Improving Global Public Health Through Devices, Sensors and Mobility

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Healthcare Challenges and Investments
Growing Stressors on Global Healthcare

**ACCESS**
Only 1.6B people have adequate coverage

**DEMOGRAPHICS**
Aging populations, growing middle class

**COSTS**
<20% of government outlays in many nations, rising fast

**LABOR SHORTAGES**
Dearth of qualified healthcare workers

**QUALITY**
Healthcare systems fragmented and siloed

**CONSUMERISM**
Growing expectations at every level
Technology Scaling Healthcare

Number of People Served Per Doctor

Data-Driven Medicine
Personal Wellness
Connected Care

PRESENT
TECHNOLOGY
PERSONALIZED
PARTICIPATORY

FUTURE
EMERGING MARKETS
PREDICTIVE
PREVENTATIVE

Quality of Care

Number of People Served Per Doctor

Data-Driven Medicine
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PRESENT
TECHNOLOGY
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FUTURE
EMERGING MARKETS
PREDICTIVE
PREVENTATIVE

Quality of Care
Anticipating the Future: Rural Environments

- Low-cost, Automated Diagnosis
- Solutions in Clients + Cloud
- Global Resources, Local Care
- Personalized Drug Delivery
- Geo-Spatial View of Health

DATA-DRIVEN MEDICINE
Anticipating the Future: **Urban Environments**
Goals:

Devices, Sensors and Mobility for Healthcare

• Invest in High-impact and socially relevant healthcare research
• Improve global public health through the reach of ubiquitous technologies (e.g., cell phones)
• Encourage the development of low-cost mobile devices
• Improve the quality of care where it is needed most
• Scalable and Interoperable
Definition of Projects that Scale

What I’d like to see is a “scale score” for projects

- **Scale Up**: The ability for a project to scale from 10 to 100 to 1000 to 1 million+ users.

- **Scale Out**: How much is a project tied to a macrocosm? Can I take the same concept and reuse it in Botswana? In Argentina, in Alaska?
  - Overcoming barriers: language, interface, customs

- **Scale In**: How does this work for individuals—does it cover just children? Adults? What about variations within groups?
  - Personalization, individualization

- **Scale Across**: How well does a system that is tested for one disease accommodate others?
  - Interoperability
Historical Investment Strategy in Healthcare

- **2005-2007**: Digital Inclusion Projects
- **2008-2009**: Global Cell Phone as a Platform for Healthcare
- **2010-2011**: African Cell Phone as a Platform for Healthcare
- **Future**: Investments Appropriate to the Region – Focus on Ubiquitous Computing Solutions
Mobile Health: The opportunity of mobile technologies to support public health in Peru

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University of Washington (Seattle, Washington)
mHealth can be defined as mobile computing, medical sensors, and communications technologies for health care*

More than 383 million cell phones in Latin America

Cell phones in Latin America

Peru

24’702.060 cell phones
87.5% penetration rate
Application areas in mHealth

Adapted from: “mHealth in the Global South: Landscape Analysis” Vital Wave Consulting 2008.
mHealth in the developing world

Adapted from: Vital Wave Consulting. mHealth for development: the opportunity of mobile technology for healthcare in the developing world. Washington (DC) and Berkshire (UK): UN Foundation–Vodafone Foundation Partnership; 2009.

Adapted from: Vital Wave Consulting. mHealth for development: the opportunity of mobile technology for healthcare in the developing world. Washington (DC) and Berkshire (UK): UN Foundation–Vodafone Foundation Partnership; 2009.
This report details 51 mHealth programs, either currently operating or slated for implementation in the near future, that are taking place in 26 different developing countries. mHealth programs are more prevalent in some countries than others for reasons that have not yet been assessed by the academic literature. In particular, India, South Africa, Uganda, Peru, and Rwanda stand out for their level of mHealth activity.
Mobile phones reach further into developing countries than other technology and health infrastructures.

Universidad Peruana Cayetano Heredia (Lima)
Feasibility of internet data collection
Real-time surveillance system for adverse events
SMS reminders and educational text-messages for PLWHA
risk assessment for PLWHA
Electronic data collection through PDAs
Supporting maternal and child care with mobile devices in Callao
Encouraging HIV testing through online videos
Internet lab access for PLWHA
SMS reminders and educational text-messages for PLWHA
Risk assessment for PLWHA
Electronic data collection through PDAs
Real-time surveillance system for adverse events
Feasibility of internet data collection
HIV in Peru

20-93,000 HIV (+)

National ART Program

May 2004
up to 88% don't take their antiretroviral medicines as the doctor prescribed.

simply forgetting
inconvenience
side effects
financial constraints
being away from home
fear of disclosure/stigma
too busy

People living with HIV in Peru are using tools such as cell phones, and the Internet (via E-mail, chat, list-serv) to support their HIV care and to make social and sexual connections.

Curioso WH, Kurth AE. Access, use and perceptions regarding Internet, cell phones and PDAs as a means for health promotion for people living with HIV in Peru. BMC Medical Informatics and Decision Making 2007; 7:24.
Focus groups

Pilot evaluation

Randomized controlled trial

Curioso WH. Evaluation of a Computer-Based System using Cell Phones for HIV positive people in Peru. Grant: FIC/NIH. 1R01TW007896-01. NIH RePORTER 2010
Focus groups

Pilot evaluation

Randomized controlled trial

Cell POS: Evaluation of a Computer-Based System using Cell Phones for HIV positive people in Peru
Four focus groups

- 26 HIV (+) participants (37 years, SD: 8.5)
- Community-based clinic (Via Libre)
- Focus group guide
- 1.5 – 2 hours
- Two researchers coded transcripts independently
- Content analysis approach
- IRB approvals:
  - Univ. Washington
  - Via Libre
  - UPCH
- Informed consent

Curioso WH, Quistberg DA, Cabello R, Gozzer E, Garcia PJ, Holmes KK, Kurth AE. "It’s time for your life": How should we remind patients to take medicines using short text messages? AMIA Annu Symp Proc 2009::129-133.
Participants preferred receiving a readable message rather than a phone call or a pre-recorded voice message because:

- It is less intrusive.
- It is less interrupting than receiving a phone call.
- SMS over recorded voice messages or a phone call as reminder alerts because they are easier, more confidential, and more readily available.
People are interested in not only receiving a reminder, but also in something that lifts their self-esteem and gives them encouragement.

"It’s time for your life"

Automated, telephone-based interventions emphasizing social cognitive concepts (e.g., motivation, self-efficacy) have demonstrated short and longer-term efficacy.

Avoid sensitive words ("having HIV", "antiretroviral pills")

The fears they shared with us about confidentiality are likely related to social issues such as empowerment, stigma towards those with HIV/AIDS, and discrimination (2)

(2) Curioso W. THPE0793. 17th Int. AIDS Conf. 2008; Mexico.
The participants often anthropomorphized the system with human characteristics such as thinking of it as a "friend," a "guide" or even an "angel."

The portability of "always ready" devices in combination with the messaging interventions can create a synergistic feedback loop between patient and device as evidenced by Milch's finding:

"several of the patients allowed that the pager became a trusted friend" (1)

Long-term relationship

Successful mobile interaction through messages should promote an intensive, positive relationship between the user and the mobile application, like a longstanding and comfortable friendship.

Results have created a basis to develop a dynamic, personalized and confidential messaging system.

These results indicate that the characteristics of the reminder (notification modality, the message, and the context) could play an important role in interventions to improve patient adherence to antiretroviral therapy.
Cell POS: Evaluation of a Computer-Based System using Cell Phones for HIV positive people in Peru

Focus groups

Pilot evaluation

Randomized controlled trial
Cell-POS: Enhancing adherence to antiretrovirals and supporting HIV transmission

http://www.cellpos.org/cellpos/cellpos.htm

Antiretroviral therapy reminders

It's the time for your life

Appointment reminders

Your appointment with Dr. X is scheduled on Monday 9am

SMS

Prevention messages and supportive health information

Hepatitis B is much more contagious than HIV. Get more info and protect yourself

Curioso WH. Evaluation of a Computer-Based System using Cell Phones for HIV people in Peru. Grant: FIC/NIH. 1R01TW007896-01. NIH RePORTER 2010
Focus groups

Pilot evaluation

Randomized controlled trial
Randomized controlled trial

Arm 1: Cell phone system + standard of care

Arm 2: Standard of care

One year
mHealth Challenges

- Culture
- Policy
- Sustainability
- Scalability
- Legal and ethical issues
- Costs
- Standards and Interoperability
- Training human resources in health informatics
- Evaluation studies
CELL PHONES & M-HEALTH

By Walter H. Curioso and Patricia N. Mechael

Enhancing ‘M-Health’ With South-To-South Collaborations

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Patricia N. Mechael is mHealth and Telemedicine Advisor for the Millennium Villages Project at Columbia University in New York City.

http://www.andeanquipu.org

Thanks!

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Example Projects
Giving Women and Community Voice in Sub-Saharan Africa

John Bennett, Ravi Sterling
University of Colorado, Boulder

Project Goals:
Enabling Women in Kenya to have a community “voice” by setting up a system to record and wirelessly transmit to radio stations

Current Project Status:
• Being tested in 34 work collectives in Kenya
• Planned expansion to India
Speech Enabled Telephone Enables Healthcare Workers to Increase Medical Knowledge and Treatment Skills

**Project Goal:**
Expand healthcare workers treatment and diagnoses knowledge without requiring literacy

**Project Status:**
- Tested in Pakistan (Urdu) with CHWs with pneumonia and tuberculosis
- Expanding to include hepatitis, sexually transmitted diseases and diabetes

**Roni Rosenberg, Rahul Tongia, Jahanzeb Sherwani**
Carnegie Mellon University

**Training for front-line, low-literacy health providers**
Project Goals:
• Data is collected from monitoring devices attached to patients and transmitted to a server using a cell phone.
• Data reasoning engine extracts all relevant information.
• Alerts are generated, when necessary, to medical officer(s) to take appropriate action (call or an onsite visit).
• The system may also make suggestions to the patient on his/her cellular phone as a result of its reasoning processes.

Long Term Goals:
• The ultimate goal is to develop a Caribbean-wide Healthcare Management System using cellular phone technology.
• The network that would integrate the medical resources of the entire region thereby promoting the sharing of medical expertise and resources in a region with very poor healthcare facilities.
Smart Phones to Promote Chronic Illness Self-Management

Jiao Ma, Cynthia LaRouge, St. Louis University
Joseph Flaherty, VA Hospital

Project Goals:
• Enable robust elderly to manage diabetes
• Enable self-monitoring and adherence prospective homecare plans in rural settings

Project Status:
• Focus groups and pilot complete
• Deployment plans underway in St. Louis
• Sichuan Province for next deployment

Treatment adherence monitoring for rural diabetics
Informing At-Risk Populations About AIDS/HIV Transmission

Henry Nyongesa, Dimane Mpoeleng
University of Botswana

Project Goal:
• Provide information to population on AIDS avoidance
• Assisting those that may suspect they have AIDS where to get diagnosis and treatment

Project Status:
• System is tested and complete
• Looking to expand the system to support non-literate users (via speech recognition)
Ultra Low Cost USB Ultrasound Probe

William Richard, David Zar
Washington University St. Louis

Project Goals:
• Reduce the cost of the ultrasound device to increase availability
• Enable ultrasound controls and images on a cell phone or Fone+ for use in rural settings

Current Project Status:
• Clinical trials study underway with Duchenne MDS patients
• Windows Mobile SDK available
CellScope: Portable Low-cost Imaging for Disease Diagnosis

Daniel Fletcher
University of California, Berkeley

Project Goals:
• Inexpensively enable field microscopy analysis via a cell phone
• MMS images for further analysis and/or direct diagnosis

Current Project Status:
• BMGF funding to extend prototype
Neck collar sensors for in home sleep monitoring
- Oximetry (oximeter), Head (neck) poise (3D accelerometer), Microphonics (throat microphone), Galvanic Skin Response, Heart rate
- Data captured by a cell phone and transmitted to a server
- “SmartLogger” UI for monitoring and querying the information across the different sensors and GPS/schedule information

Goals:
- Enable similar data that is collected in a sleep lab to captured in the home and over several days
- Easy to add sensor interface for cell phones
- Application to displaying information across multiple sensors in one UI
Africa: Cellphone as a Platform for Healthcare Awards

Lowering maternal mortality rates in Sierra Leone
Gary Marsden, University of Cape Town, South Africa

Use of SMS services to improve TB treatment completion in integrated tuberculosis and HIV care in resource-limited settings
Sabine Hermans, Makerere University College of Health Sciences Research, Uganda

CellChek: A cost-effective cell phone-based patient monitoring and advising system
Tamer ElBatt, Nile University, Egypt

SurgilLink: surgical guidance via mobile phones
Mohamed ElHelw, Nile University, Egypt

Mobile microscopy for automated malaria diagnosis in field conditions
John Quinn, Makerere University, Uganda
Microsoft Research

Faculty Summit 2010

Guarujá, Brasil | May 12 - 14 | In collaboration with FAPESP

November 8th- 10th,
Washington Convention Center, Washington, D.C., USA

NIH 2010 mHealth Summit
Questions?