Mobile Personal Sensing for Personalized Health & Wellness

Mary Jane Rotheram-Borus
Deborah Estrin
UCLA
NIMH controls the Venture Capital for our nation’s mental health.
NIMH has a broad, successful portfolio, especially in neuroscience.
Currently, it takes 40-50 years for the public to benefit from these investments.

Efficacy  >  Effectiveness  >  Diffusion
In contrast, Facebook went from 0 - 200,000,000 users in 5 years.

Years

2004

2005

Friday, August 28, 2009
In contrast, Facebook went from 0 - 200,000,000 users in 5 years.
MPS can catalyze NIMH’s successes to improve.

Provider
Quality of Care

Research

Patient
Self-management
MPS needs NIMH’s investment in open-source platforms to realize its public health potential.
Enabled by $\sim 4 \times 10^9$ mobile phone users, increasingly with gps, imagers, UI

Motivated by $6 \times 10^9$ people on planet earth and their concerns...
Mobile smartphones + web/cloud services

real time
(always on)

real place
(always carried)

real context
(historical, environmental, spatial, social)
what can we learn,
what impact can we have,
with access to

...the other 167 hours of the week...
...the other 1439 minutes of the day...
Ambulation: monitor chronic disease progression and response

Mobile Sensing Client

Data Storage Service

GPS Traces

Transportation Modes

Visualization Platform

Processing Module

Aggregation

Event detect

Ambulation
Current state: Running
Current mode: Walk
Speed: 0.55
Accuracy: 16.0
Lat: 34.0692740670346069
Long: -118.443056161499
AndWellness: health behavior change through self monitoring

- real time prompting
- real place observations
- real context from mapping, GIS, social networking

[Image of AndWellness app interface]
Web/cloud services: historical, environmental context

When do I eat on and off plan?  Where do I eat on and off plan?

http://andwellness.cens.ucla.edu/beta/demo.php
Vision: Integrated Personal Data Stream creates a *Living Record*

Physiological measures (BP, glucose…)

- Prompted patient reporting
- Location/activity traces
- Contextual constraints
General mobile to web architecture

**General flow**

**APPLICATIONS**
web, researchers/
health providers/community

**PROCESSING**
mobile device and
web Services

**DATA CAPTURE**
mobile device
and individual

**Potential Examples**

Chronic disease
monitoring/mngmt

Health behavior
change/adherence

Activity, mobility
trends

Health behavior
diaries

Location
traces

Geo-coded
mobile EMA
Architectural opportunities

Common workflow

Personal data vault

Legible interfaces/data
Mobile Personal Sensing
common workflow and services
Personal Data Vault
allowing participants to retain control over their raw data
Legible interfaces for data and sharing

What you share with others

What you see

GoGreen Foundation

YOUR GO GREEN RANKINGS

Your rankings are displayed below for each group you're in:
(Shorter bars are better)

My Impact: 0.00 lbs CO2, 0% of 112 hrs
Score: 0

Group Average: 9.85 lbs CO2, 49% of 112 hrs
Score: 4447567

GoGreen Testing Group

My Impact: 0.00 lbs CO2, 0% of 112 hrs
Score: 0

Group Average: 239.64 lbs CO2, 49% of 112 hrs
Score: 180432

July 1, 2009

21% home 79% out

8% Driving
0% Running
13% Walking
87% Still
July 1, 2009

21% home 79% out

8% 🚗 Driving
0% ⚾ Running
13% ⚽ Walking
87% 🕒 Still
Inspiring applications

sustainability and personal transportation
PEIR

civic engagement and citizen science
Participatory Sensing

global epidemiological studies
Surya
Personal and community sustainability tool: PEIR: Personal Environmental Impact Report

http://peir.cens.ucla.edu
Participatory Sensing: Civic Engagement, Citizen Science
coordinated, real-time, geo-coded, tagged, images and prompted entries

http://garbagewatch.com
http://foodyouwaste.com
Monitoring exposure to cookstove pollution in rural India: profile daily activities, exposure to indoor air pollution, at unprecedented detail (Ramanathan et al)

- GPS, accelerometer traces
- Bluetooth temperature sensor beacons
- Images of a special filter

Outdoor activities
Cooking duration
Pollution levels

Exposure Model
Guiding Principles

If you can’t go to the field with the sensor you want... go with the sensor you have! (Anon)

The power of the Internet, the reach of the phone (Voxiva)

Burke, et al
Global Penetration Rates of Mobile Phones

“More than one phone per person.”
Many countries have penetration rates of above 100%.
MPS can be used in Data Collection for Assessment & Intervention Delivery
Penetration of Mobile Phones in Africa is higher than the US
MPS has improved the Efficiency, Quality, & Ease of Data collection: Africa jumped the wired era.
Account Overview

This is your account overview page. From here you can see all the latest activity across the scope of your research projects.

Responses Uploaded in last 90 days

Total Responses for Top 5 Surveys

<table>
<thead>
<tr>
<th>Key</th>
<th>Survey Title</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Clinic Register</td>
<td>3520 (91.29%)</td>
</tr>
<tr>
<td>2</td>
<td>Clinic</td>
<td>114 (2.96%)</td>
</tr>
<tr>
<td>3</td>
<td>02 Pre-Assessment</td>
<td>86 (2.23%)</td>
</tr>
<tr>
<td>4</td>
<td>01 Pre-Assessment</td>
<td>72 (1.87%)</td>
</tr>
<tr>
<td>5</td>
<td>03 Pre-Assessment</td>
<td>64 (1.66%)</td>
</tr>
</tbody>
</table>

Latest Communication

- **23 Jul**  
  Sorry, I see Monday. But nothing for Tuesday or today.  
  sent to HSRC 015 2630 (Balgowan)

- **23 Jul**  
  Hi Tola, I have not received any clinic counts from you f...  
  sent to HSRC 015 2630 (Balgowan)

- **08 Jul**  
  Hi Buyi, please use the first 6 numbers of your ID as the...  
  sent to HSRC 015 2630 (Howick)
### Latest Communication

<table>
<thead>
<tr>
<th>Date</th>
<th>Messages</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 Jun</td>
<td>Alastair said: Hi, pls get the following May TOTALS for ANC 1st Visits. (1)Visits, (2)R.... Use message text</td>
</tr>
<tr>
<td>16 May</td>
<td>Clyral said: Click to Download v1.5.11-200805 Use message text</td>
</tr>
<tr>
<td>16 May</td>
<td>Clyral said: WAP PUSH FAILED: Insufficient credit to process transaction. Use message text</td>
</tr>
<tr>
<td>18 Mar</td>
<td>Alastair said: Click to Download v1.5.11 Use message text</td>
</tr>
</tbody>
</table>

### Latest Survey Activity

<table>
<thead>
<tr>
<th>Date</th>
<th>Messages</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 Jul</td>
<td>Response #4027 to MB - Antenatal Visit conducted on 25 July was uploaded.</td>
</tr>
<tr>
<td>25 Jul</td>
<td>Response #4026 to Clinic conducted on 24 July was uploaded.</td>
</tr>
<tr>
<td>25 Jul</td>
<td>Response #4025 to Clinic conducted on 24 July was uploaded.</td>
</tr>
<tr>
<td>24 Jul</td>
<td>Response #4000 to 01 Pre-Assessment (Zulu) conducted on 24 July was uploaded.</td>
</tr>
<tr>
<td>24 Jul</td>
<td>Response #3999 to 03 Pre-Assessment (Zulu) conducted on 24 July was uploaded.</td>
</tr>
</tbody>
</table>
Visit every household in their geographical area
Identify children underweight for age
Encourage hygienic behaviors & protection of the child
Child support grant
Mother to be program
Effective Support & Supervision
Net-CLEAR for HIV+ Young People

**Healthcare Provider or Support**
- Encourage EBP adoption and adherence
- Support Patients via Web-based system

**Mobile phone monitors**
- Automatic recording
  - Place
  - Time
- Combination automatic & personal Probe
- Activity
- Social context
- User’s thoughts, feelings, actions

**Web-based System**
- Recognizes patterns
- Transforms trace to usable form
- Launches probes & interventions
- Improves personally tailored interventions over time
- Exports data to multiple outlets

**USER**
- Controls privacy & access to personal data
- Reacts to probes
- Initiates requests for help
- Allows access to network members

**Key**
- From User
- To User
“Hey, c’mon now! ... You two were MADE for each other!”
National Marketing Data: Providers & Teachers
Time is of the Essence to investing.
Health care system will not have capacity for HIV to be addressed prior to 2050.
We are moving too slow to help the 2 billion children with preventable diseases.
We need to scale what we have built for 40 years to meet the global health needs.
Thank You
Penetrating the possibilities