mHealth: Using Mobile Technologies to Improve Health Behavior and Measurement

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What is mHealth?

- Diverse application of wireless and mobile technologies designed to improve health research, health care services and health outcomes
- NOT JUST PHONES
Includes any wireless device carried by or on the person that is accepting or transmitting health data/information

- Sensors (e.g., implantable miniature sensors and “nanosensors”)

- Monitors (e.g., wireless accelerometers, blood pressure & glucose monitors)

- Mobile phones
Beyond Telemedicine

- **Portable**: Beyond POC Diagnostics
- **Scalable**: Economical to scale
- **Richer data input**: Continuous data sampling
- **Personal**: Patient can receive & input information
- **Real-time**: Data collection and feedback is in real-time using automated analyses and responses
Leveraging the Ubiquity of Wireless
Continuum of mHealth tools

- **Diagnostic**
  - POC Diagnostics
  - Portable imaging
  - Biomarker sensing
  - Clinical decision making

- **Measurement**
  - Sensor sampling in real time
  - Integration with health data

- **Treatment**
  - Chronic disease management
  - Remote Clinical trials
  - Disaster support/care

- **Global**
  - Service Access
  - Remote treatment
  - Dissemination of health information
  - Disease surveillance
  - Medication tracking and safety
  - Prevention and wellness interventions
Measurement and Assessment
Implantable Biosensors

**Problem:** Measurement of analytes (glucose, lactate O2 and CO2) that indicate metabolic abnormalities

**Solution:** Miniaturized wireless implantable biosensor that continuously monitors metabolism

- Inserted by needle subcutaneously
- Operated remotely using a PDA
- Multi-analyte sensor
- One month continuous monitoring

Diane J. Burgess, University of Connecticut
NHLBI, R21HL090458
Population Scale Activity Measures

- **Problem:** Population-scale measurement of physical activity
- **Solution:** Miniature, low-cost devices that measure human motion using redesigned accelerometers in a user-friendly format

Stephen Intille, PhD, Northeastern University
NHLBI, U01HL091737
Wearable Chemical Sensor System

- **Problem:** Chemical exposure varies by context, need personal exposure
- **Solution:** Selective detection of VOCs (hydrocarbon and acid vapors)
  - Sensitive: ppb – ppm
  - Real-time: sec. – min.
  - Spatially resolved
  - Wearable: cell phone size
  - Cell phone based interface

http://www.airnow.gov

Today's AQI Forecast
Friday, November 05, 2010

Nongjian Tao, Arizona State University, NIEHS, U01 ES016064
Drug Use Detection

- **Problem**: Detection of stress and addiction in order to fight the growing epidemic
- **Solution**: Wearable sensor designed to interfere with stressors and addictive behavior or urges as they occur in real-time

*Santosh Kumar, PhD, University of Memphis, NIDA, U01DA023812*
Stress Hormone Detection

- **Problem:** Detection of salivary stress hormones in real-time is expensive and not practical in clinical settings
- **Solution:** Develop wireless salivary biosensors
  - Salivary α-amylase biosensor
  - Salivary cortisol biosensor
Diagnostics
**Problem:** Create a low-cost quality microscope to use in low resources settings.

**Solution:** A specially-developed lens fits to a cell phone to create a microscope

**Field testing:** Malawi, Mozambique and Brazil

LUCAS images of CD4+ and CD8+ T cells compared to a regular microscope image

Karin Nielsen, UCLA, FIC, R24TW008811
Molecular Analysis of Cells

Problem: Detection a variety of biologics rapidly and without a laboratory.

Solution: A chip based micro NMR unit Smartphone powered analysis: Ca Protein bio-markers, DNA, bacteria and virus drugs

Ralph Weissleder, MIT, NIBIB RO1 EB004626
High-resolution fiber-optic microendoscope

- **Problem:** Methods to detect cancer from traditional biopsies are invasive for patients and require lab facilities.
- **Solution:** A scientific charge-coupled device camera and a laptop computer for under $4,000 (clinical trials in China, Botswana, Guatemala)

Rebecca Richards-Kortum, Rice Univ.
NIBIB RO1 EB007594
Treatment
Body Sensor Networks

- **Problem**: Overweight and Obesity among urban, minority youth
- **Solution**: KNOWME networks personalized monitoring & feedback in real-time
  - Immediate access to data allows nimble reactions to events, environments, & behavior
  - User interface for health professionals, children & families

Donna Spruijt-Metz, PHD,
USC, U54-CA-116848
Chronic Disease Management

- **Problem:** Chronic diseases are difficult and expensive to manage within traditional healthcare settings
- **Solution:** CHESS: Disease self-management programs for asthma, alcohol dependence and lung cancer
- Information provided the user needs it
- Intervene remotely with greater frequency than traditional care
  - Real-time management
  - More efficient triage
  - Reduces acute care

David Gustafson, University of Wisconsin, NIAAA R01 AA 017192-04
Cardiac Disease Management

**Problem:** Patients with CVD have symptoms that frequently bring them to emergency care where there is limited baseline data

**Solution:** Remote monitoring to create physiological cardiac activity “fingerprints” that alert professionals and patient when there are irregularities based on their own cardiac patterns

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Vladimir Shusterman, PinMed, NHLBI, R43-44 HL0771160, R41HL093953
Remote Clinical Trials

Do you have Overactive Bladder (OAB)?

Find yourself rushing to the bathroom?

Wishing you could get there on time?

You may be eligible to participate in a 16-week clinical research study sponsored by Pfizer, conducted under FDA regulations and overseen by the University of California, San Francisco.

Why participate?

• Help advance research and potentially help others with OAB symptoms.
• You can participate in the privacy and comfort of your home!
• Get paid $25 for each online assessment and/or lab visit completed. Get paid up to $175.

You will be paid for your time and effort and you can participate from home.
Aging in Place: Smart Environment/Mobile Technologies

- **Problem:** Assessment of and intervention for everyday functional limitations of persons with early-stage dementia without need of assisted living (aging in place)

- **Solution:** Automated wireless and fixed monitoring and assistance to help people cope with age-related limitations
Global
Necessity for Global Health

- Lack of providers in developing world
- No wired infrastructure
  - Well-developed and rapidly growing wireless
- Healthcare needs to be provided through low-cost and immediate, scalable services
- Potential for reverse technology transfer
  - Knowledge from developing world informs domestic research and practice

![Mobile penetration chart](source:ITU)
Adherence Monitoring (Uganda)

**Problem:** Adherence to chronic disease medications is poor. In resource-poor settings, getting people medication is only part of the solution.

**Solution:** Wireless medication canisters that signal medication timing, transmit adherence data and allow resources to target the non-compliant

Jessica Haberer, Partners Healthcare NIMH K23MH087228
Adverse Event Monitoring (Peru)

**Problem:** Following at-risk patients for adverse events in low- to medium resource countries is expensive/impractical

**Solution:** Wireless adverse events reporting and database improves patient and community care

- Real time data via IVR on cell phones
- Queries on demand via Internet
- Real time alerts via E-mail
- Secure database
- Urban and rural areas of Peru
- Real time alerts via SMS
- Communication back to the field via cell phones

Walter Curiso, MD, University of Peruana
FIC R01TW007896
Moving “Hype” to Productivity

mHealth Hype Cycle

- Peak of Inflated Expectations
- Plateau of Productivity
- Slope of Enlightenment
- Trough of Disillusionment

Technology Trigger

TIME