"The Quantified-Self: From Idiosyncratic Hobby to an Emerging Growth Industry"

Invited Hot Topic Talk

San Diego Venture Group

San Diego, CA

June 19, 2014

Dr. Larry Smarr

Director, California Institute for Telecommunications and Information Technology

Harry E. Gruber Professor,

Dept. of Computer Science and Engineering

Jacobs School of Engineering, UCSD

http://lsmarr.calit2.net

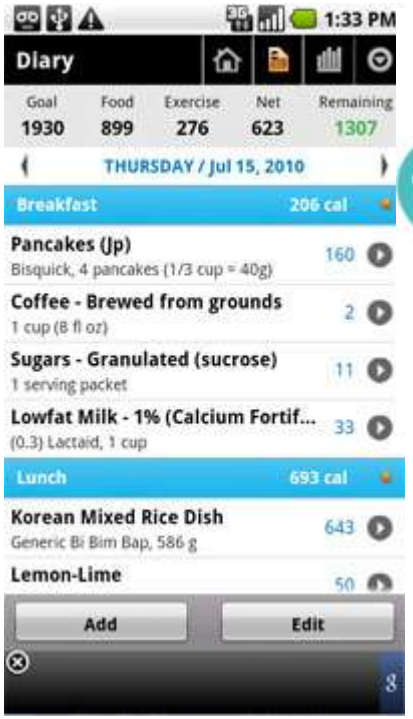
Consumer Self Measurement is Exploding Totally Outside of the Medical Complex

From the First San Francisco QS Meetup in 2008
To 116 Cities in 37 Countries in Four Years



Quantified Self Public Health Symposium Held
In Calit2's Qualcomm Institute April 2014

I Used a Variety of Emerging Personal Sensors To Quantify My Body & Drive Behavioral Change



MyFitnessPal-
Calories Ingested



FitBit -
Daily Steps &
Calories Burned



Withings/iPhone-
Blood Pressure





Withings WiFi Scale -
Daily Weight

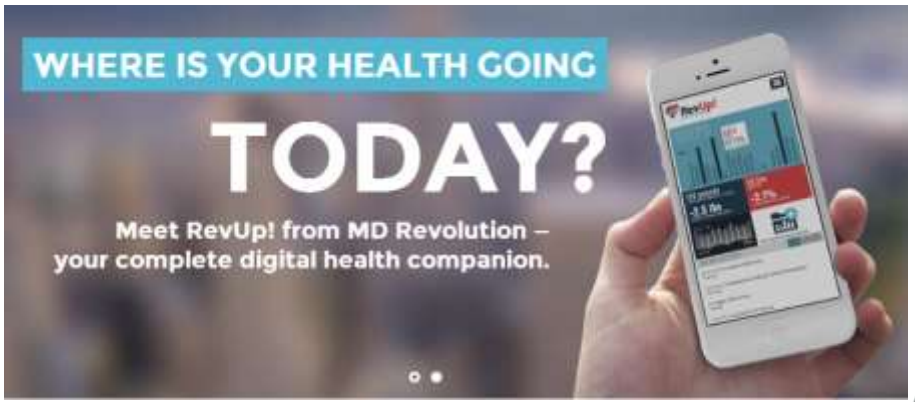


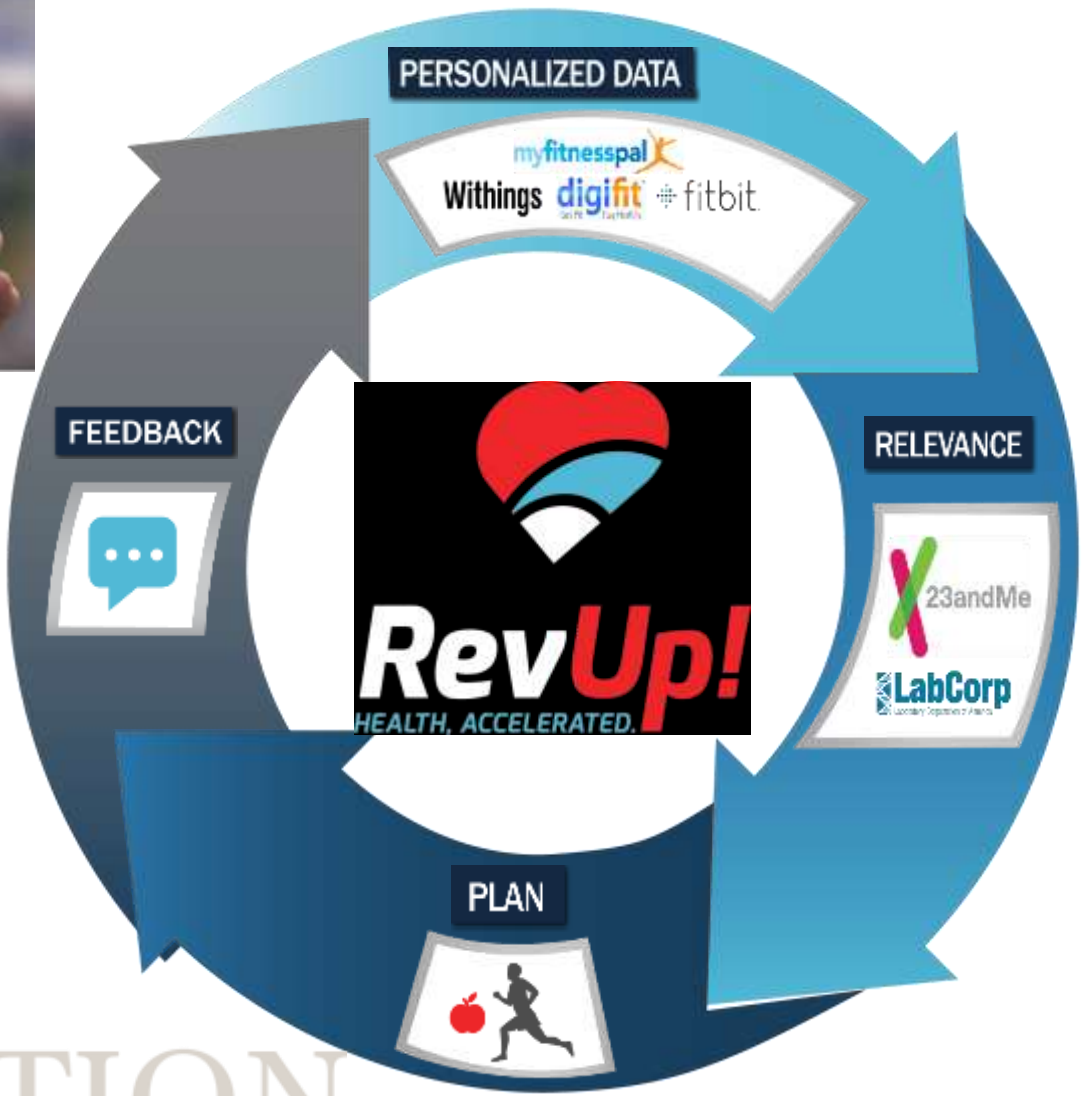
Zeo-Sleep



Azumio-Heart Rate

2014 is the Year of the Sensor Integrated Dashboard Combined with Coaching



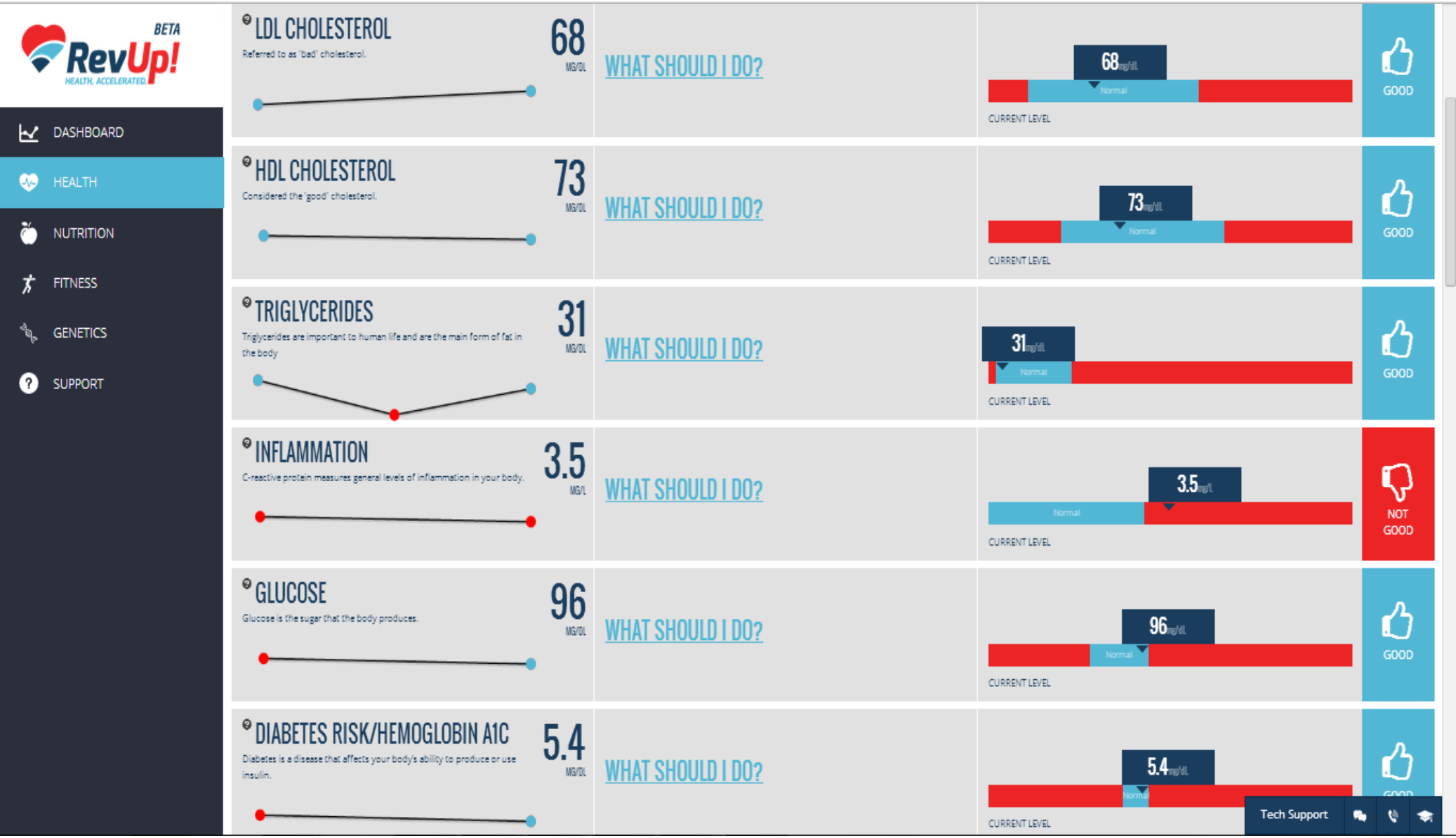


My RevUp! Age Has Decreased to 60
My Physical Age is 65.5

MD REVOLUTION

Source: Samir Damani, MD Revolution

MDRevolution's RevUp!
Also Integrates Blood Variables and Genetics



The Self-Monitoring Business Has Reached Market Takeoff

- **MyFitnessPal**
  - 40 Million Users
  - Aug 2013 Raised $18M Series A, Led by Kleiner Perkins
- **Fitbit**
  - Has Raised ~$70M
- **BodyMedia Was Bought by Jawbone**
  - For ~$100M
- **Zeo Sleep Monitor**
  - Closed Down in 2013

More Mergers Likely as the Shakeout Continues

From Measuring Macro-Variables to Measuring Your Internal Variables



www.technologyreview.com/biomedicine/39636

Calit2 is Creating a Network of Innovators in Personal Health Data



$1.9M Grant From the RWJF

UCIrvine
University of California, Irvine

UC SanDiego

Robert Wood Johnson Foundation

it²

Early Adopting MDs Are Creating Partnerships with Their Quantified Patients

- **"The 100 participants will be guided on this 9-month journey by a coach and when necessary, be referred to their own health care practitioners."**
- **The data sets that will be evaluated include:**
  - **Self-Tracking Devices**
  - **Medical History, Traits, Lifestyle**
  - **Blood, Urine, Saliva**
  - **Gut Microbiome**
  - **Whole Genome Sequencing**
- **I am One of the One Hundred**



PIONEER 100

HUNDRED PERSON WELLNESS PROJECT

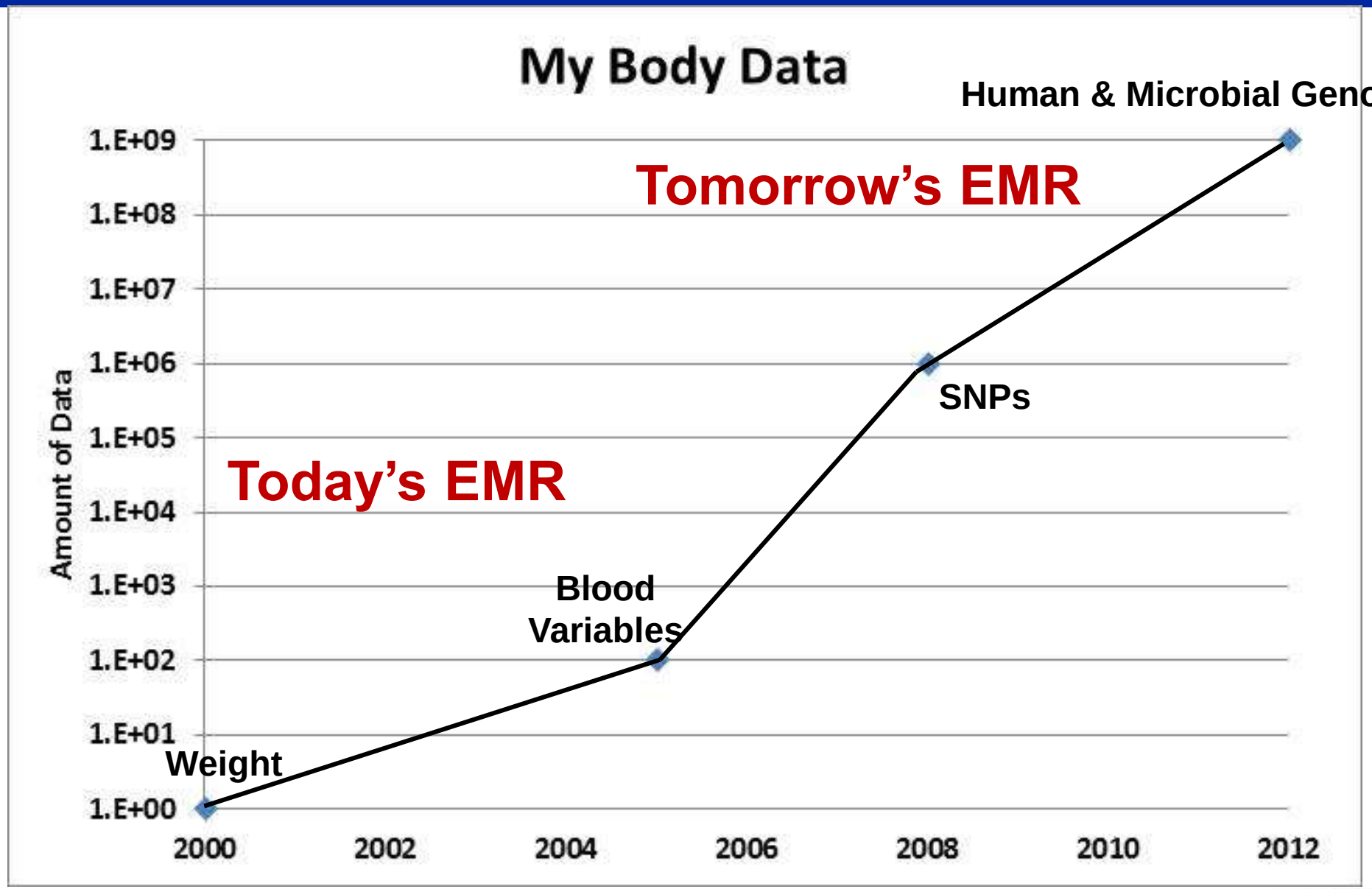
Institute for Systems Biology

Will Grow to 1000, then 10,000

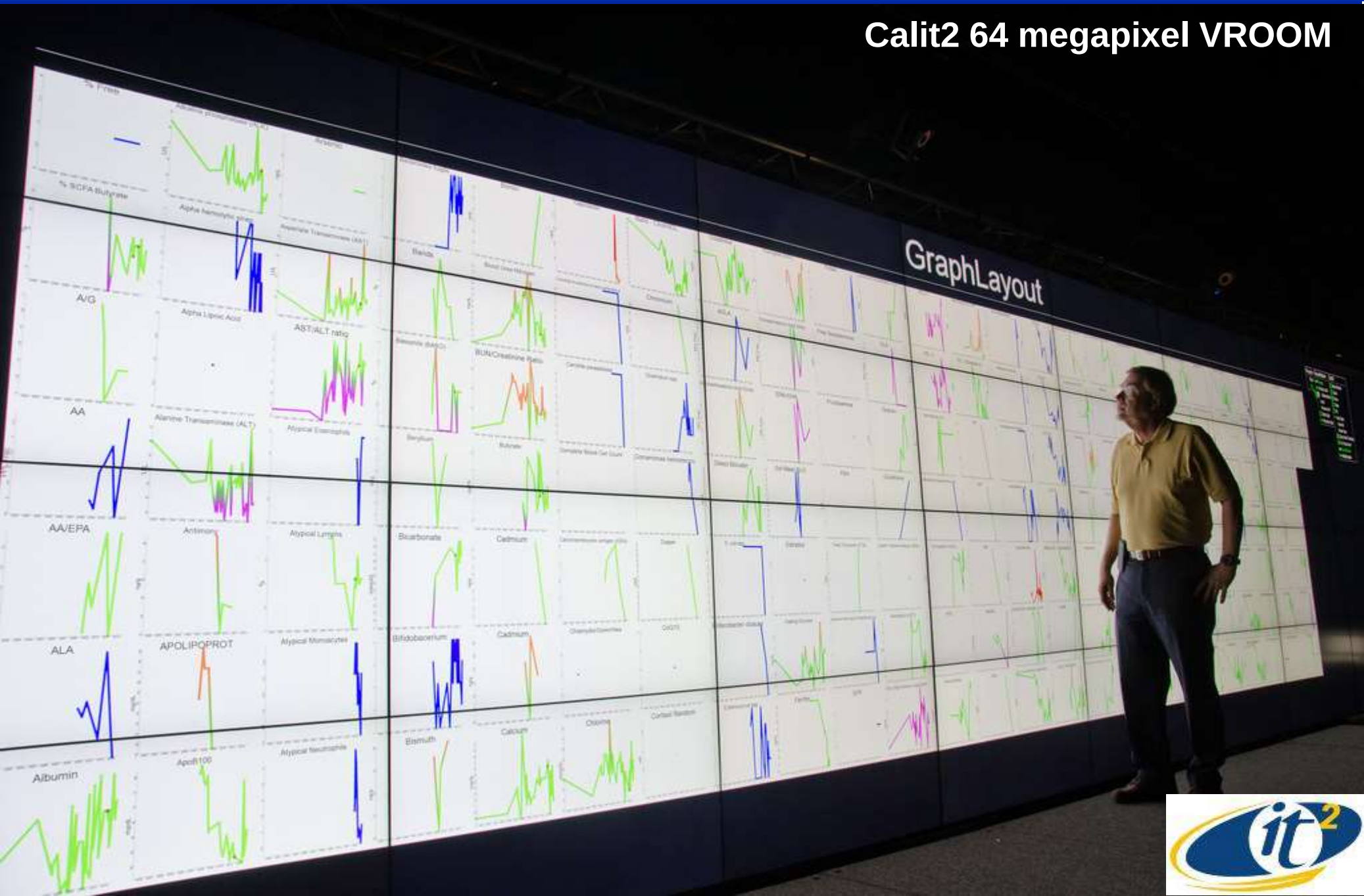
How Will the *Quantified Consumer*
Be Integrated into Healthcare Systems?

https://pioneer100.systemsbiology.net/

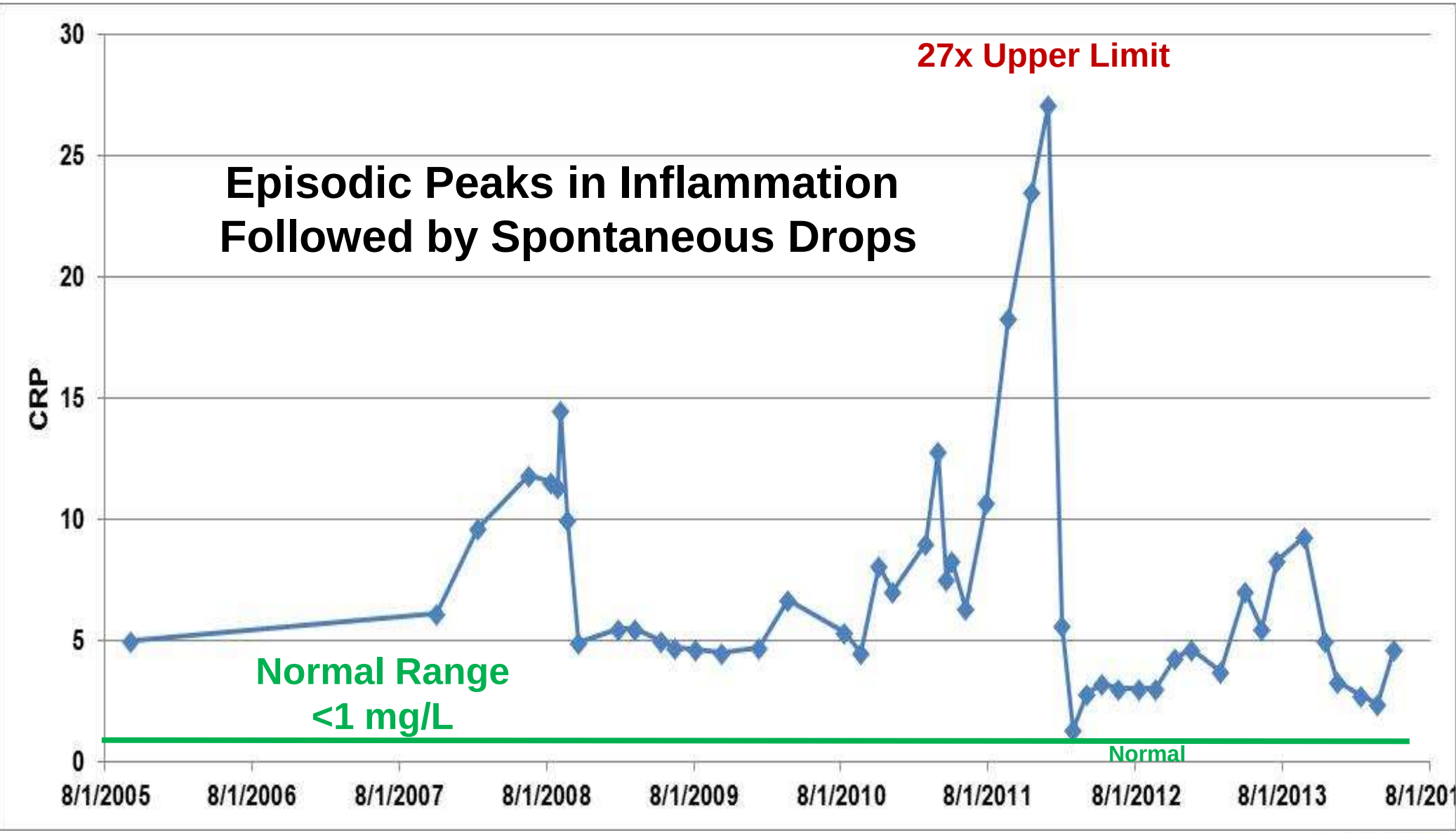
From One to One Billion Data Points Defining Me: *Big Data* Coming to the Electronic Medical Record (EMR)



Visualizing 5-10 Year Time Series of 150 Blood & Stool Variables Led Me to Discover a Chronic Disease

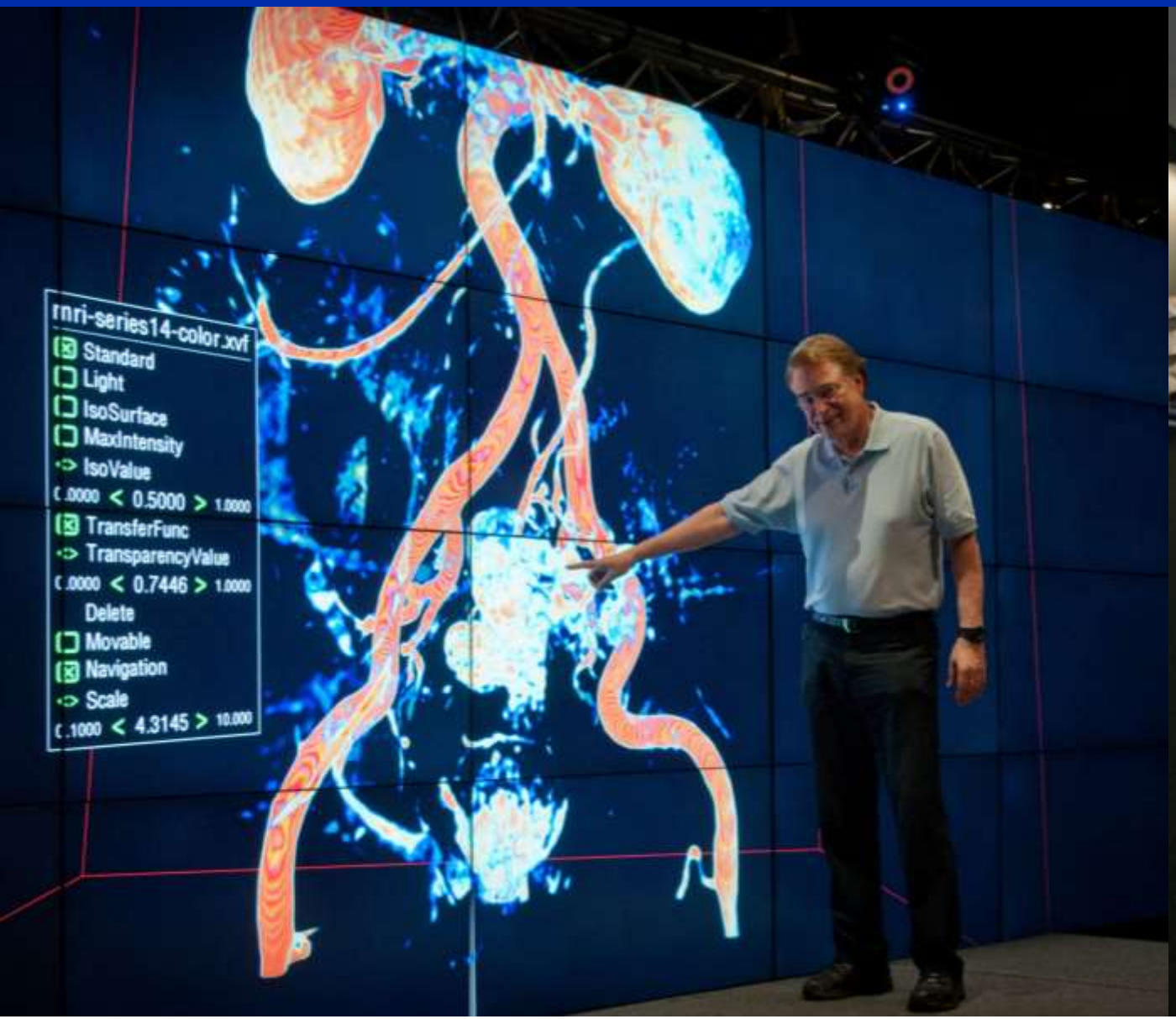


Only One of My Blood Measurements Was Far Out of Range--Indicating Chronic Inflammation



Complex Reactive Protein (CRP) is a Blood Biomarker for Detecting Presence of Inflammation

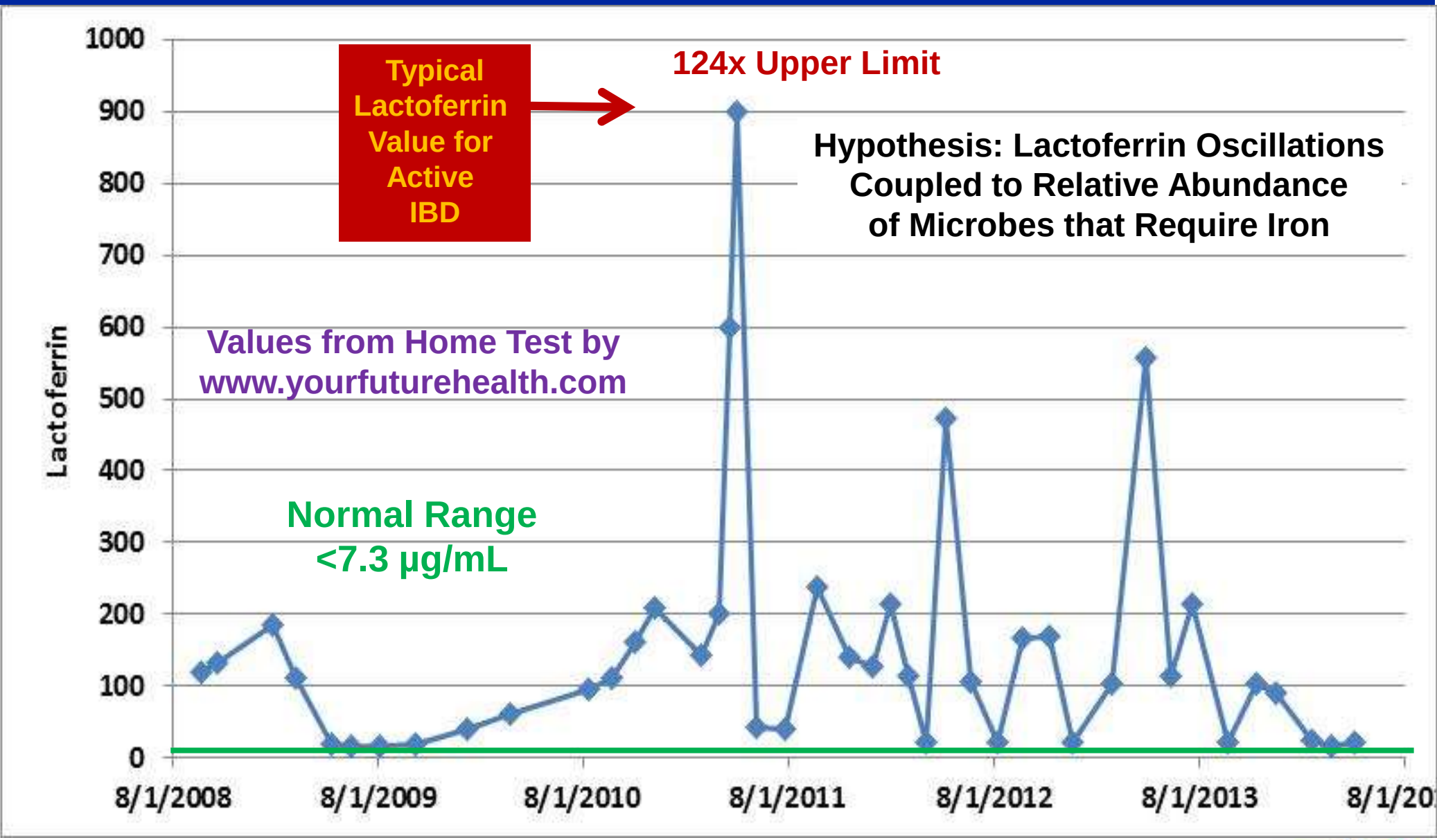
Finding My “Smoking Gun” - Interactive Virtual Reality and 3D Printed Colon Hard Copy from LS MRI Data





Research: Calit2 FutureHealth Team

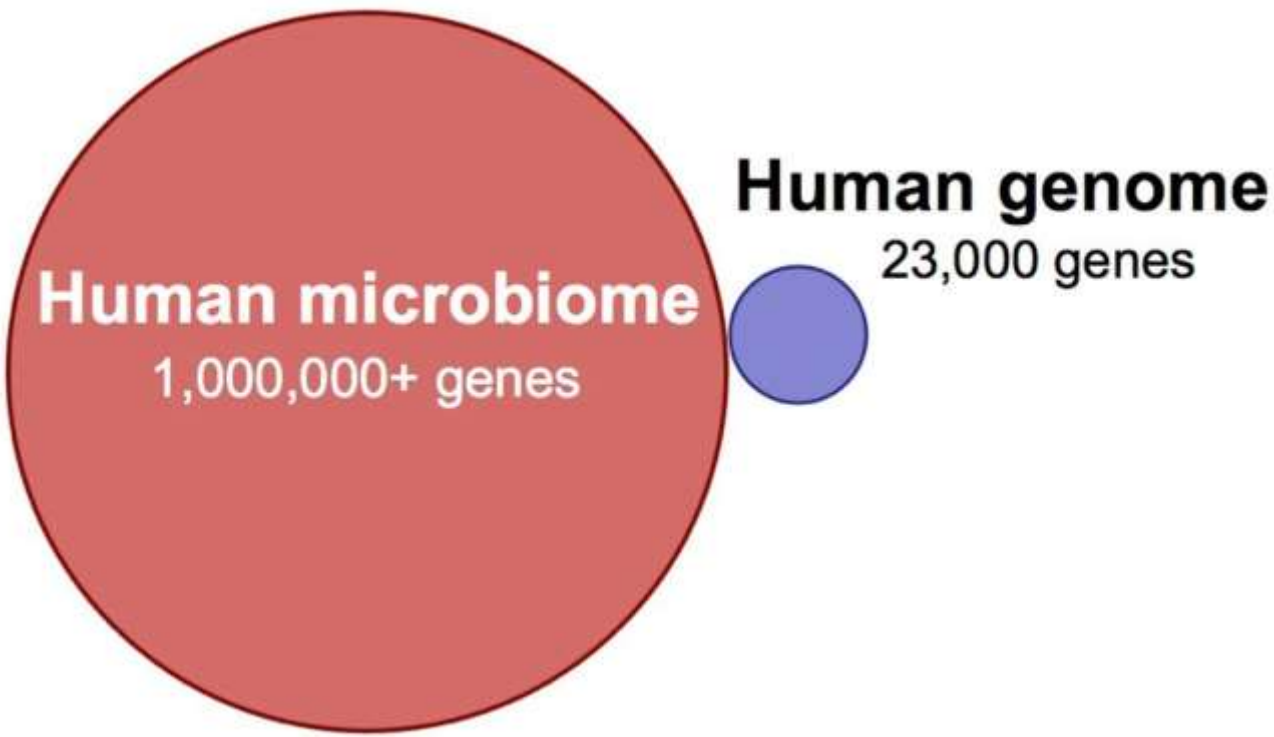
But by Using Stool Analysis Time Series, I Discovered I Had Oscillating Immune Variables Far Above Normal



Lactoferrin is a Protein Shed from Neutrophils - An Immune System Antibacterial that Sequesters Iron

Healthcare Must Include a Vast Amount of Microbial Information That is Not in Today's Medicine

Your Body Has 10 Times As Many Microbe Cells As Human Cells



99% of Your DNA Genes Are in Microbe Cells Not Human Cells

Inclusion of the Microbiome Will Radically Change Medicine

J. Craig Venter™ INSTITUTE

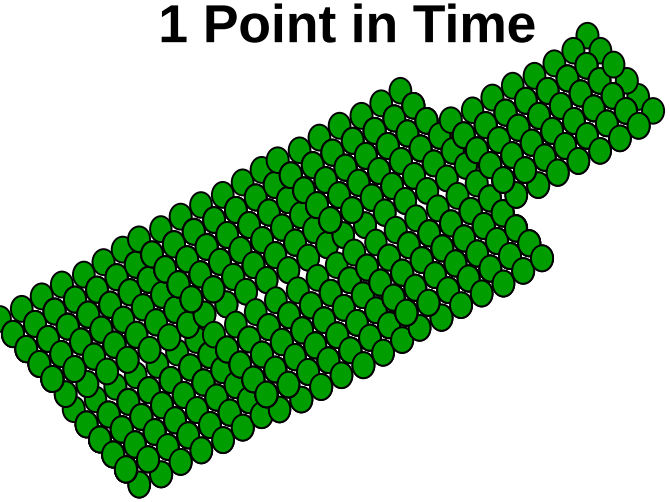
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We Compared Human Gut Microbiomes With My Time Series

From Sequences to Bacterial Species Relative Abundance Required 25 CPU-Years at San Diego Supercomputer Center

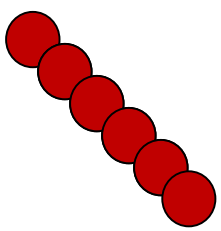
"Healthy" Individuals

250 Subjects
1 Point in Time



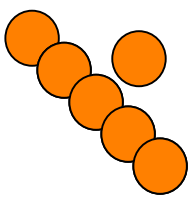
Larry Smarr

6 Points in Time

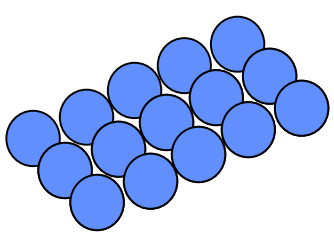


IBD Patients

2 Ulcerative Colitis Patients,
6 Points in Time



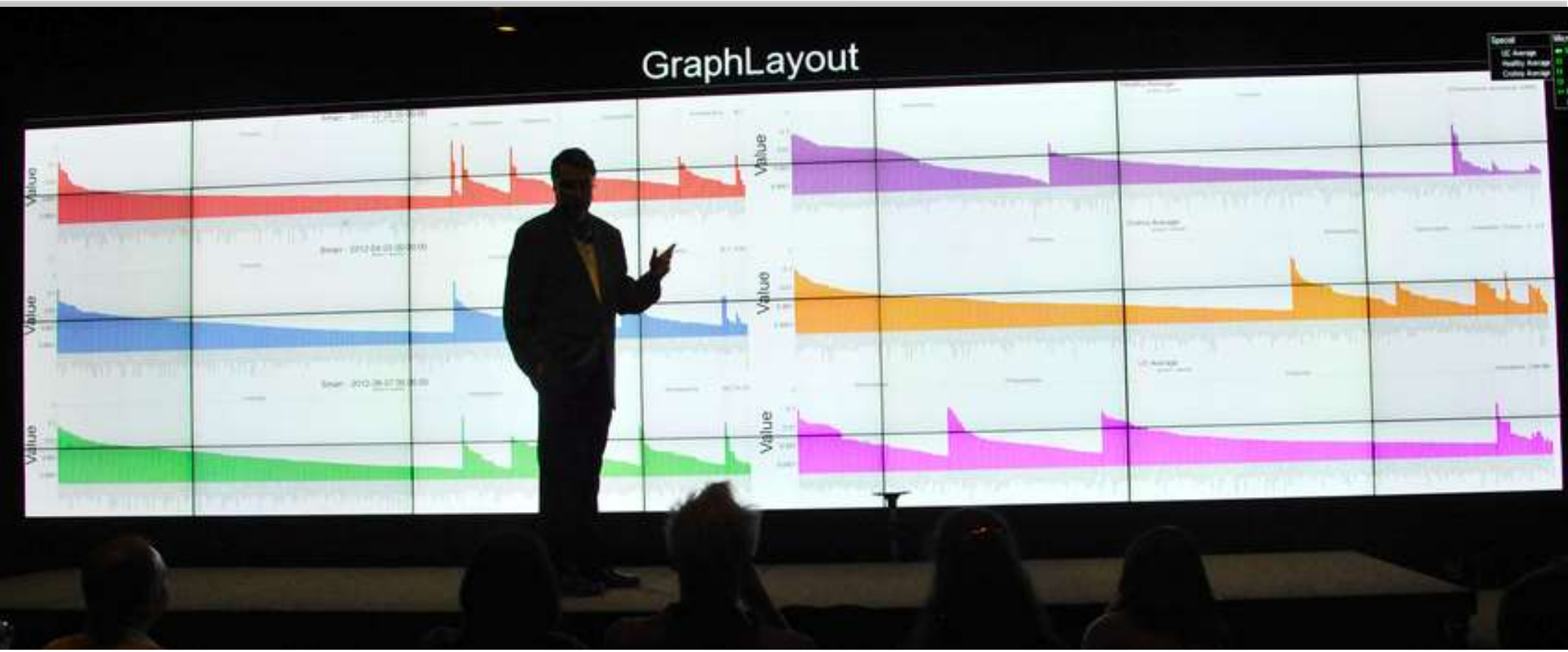
5 Ileal Crohn's Patients,
3 Points in Time



Total of 27 Billion Reads
Or 2.7 Trillion Bases

Source: Jerry Sheehan, Calit2
Weizhong Li, Sitao Wu, CRBS, UCSD

Using Supercomputing Allows Comparison of the Relative Abundance of 200 Gut Microbe Species

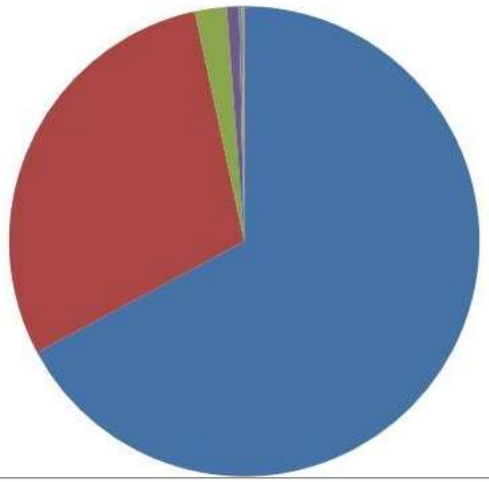


Comparing 3 LS Time Snapshots (Left)
with Healthy, Crohn's, UC (Right Top to Bottom)

Calit2 VROOM-FuturePatient Expedition

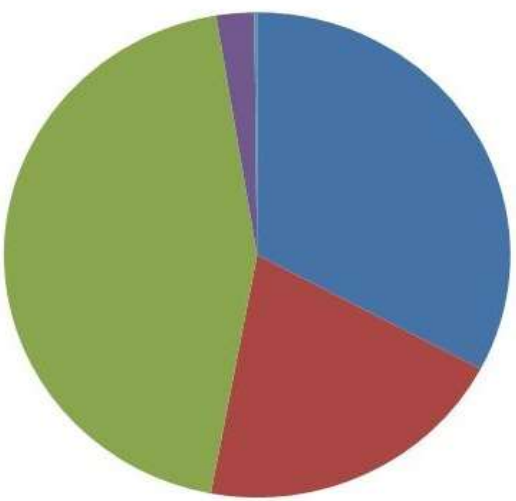
Toward New Diagnostics - Major Shifts in Microbial Ecology Between Healthy & Two Forms of Inflammatory Bowel Disease

Ave. Healthy



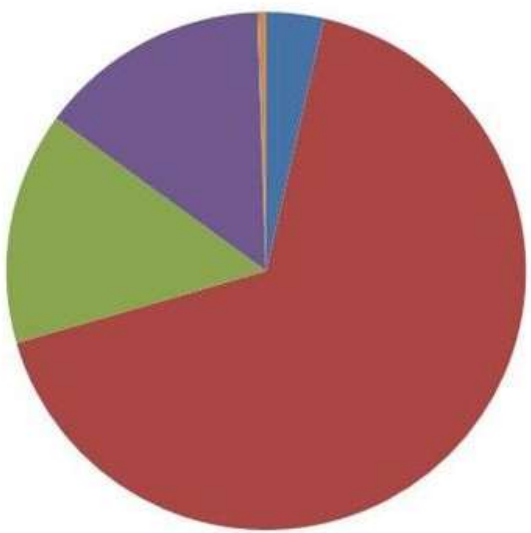
- Bacteroidetes
- Firmicutes
- Proteobacteria
- Actinobacteria
- Fusobacteria
- Euryarchaeota

Ave. Ulcerative Colitis



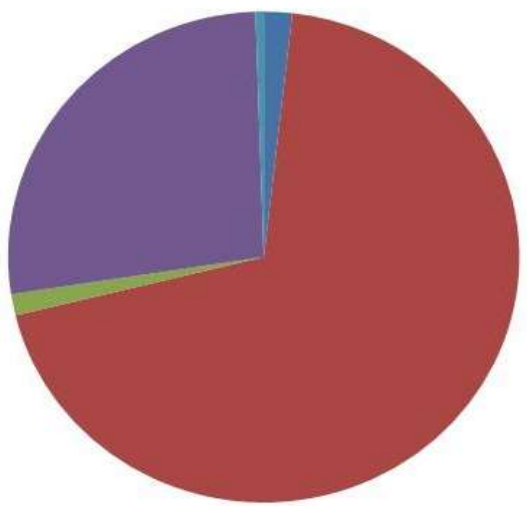
Explosion of Proteobacteria

LS Apr 2012



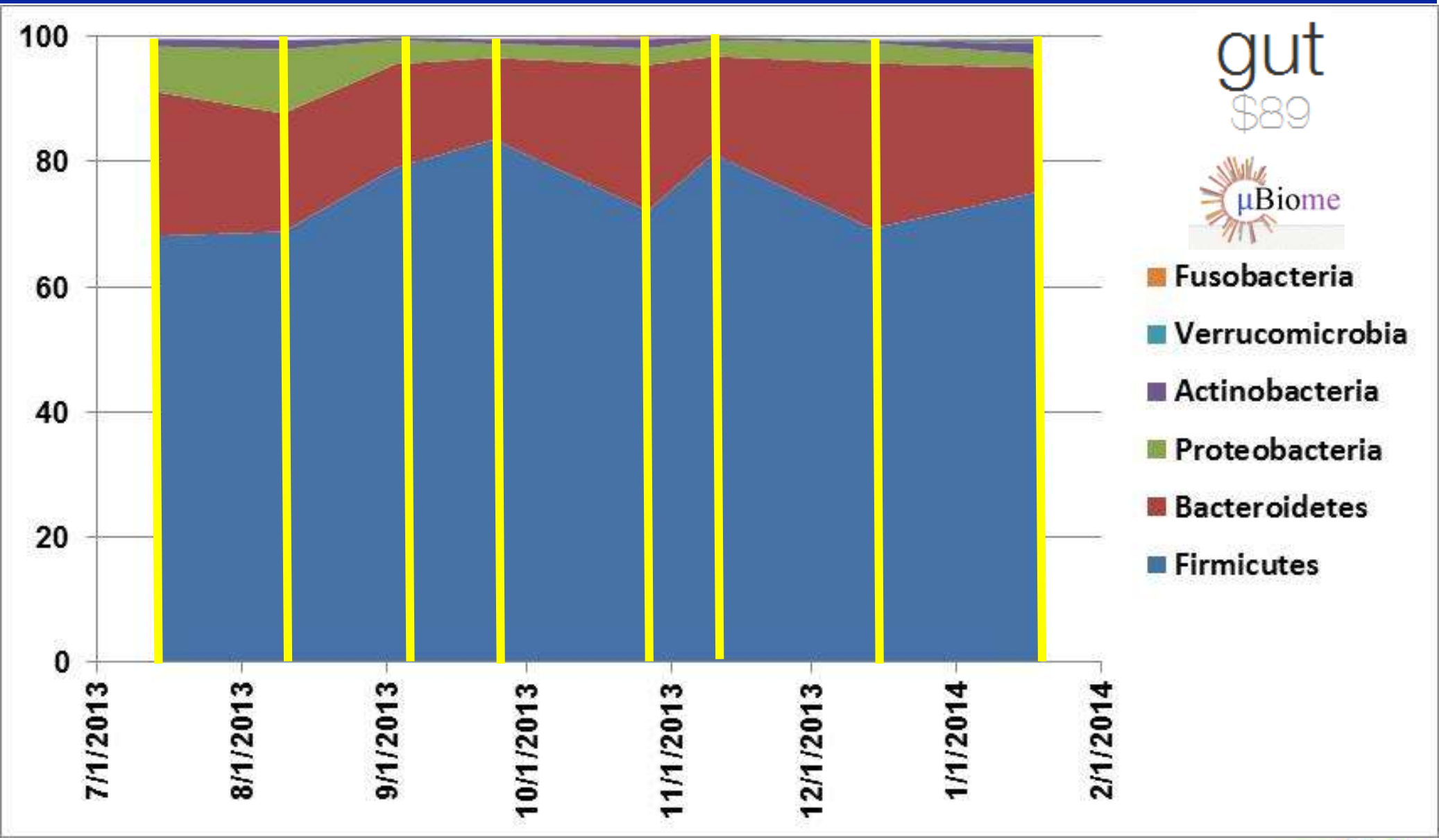
On the IBD Spectrum

Ave. Crohn's



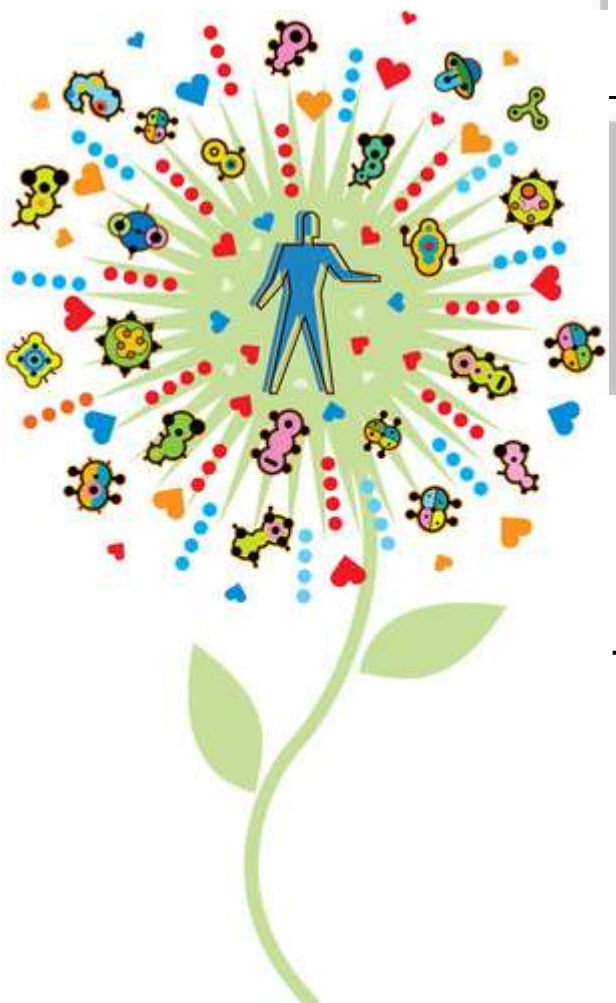
Collapse of Bacteroidetes

Inexpensive Consumer Time Series of Microbiome Now Possible Through Ubiome



Data source: LS (Yellow Lines Stool Samples); Sequencing and Analysis Ubiome

There is a Huge New Field of Products Coming Which Enable You to "Garden" Your Microbiome



The New York Times

Science

Tending the Body's Microbial Garden

By CARL ZIMMER

Published: June 18, 2012

"I would like to lose the language of warfare,"
said Julie Segre, a senior investigator at
the National Human Genome Research Institute.
"It does a disservice to all the bacteria
that have co-evolved with us
and are maintaining the health of our bodies."

Will Medical Foods Provide New Tools for Altering Gut Microbiome?

Everything I Discussed Can Be Done by Startups - Outside of the Traditional Medical Complex

Blood Variable Time Series

WellnessFX

InsideTracker

MD REVOLUTION

Stool Variable Time Series

YFH™

Human Genetic Variations

23andMe

MicrobiomeTime Series

µBiome

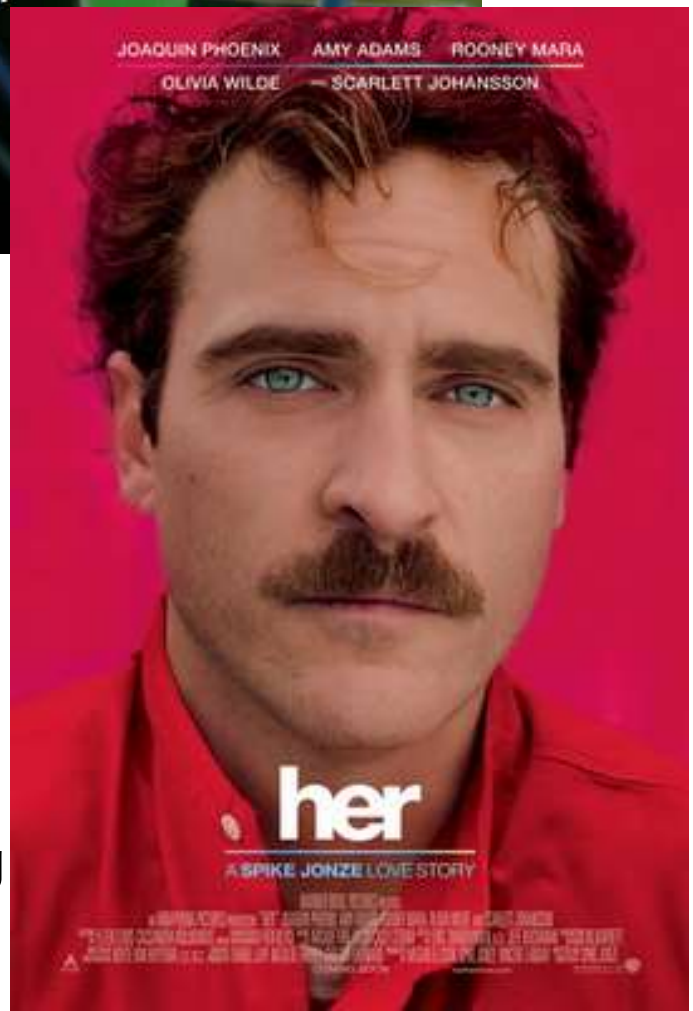
Deep Learning Will Provide Personalized Assistants to Coach Us to Wellness

What Is Watson?

Watson is a cognitive technology *that processes information more like a human than a computer—by understanding natural language, generating hypotheses based on evidence and learning as it goes.*

IBM is Spending $1 Billion on Watson

Where Medicine Coaching is Now



Where Wellness Coaching is Going

The Looming Disruption In Healthcare

- Citizens Create Vast Datasets Outside of EMRs
- Post-“Watson” Personalized Coaches
- Doctors Must Partner with Super-Informed Patients
- From Pharmaceuticals to Medicinal Foods
- From Treating Sickness to Maintaining Wellness

Thanks to Our Great Team!

UCSD Metagenomics Team

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