Wearables and Precision Health

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Conflicts: Personalis, Genapsys, SensOmics, Qbio, January, Filtricine, Akna
**Presently**
- Focus on **Illness**
- Reactive
- Measure very few things
- Infrequent
- Population based

**Should be**
- Focused on **Health**
- Proactive
- Measure many things
- Frequent?
- Individual based

**Precision Health**
Health Is a Product of Genome, Exposome, Lifestyle

Genome

Environmental Exposures

Stress

Lifestyle

Exercise

Food
Longitudinal Personal Omics Profiling

Omics Measurements
- Genome
- Epigenome
- Transcriptome
- Proteome
- Cytokines
- Metabolome
- Lipidomics
- Autoantibody-ome
- Microbiome (Gut, Urine, Nasal, Tongue, Skin)

Biosensors

Billions of Measurements!
- Clinical Tests
- Questionnaires
- Stress Echos
- Glucose Control

107 Individuals

Year 1

Viral infection

Year 2 ...

5.5 yrs
49 Major Health Discoveries

**Metabolic**
- 1 MODY mutation (gene)
- 1 ABCC8 Mutation (gene)
- 14 New Diabetes

**Cardiovascular**
- 6 Carotid Plaques (imaging)
- 1 Atrial Fib. (wearable)
- 1 RMB20 mutation (gene)
- 1 Reduced LVEF/GLS (imaging)
- 3 Dilated L. Atrium (imaging)
- 1 Pharmagenomic (gene)

**Other**
- 1 Sleep Apnea (wearable)
- 1 SLC7A9 mutation (cystinuria risk)
- 2 Macroalbuminuria

**Infectious**
- 1 Lyme Disease (wearable)

**Heme/Onc**
- 7 Oncologic Risk Genes (Thyroid Cancer in 1)
- 1 Lymphoma (Imaging)
- 1 MGUS (IgM)
- 1 Smoldering Myeloma (IgM)
- 1 α Thalassemia (Clinical)
- 1 β Thalassemia (Gene/Clinical)
- 1 Pros1 Mutation (gene)

Rose, Contrepois et al. Nat. Medicine, in press
Discovery of B-Cell Lymphoma

Rose, Contrepois et al. Nat. Medicine, in press
Transitions in DM status

Rose, Contrepois et al. Nat. Medicine, in press
Strong Personal Characteristics

MultiDimensional Scaling for 12 subjects with at least 10 healthy baseline visits

Cytokines

Clinic Labs

Metabolome

Transcriptome

Strong Personal Characteristics
Sensors: Over 900 Devices

Li, Dunn et al. PloS Biol 2017
43 People: All are different
SpO2 Levels Drop During Airline Flights
SpO2 Measurements Associated With Fatigue

Li, Dunn et al. PloS Biol 2017
Early detection of Lyme disease

![Graph showing early detection of Lyme disease with outlier analysis.](image)
Detects All Days of Illness

Li, Dunn et al. PloS Biol 2017

Change-of-Heart Algorithm
Continuous Glucose Monitoring: Lots of Spikers

2-4 weeks

Dexcom G4

24 hours
Classification of People into Glucotypes Based on CGM Profiles

Segment CGM profiles into windows and cluster

Glucotypes
The same meal triggers different glycemic responses in different people.

- Bread + Peanut Butter
- Protein Bar
- Cornflakes + Milk
Glucotype classification may help find diabetes risk

Clustering based on clinical and glucose data.

PC1 (39%) vs PC2 (12%) plots showing different clusters for severe, moderate, and low glucotypes.
Latest Wearable: Human Exposome

Biotics

Asthma & allergies strike
1 out of 5 Americans

Abiotics

Carcinogens, Pollutants, Smoke
Identify Personal Exposomes:
Track individuals up to 890 days

Flow rate: 0.5L/min

Average human breathes in 11L/min
What can we capture?
(Minus human reads)

- >70 billion reads
- >10 Trillion base pairs
- > 7 million assembled contigs

>2500 species
~300/sample

Empty filter  Pine Pollen  Eucalyptus Pollen

“Stem rust” spores  Brochosomes  Inorganic materials

Puccinia graminis (water repellent coating on insects)
Dynamic exposome specific to individuals

Kingdom level

Taxons
- Bacteria
- Fungi
- Viridiplantae
- Viruses
- Archaea
Season and location matter

Forward-selected variables from a collection of 64 meta-variables
Location, location, location
Different persons, same month

San Francisco
Alkanindiges: Sludge bacteria
Klebsiella: pneumonia pathogen
Seasonal influence on the genera

Pine tree sheds millions of pollens

“False Turkey Tail”, spore season starts around fall

Kruskal−Wallis, p = 0.00016
Chemicals are influenced by location

Plastic components

"Earthy" smell

Body Scent

Pesticide

Phthalate

Geosmin

Caprylic acid

Omethoate
Chemicals are correlated with biologicals.

Common Fungal genera

Organic solvent, used in paint
The Exposome Cloud – connections between detected species
Smart Phone = Control Center
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The Future?

Genomic Sequencing

1. Predict risk
2. Early Diagnose
3. Monitor
4. Treat

Omes & Sensors: Personal Devices

Amanda Mills
SpO2 Measurements

Can Adapt on Flights >7hrs
Share Information With Physician
Importance in Individual Variation from “Normal”

Oral temp in 2749 healthy individuals

Sequences related to pathogens: rare

Species level
6 people with Carotid Plaque
MGUS PreCancer: High IgM

Rose, Contrepois et al. Nat. Medicine, in press
Circadian and diurnal patterns

Li, Dunn et al.
PloS Biol 2017