Choosing Wisely:
What should be measured in a cohort this large?

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Building a Large U.S. Cohort for Precision Medicine Research
NIH, February 11-12, 2015

Co-Investigator
What should be measured?

Editorial

Complementing the Genome with an “Exposome”: The Outstanding Challenge of Environmental Exposure Measurement in Molecular Epidemiology

Christopher Paul Wild

Molecular Epidemiology Unit, Centre for Epidemiology and Biostatistics, Leeds Institute of Genetics, Health and Therapeutics, Faculty of Medicine and Health, University of Leeds, Leeds, United Kingdom

Cancer Epidemiology, Biomarkers & Prevention

2005;14(8):1847-50
“At it’s most complete, the exposome encompasses life-course environmental exposures (including lifestyle factors), from the prenatal period onwards…”

-- Christopher Paul Wild
NIH Exposure Biology Program
“Genes load the gun; environment pulls the trigger”
– Francis Collins, MD, PhD

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<th>2007</th>
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Environmental Sensors
- Diet/Physical Activity
- Chemicals/Biologics
- Psychosocial Stress/Addictive Substances

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

DEVICES
APPLICATION
Genome Wide Association & Other Research

FINGERPRINTS
Lab on a Chip
DEVICES
How can mobile devices and related technologies enhance Precision Medicine research?

Greater precision on measures of **physiological parameters** that can aid in monitoring treatments, treatment response and outcomes.

Wireless and/or wearable sensors for:

- Heart rate and heart rate variability
- Respiration
- Blood pressure
- Glucose, lactate & electrolytes
- Hydration & metabolism
- Medication adherence via smart pills, pill bottles and other drug delivery (e.g. inhalers)
- Spirometry
How can mobile devices and related technologies enhance Precision Medicine research?

Greater precision on measures of behaviors and related health states and their context

Wireless and/or wearable sensors for:

- Physical activity, sedentary behavior, and overall movement patterns that have unique signatures for underlying disease or health risk (e.g. Parkinson’s, fall risk, etc.)
- Diet through self-report with always-available apps or with cameras
- Weight (and with BP, hydration status)
- Stress
- Sleep
- Cognitive function
- Location via GPS and other mobile phone-based approaches
Importance of Place to Precision Medicine

- Disease clusters
- Toxic exposure
- Health disparities
- Stress & incivilities
GPS Data & Geographic Information Systems (GIS) data

- Parks
  - Distance & density & acreage
- Schools
  - Distance & density
- Recreation Facilities
  - Distance & density
- Census data
  - Housing unit density
- Parcel & Land Use
  - Commercial, industrial, institutional, residential, office, open space, vacant
  - Retail parcel count
- CoStar / SD County Tax Assessor
  - Retail floor area ratio
- Coastline
  - Distance to coast
- Local & Major Roads
  - Intersection & cul-de-sac counts

Feb 16, 2011
How can mobile devices and related technologies enhance Precision Medicine research?

Greater precision on measures of experience and subjective states through Ecological Momentary Assessment (EMA), the use of a mobile device to query participants as events happen

EMA:

• Is highly configurable to the underlying research question(s)
• Can be preset or automatically prompted based upon context (e.g. GPS)
• Can be intensive on an App, or “light” via quick-response text messages
• Can be offered in any language and at multiple levels of literacy and numeracy
How can mobile devices and related technologies enhance Precision Medicine research?

Greater precision on measures of social interactions via online social networks, searches and other technologies such as sound, cameras, location and context.
How can mobile devices and related technologies enhance Precision Medicine research?

Greater precision on measures of environmental exposures such as particulate matter, noise, electromagnetic fields, environmental toxins & other insults that might impact such things as oxidative stress, immune response, hormonal regulation or other phenomena.

- Wearable sensors that can store or transmit to/through the mobile phone data on exposures
- Combining data from wearable sensors with that from fixed sources in the Environment to enrich the understanding of cumulative exposure
- Periodic EMA & other triggered measurement tailored to specific research questions, or such things as occupation, location, natural disaster, or other Circumstance that might influence the natural course of treatment and/or outcomes

CitiSense

Always-on Participatory Sensing for Air Quality

PI: Bill Griswold/UCSD, CSE
Co-PIs: K. Patrick, I. Krueger, T. Rosing, S. Dasgupta, H. Shacham

Cyber-Physical Systems Program, NSF, 0932403
CitiSense: System Overview

Air Pollution Sensor

CO, NO2, O3, Humidity, Pressure, Temp

Upload Measurements
How can mobile devices and related technologies enhance Precision Medicine research?

Finally, these devices can support **recruitment and retention** in Precision Medicine research.

- Partner with telcomms on enrollment and tracking over time as participants move (opt in, of course)
- Text message reminders for data collection, in-person visits, special queries
- Use of text messages, social media, and other communication channels to support queries from and among study participants if questions/issues arise
Recommendations

Ideally, all cohort participants will carry a Smartphone and wear a Smartwatch

- Movement (accel/gyro)
- GPS
- Ecological Momentary Assessment (EMA)
- Voice/Sound
- Image
- Bluetooth connectivity to other devices
- Specialized apps

Carried as usual

Worn 24x7

- Movement (accel/gyro)
- Light EMA via SMS
- Heart rate/HR variability
- Specialized apps
Recommendations

Other mobile and wireless devices - and sources of data - will be used in subsets of the cohort based upon research questions and underlying health state.