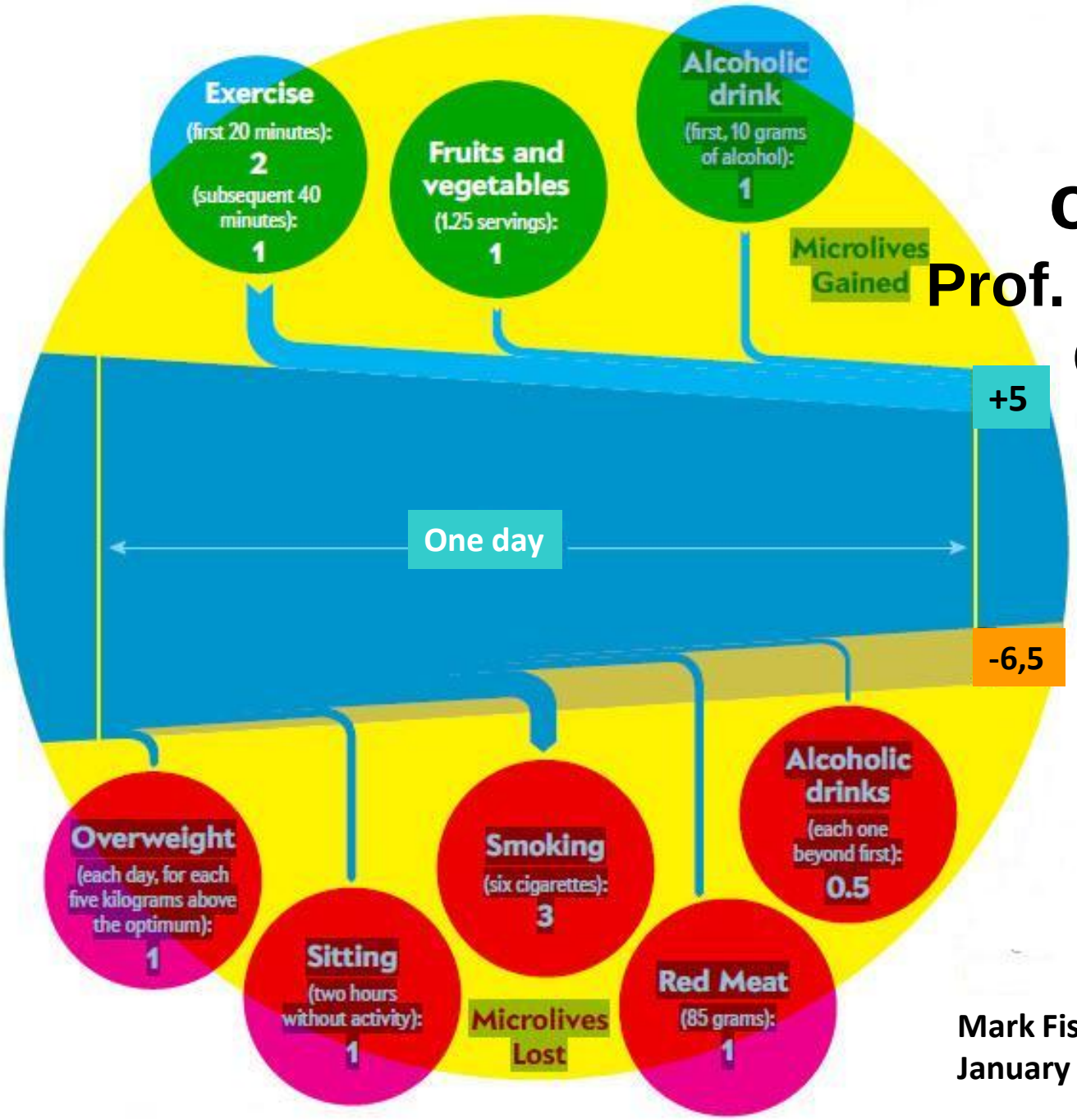
Изменение поведения у 7519 пациентов после инфаркта или инсульта –PURE project



17 апреля 2013 г. JAMA

Theory of microlives

Prof. David Shpigelhal Cambridge Uni



Mark Fischetti, Scientific American, January 2013, vol. 308, 1, p. 76

European Directory of Health Apps 2012-2013

A review by patient groups and empowered consumers

With foreword by **Robert Madelin**

European Commission Director General for Communications Networks, Content and Technology

Media partner

European Health Forum Gastein

Partners

how are you?

GlaxoSmithKline Consumer Healthcare

novo nordisk

SANOFI

Publisher

PATIENT VIEW

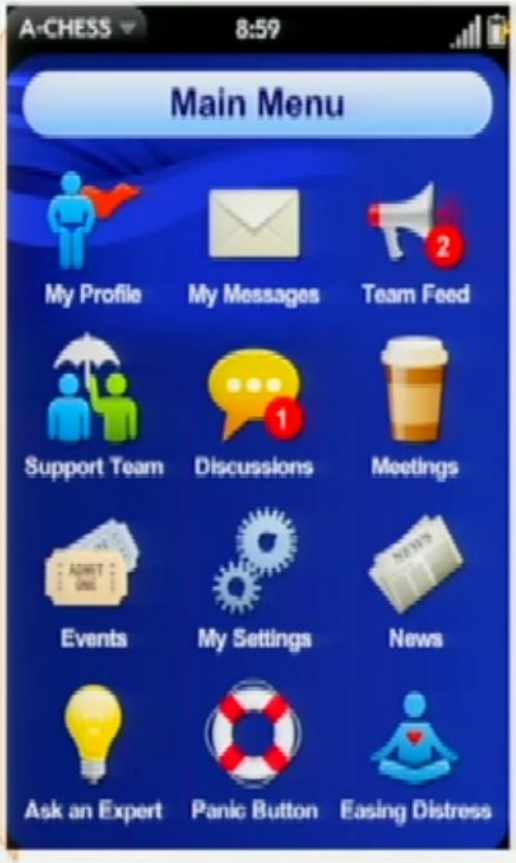
Adaptations for elderly

- Meet us where we are
  - Our hands tremble
  - We forget
  - Our eyes are dimmer
  - Our filters go away – manage communication
- So:
  - Maybe not mobile
  - Keep it simple
  - Anytime training
  - Minimal data collection

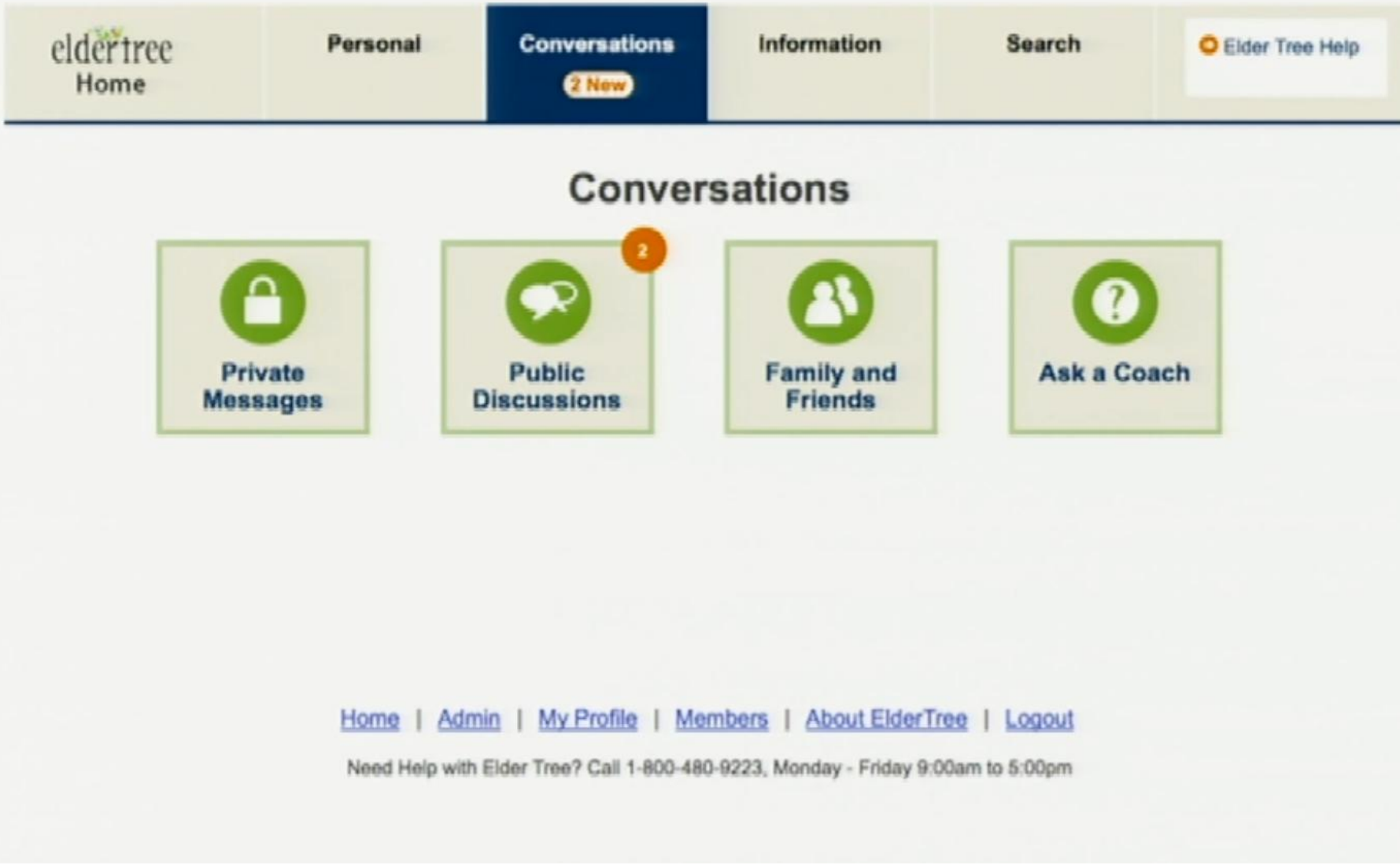
Typical CHESS: too compex

ACHESS

is operating now!



- Monitoring and alerts
- Reminders
- Autonomous motivation
- Assertive outreach
- Care coordination
- Medication reminders
- Peer & family support
- Relaxation
- Locations tracking
- Contact with professionals
- Information

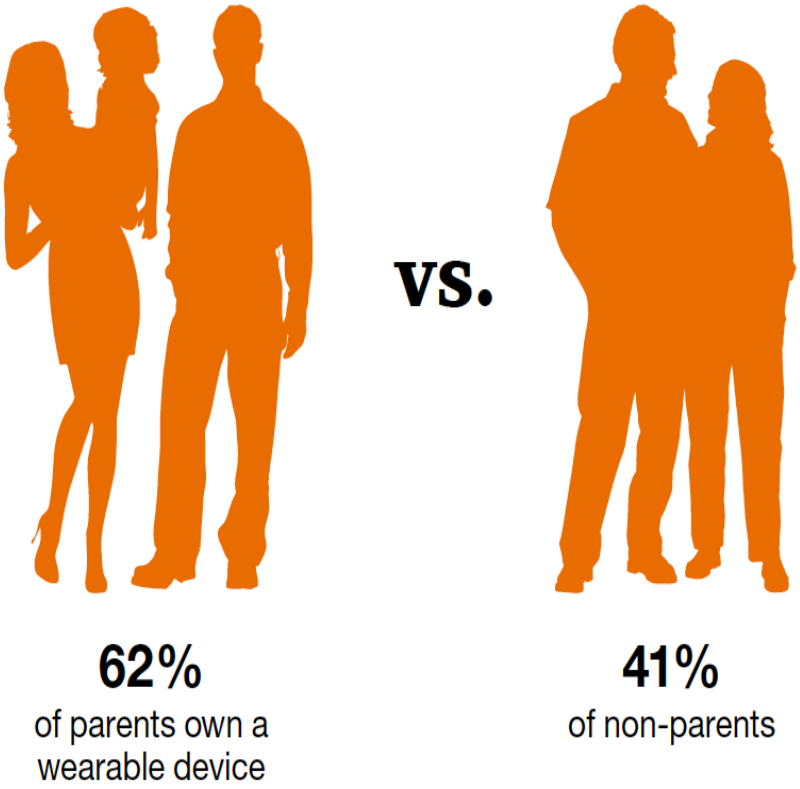

eldertree
Home
Personal
Conversations
2 New
Information
Search
Elder Tree Help
Conversations
Private Messages
2
Public Discussions
Family and Friends
Ask a Coach
Home | Admin | My Profile | Members | About ElderTree | Logout
Need Help with Elder Tree? Call 1-800-480-9223, Monday - Friday 9:00am to 5:00pm

Spotlight on parents

Parents (adults with at least one child in the household) are significantly more likely (49%) than non-parents (24%) to own not just one, but *multiple* wearable devices.

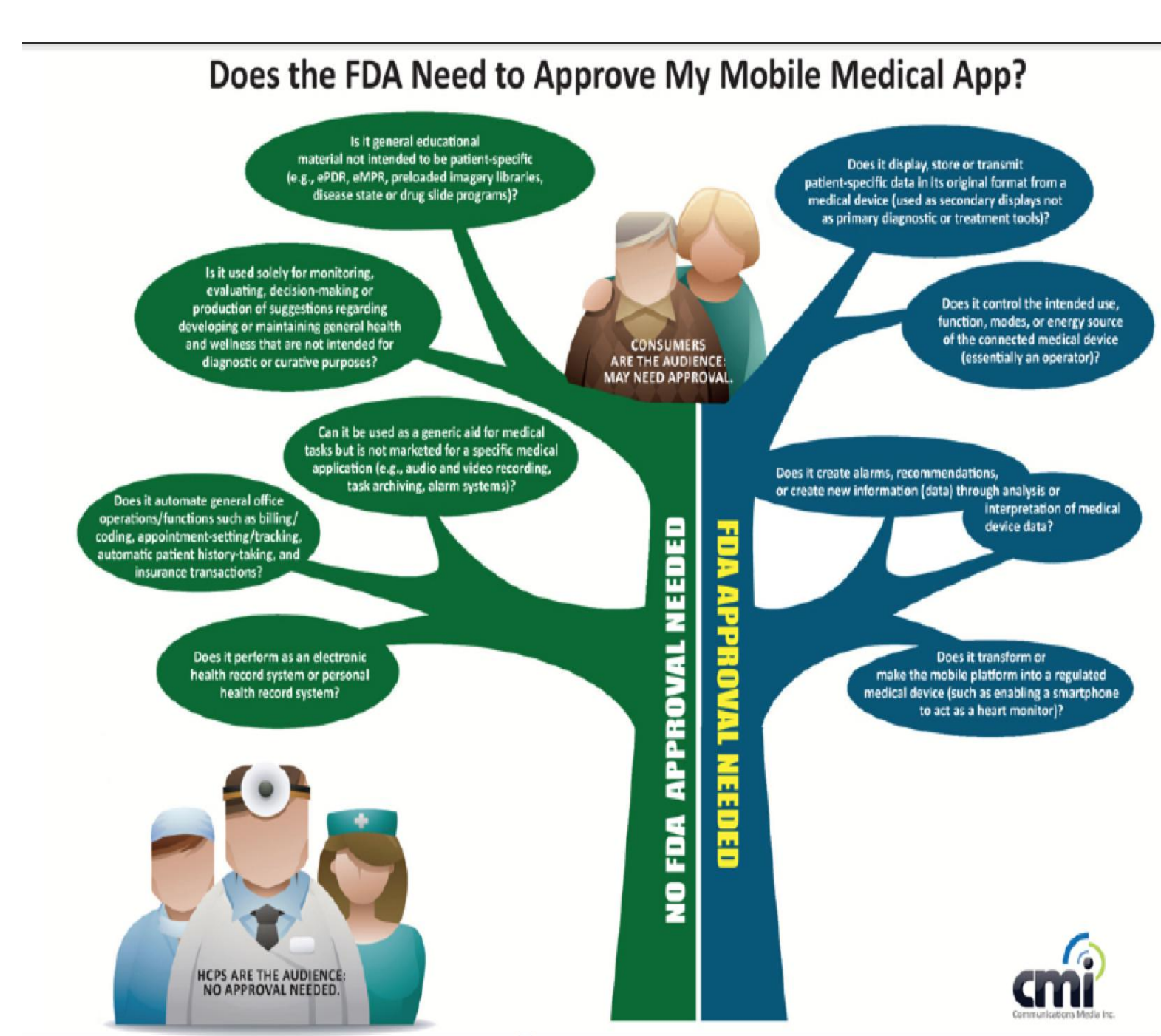
As with consumers overall, parents' main motivator for initial purchase was health (20%). Most non-parents, however, received their first device as a gift (18%).

Parents are also more likely than both non-parents and consumers overall to see wearable technology in a positive light. And parents are also *less* likely to believe that wearable technology will hurt their ability to relate to other humans, invade their privacy, or make them more vulnerable to security breaches.



http://www.pwc.com/us/en/industry/entertainment-media/publications/consumer-intelligence-series/wearables.html

Does the FDA Need to Approve My Mobile Medical App?



6 GUIDELINES

6.1 Criteria

This section explains the main criteria and the basis for selecting those criteria

A total of nine criteria have been identified based on the analysis of existing assessment frameworks (Annex A1) that are relevant for the assessment of mHealth apps

In addition to validity and reliability, other aspects have been identified such as usability, accessibility, transparency that are important from the end-user perspective for improved confidence and wider adoption of mHealth apps; likewise, effectiveness & credibility from the professional perspective.

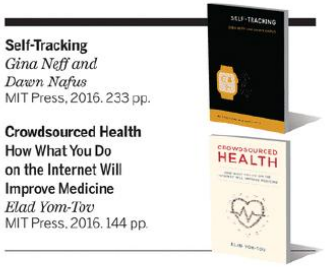
The diagram above illustrates these nine criteria, or domains, as all contributing to the data quality objective.

HEALTH ANALYTICS

Big data meets human health

Internet searches and fitness trackers are poised to play a role in the future of health care

By **Conor Farrington**



Self-Tracking
Gina Neff and Dawn Nafus
MIT Press, 2016. 233 pp.

Crowdsourced Health How What You Do on the Internet Will Improve Medicine
Elad Yom-Tov
MIT Press, 2016. 144 pp.

Last fall, I visited Stanford University to present new research on an artificial pancreas system for people with type 1 diabetes. Although I don't have diabetes myself, I chose to wear the system. I had never monitored my glucose levels before, and it was fascinating—and at times alarming—to see how they fluctuated in response to food, drink, stress, fatigue, exercise, and sleep. I had unconsciously joined a large and growing community of self-trackers.

As Gina Neff and Dawn Nafus emphasize in their excellent book *Self-Tracking*, there is a "veritable explosion" in the number of people using digital and wearable devices to record, analyze, and reflect upon data created by their own bodies and behaviors. Self-tracking activities can be undertaken for a wide range of motivations—for example, to maintain wellness, monitor specific medical conditions, foment political change, or create new forms of digital art and fashion. Data artist Laurie Frick, for example, has developed FrickBits, an app that converts smartphone GPS data into abstract collages, and sculptor Stephen Cartwright creates elegant representations of his tracked movements through space and time.

These activities depend on the latest technology, but Neff and Nafus point out that self-tracking has a long history. Benjamin Franklin used charts to monitor his productivity and moral character, giving particular attention each week to one of 13 virtues.

But can self-tracking induce positive change for the average contemporary user? Neff and Nafus quote an exchange from Stanford Medicine X 2012, an annual conference that explores the potential roles that emerging technologies will play in the future of medicine and health care. Here, one panelist argued, "Data leads to knowledge and knowledge leads to change." If this were true, "there would be no need for psychologists," countered another panelist. And indeed, although there is some evidence that self-tracking data can induce behavioral changes, social scientists have convincingly demonstrated the motivational and data interpretation challenges that confront self-trackers.

Neff and Nafus tread carefully between the twin pitfalls of techno-utopianism and techno-dystopianism to develop a nuanced position that acknowledges both the opportunities and the challenges raised by self-tracking. In doing so, they raise a number of important questions. Can quantitative self-tracking data fully capture who we are as individuals? Will self-tracking practices continue to exclude the sickest and poorest in our societies? In medical contexts, will self-tracking patients manage the burden of interpreting their own data, and will health care professionals be willing to incorporate such data into more personalized care? Who profits financially from self-tracking data? And, more broadly, will we continue to defend the right to data privacy, or will our societies shift toward total transparency?

A visitor demos a mobile blood-pressure monitor at the Wearable Expo in Tokyo.

PHOTO: BLOOMBERG/CONTRIBUTOR

Elad Yom-Tov's *Crowdsourced Health* discusses a different field of digital health, in which data are generated not through the use of wearable devices but from queries entered in search engines. Based on the premise that these searches mirror our offline behavior and that the Internet offers greater privacy and accessibility than many other possible sources of information, he suggests that these data could reveal information about health that would be difficult or impossible to gather in other ways.

Yom-Tov, a researcher at Microsoft Research, describes the studies he has carried out on medical conditions, ranging from anorexia to bipolar disorder. Among the more striking assertions is his claim to have generated a quantitative foundation for the Kübler-Ross "five stages of grief" model. Using cancer diagnosis as a proxy for bereavement, Yom-Tov and his team tracked queries and page visits by cancer patients and their families. They separated the most-visited sites into 11 categories and used a hidden Markov model to reveal the five predicted stages. They also revealed different progressions through the stages, depending on whether the searcher's cancer was acute or chronic, leading Yom-Tov to suggest that a more tailored communication method might be of benefit to patients.

Yom-Tov also claims to have discovered a new class of long-term drug side effects by tracing search queries about mild symptoms. While serious side effects emerging soon after drug use begins are likely to be reported to the FDA, he argues that patients may not associate long-term and milder symptoms with specific drugs, thus hindering their discovery as side effects.

Crowdsourced Health draws an overly stark divide between traditional medical research and newer digital research approaches, in part because Yom-Tov overlooks the contributions of qualitative and mixed-methods research in medicine. And for a book focused on Big Data, relatively little detail about the author's methods of analysis appears in the text. Nevertheless, Yom-Tov succeeds in demonstrating that online queries represent a potentially important source of medical data.

The question that has yet to be answered is what should ultimately be done with all of these data—and by whom.

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10.1126/science.aaf8769

(David Pierce/KQED)

An Unconventional Decision

Frankovich had been helping build a database of pediatric lupus patients who had been seen previously at the hospital. She had digitized the charts and made them searchable with key words.

This isn't typical.

Like any chronic medical condition, lupus generates a staggering amount of paperwork. Doctors follow each patient for years, even a decade.

Now, we have one simple measure that shows what works... Heart Rate Variability.

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- Working and mental habits
- Resting habits and sleep
- Physical activity
- Home & office ergonomics
- Health control and self-care

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Self service	Monitoring& support	Personal advice	**Proactive care**	VIP

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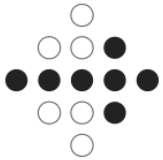
Withings

23andMe

Genotek

iHealth



FitBit

MyFitnessPal

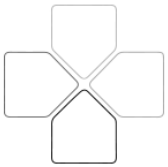
Lifesum

Noom Coach

Jawbone

Kinsa

Qardio



VitaDock

ThermoWatch

Moves

RunKeeper

Strava

Mi Fit

Apple Watch

Pebble

Beddit

Withings Aura

SleepCycle

MisFit

iPhone

Welltory

Swarm

WMe2

Importance of personalised data

- Sequental measurements started early in life create basis for getting individual “norm” value for the parameters measured
- Measurements in healthy people the only way for early diagnostics of the diseases
- Sequental measurements are not so demanding on the precision of the sensors

This child is our main user