Microsoft® Research
Faculty Summit2010

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

Healthcare Challenges and Investments

ACCESS
Only 1.6B people have adequate coverage

DEMOGRAPHICS
Aging populations, growing middle class

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

Growing Stressors on Global Healthcare

LABOR SHORTAGES
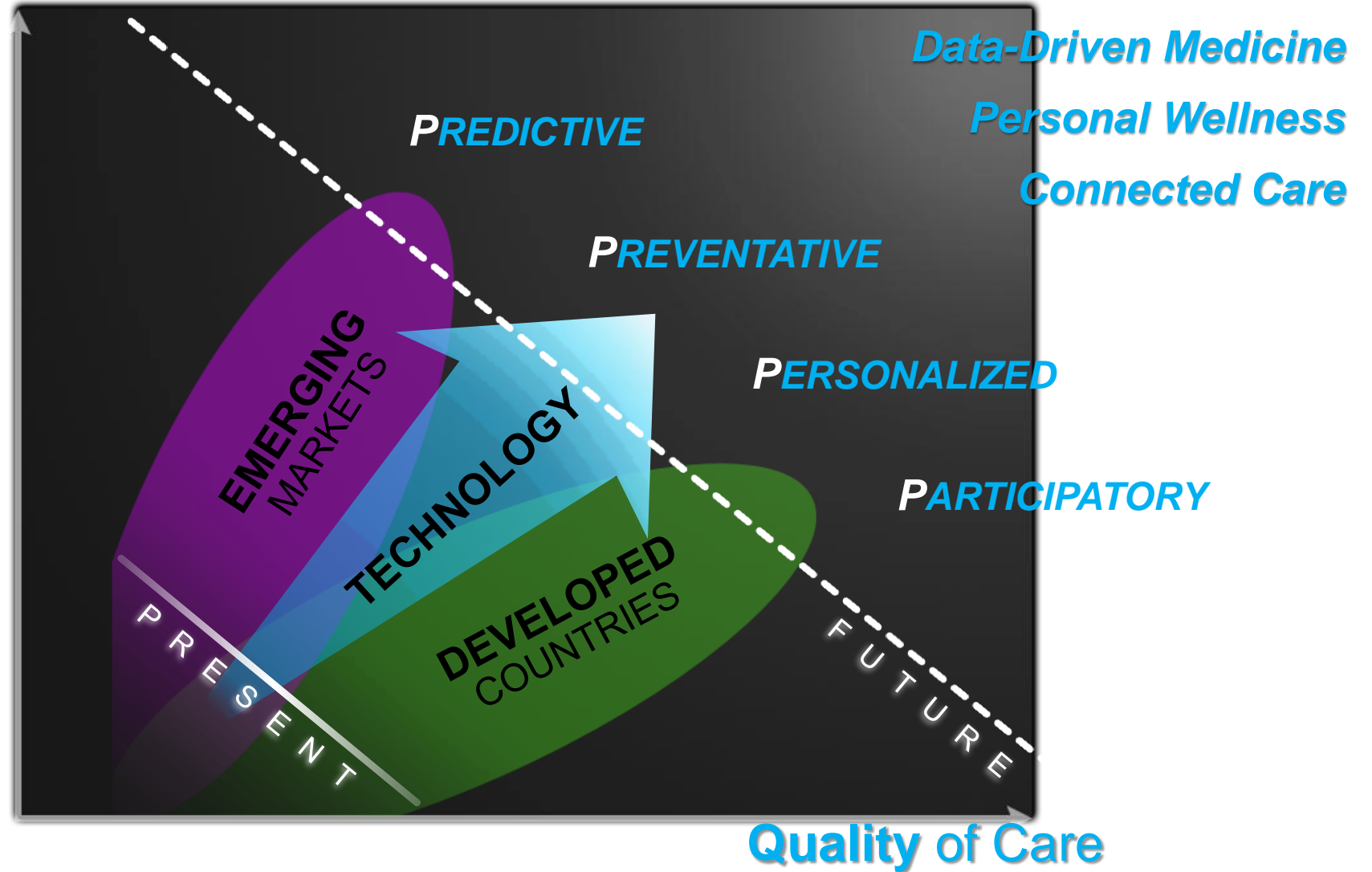Dearth of qualified healthcare workers

QUALITY
Healthcare systems fragmented and siloed

CONSUMERISM
Growing expectations at every level

Technology Scaling Healthcare

Anticipating the Future: **Rural Environments**

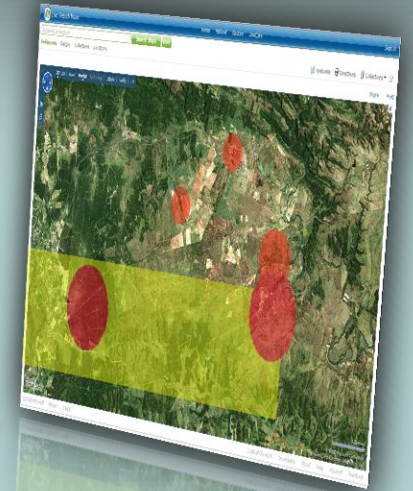**Low-cost, Automated Diagnosis**

Solutions in Clients + Cloud

Global Resources, Local Care

Personalized Drug Delivery

Geo-Spatial View of Health

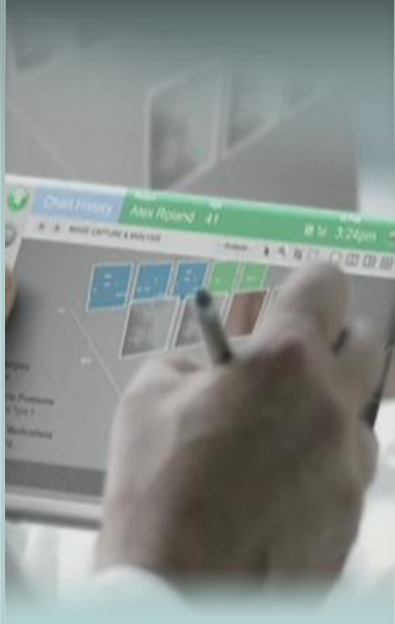# DATA-DRIVEN MEDICINE

Anticipating the Future: Urban Environments

Personal Monitoring

Advanced Analytics

Smart Medication

you have 1 prescription on your account

80mg oral hypoglycemic $20

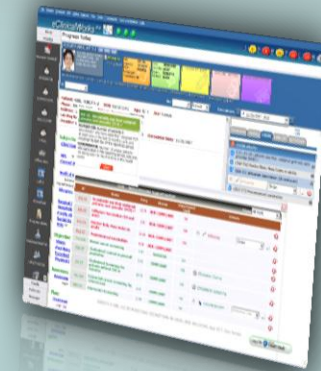would you like to send this to the pharmacy?

no   yes

Personal Health Management

Connected Data, Connected Care

Anticipatory Medicine

P E R S O N A L   W E L L N E S S

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

Walter H. Curioso, MD, MPH
Research Professor
Universidad Peruana Cayetano Heredia (Lima, Peru)
Affiliate Assistant Professor
University of Washington (Seattle, Washington)

mHealth can be defined as mobile computing, medical sensors, and communications technologies for health care*

Cell phones

PDAs

Ebook readers

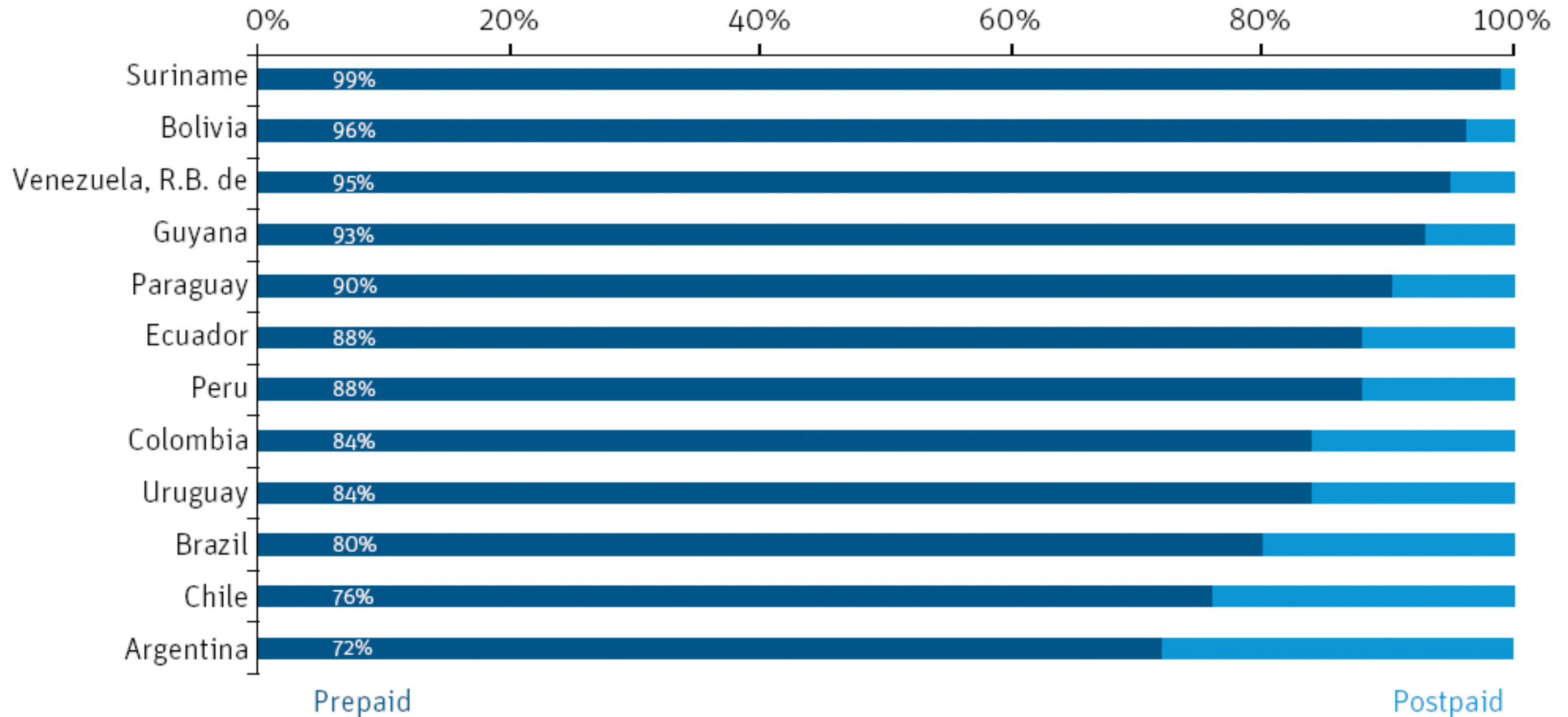**Smart phones**

Monitoring Devices (mobile EKG)

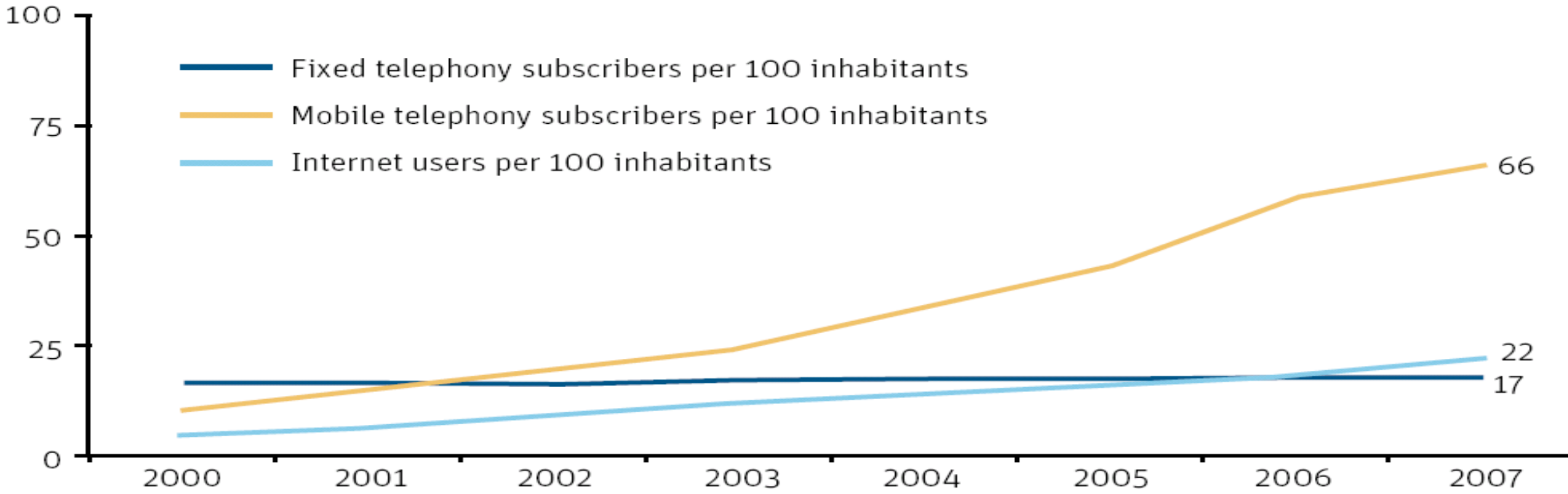**MP3 players (iPods for mLearning)**

*Istepanian, R. Introduction to the Special Section on M-Health: Beyond Seamless Mobility and Global Wireless Health-care Connectivity. IEEE Transactions on Information Technology in Biomedicine: 2004. 8(4), 405-413.

More than 383 million cell phones in Latin America

	0%	20%	40%	60%	80%	100%
Suriname	99%					
Bolivia	96%					
Venezuela, R.B. de	95%					
Guyana	93%					
Paraguay	90%					
Ecuador	88%					
Peru	88%					
Colombia	84%					
Uruguay	84%					
Brazil	80%					
Chile	76%					
Argentina	72%					

Prepaid   Postpaid

Source: ITU 2007.

Cell phones in Latin America

Legend:
- Fixed telephony subscribers per 100 inhabitants
- Mobile telephony subscribers per 100 inhabitants
- Internet users per 100 inhabitants

Y-axis values: 0, 25, 50, 75, 100
X-axis values: 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007
End values: 66, 22, 17

Source: International Telecommunications Union (ITU). 2007.

Peru

24'702.060 cell phones

87.5% penetration rate

Cell phones

Land lines

24.000.000
22.000.000
20.000.000
18.000.000
16.000.000
14.000.000
12.000.000
10.000.000
8.000.000
6.000.000
4.000.000
2.000.000
0

2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
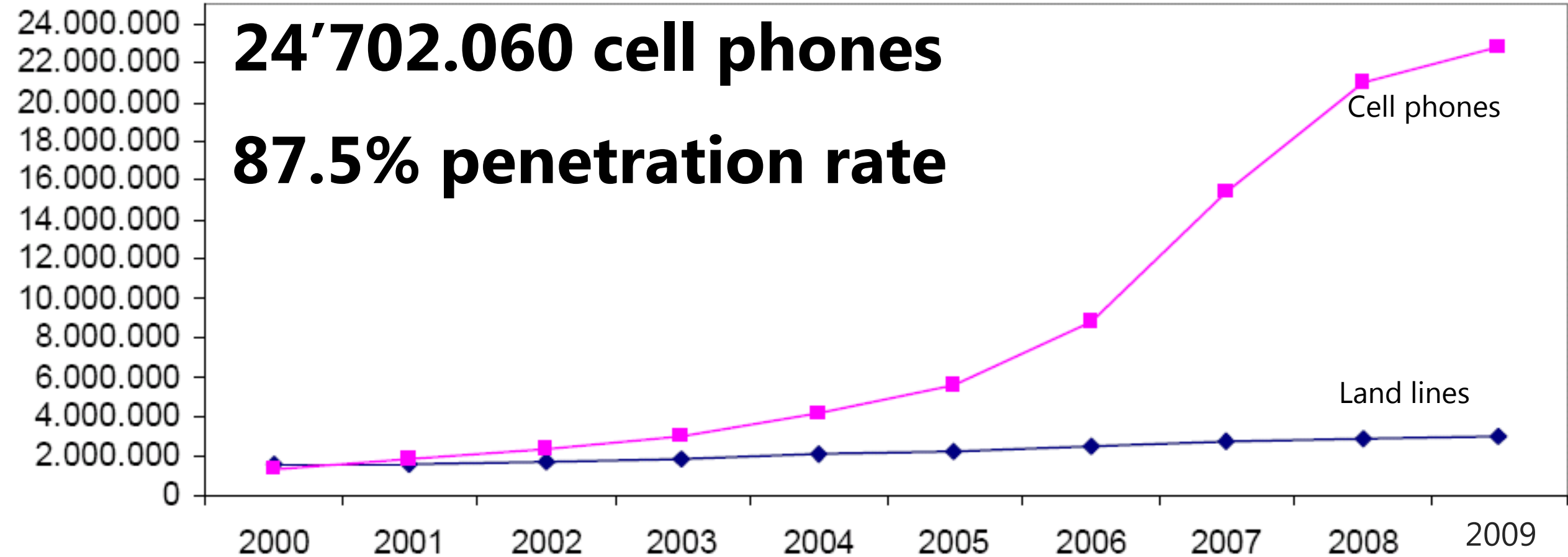
Aplication areas in mHealth

Low   High

← Complexity of applications in mHealth →

| Education | Monitoring/ Adherence | Data collection | Emergencies | Information Systems | Diagnosis and Consultations |

mHealth in the developing world

Legend:
- ■ Analysis, Diagnosis, and Consultation
- ★ Data, Health Record Access
- ● Education & Awareness
- ◆ Health/Administrative Systems
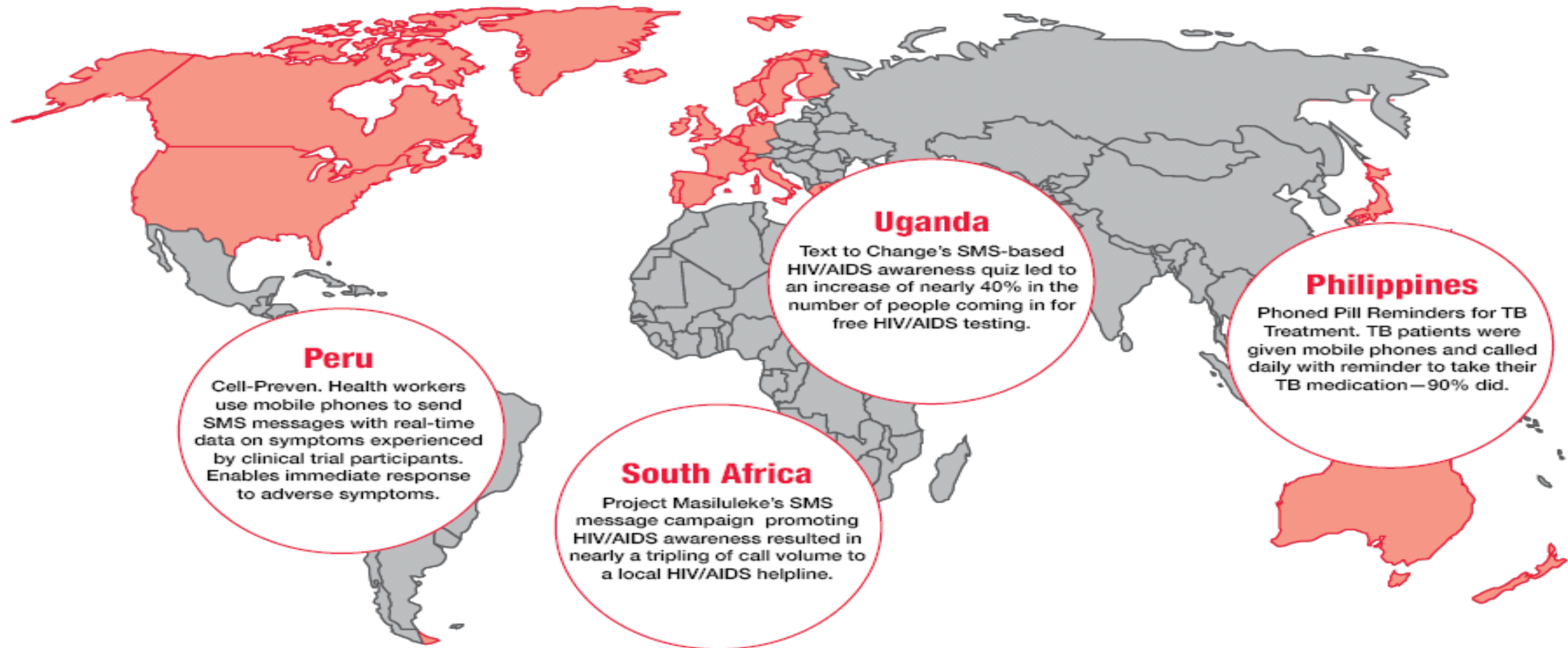- □ Monitoring/Medication Compliance
- ✚ Disease/Emergency Tracking
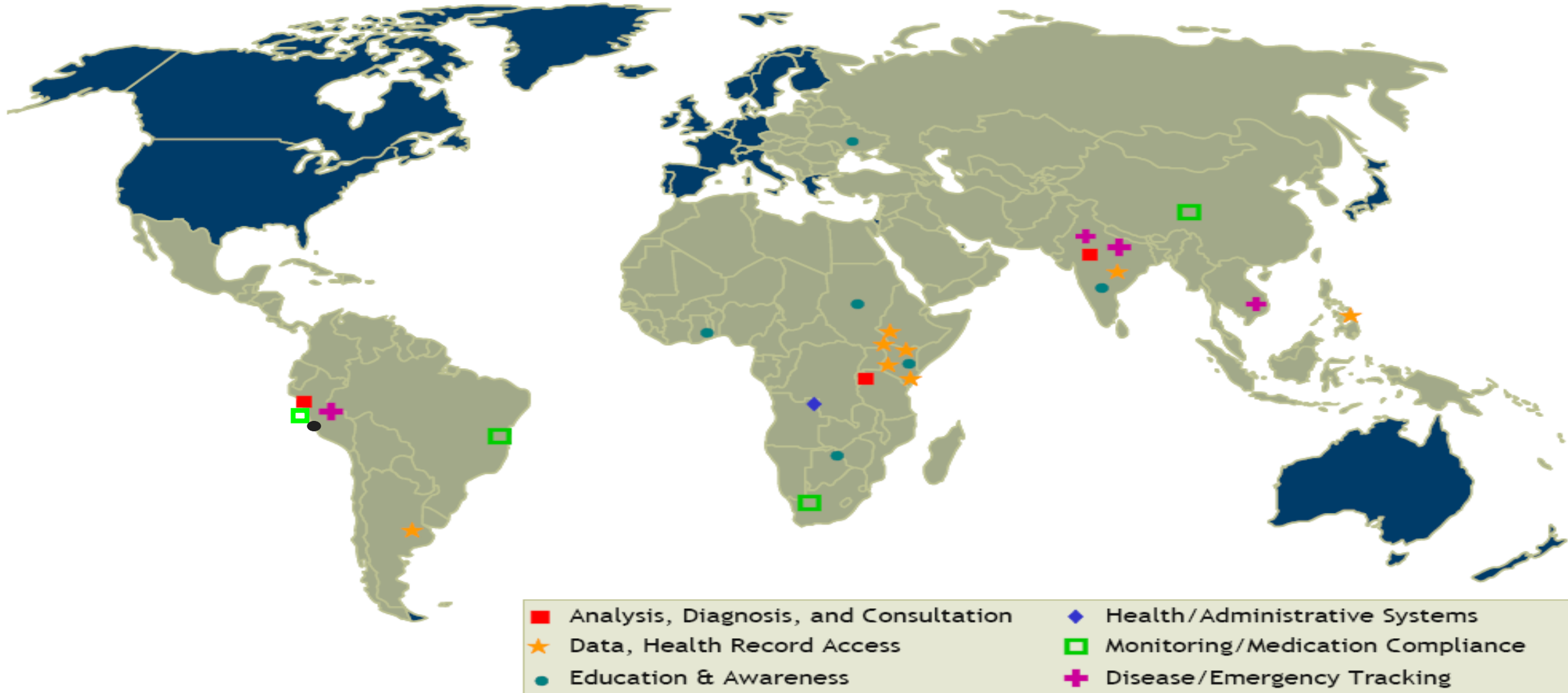
Adapted from: Vital Wave Consulting. mHealth for development: the opportunity of mobile technology for healthcare in the developing world. Washington (DC) and Berkshire (UK): UN Foundation–Vodafone Foundation Partnership; 2009.

mHealth for development

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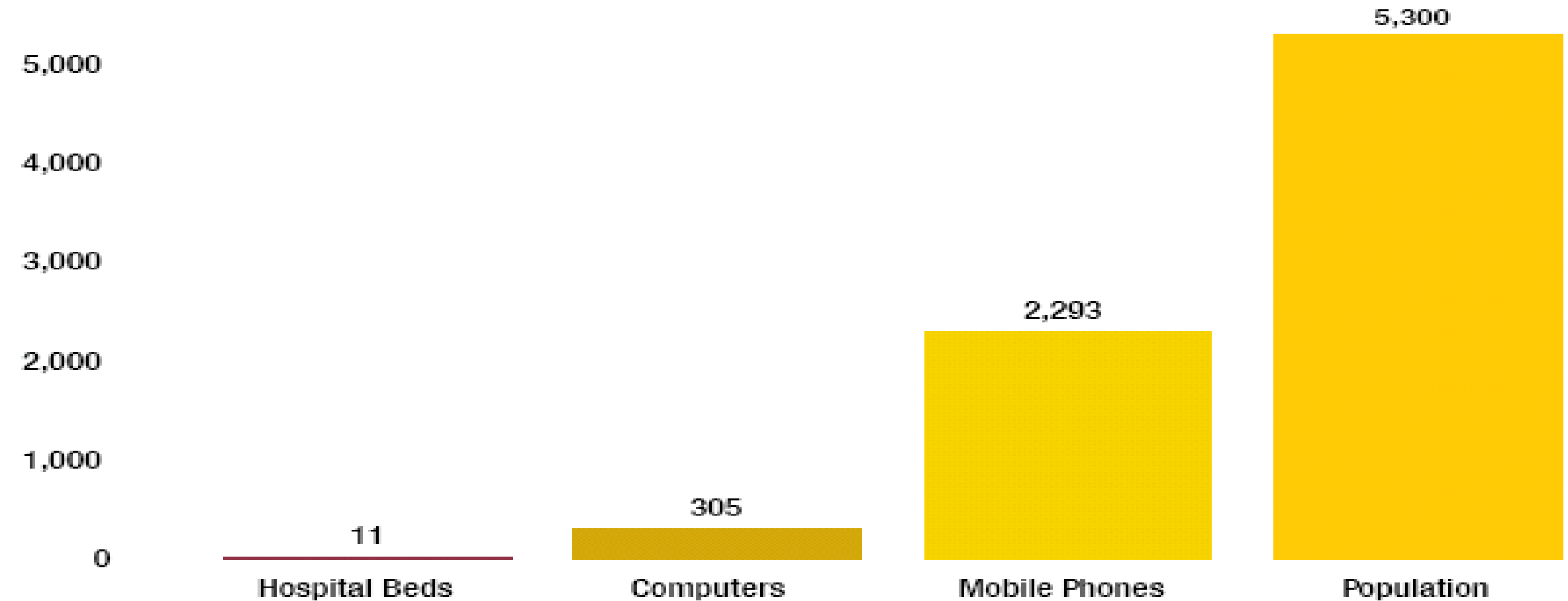
From: Vital Wave Consulting. mHealth for development: the opportunity of mobile technology for healthcare in the developing world. Washington (DC) and Berkshire (UK): UN Foundation–Vodafone Foundation Partnership; 2009.

Impact of mHealth applications

Impact of mHealth applications across the developing world.

Mobile phones reach further into developing countries than other technology and health infrastructures

Technology and health-related statistics for developing countries (millions).[4]

Vital Wave Consulting, Business Monitor International (BMI), International Telecommunications Union, World Bank's World Development Indicators, and the United Nations.

Universidad Peruana Cayetano Heredia (Lima)

Cell-POS
(www.cellpos.org)

SMS reminders and educational text-messages for PLWHA

Via-Net

Feasibility of internet data collection

SOMOS

Encouraging HIV testing through online videos

WaWaNet
(Mobile Citizen)

Supporting maternal and child care with mobile devices in Callao

Cell-PREVEN
(www.prevenperu.org)

Real-time surveillance system for adverse events

Research
Health Informatics
UPCH

Colecta-PALM

Risk assessment for PLWHA

Net-Lab

Internet lab access for PLWHA

PDA-PREVEN

Electronic data collection through PDAs
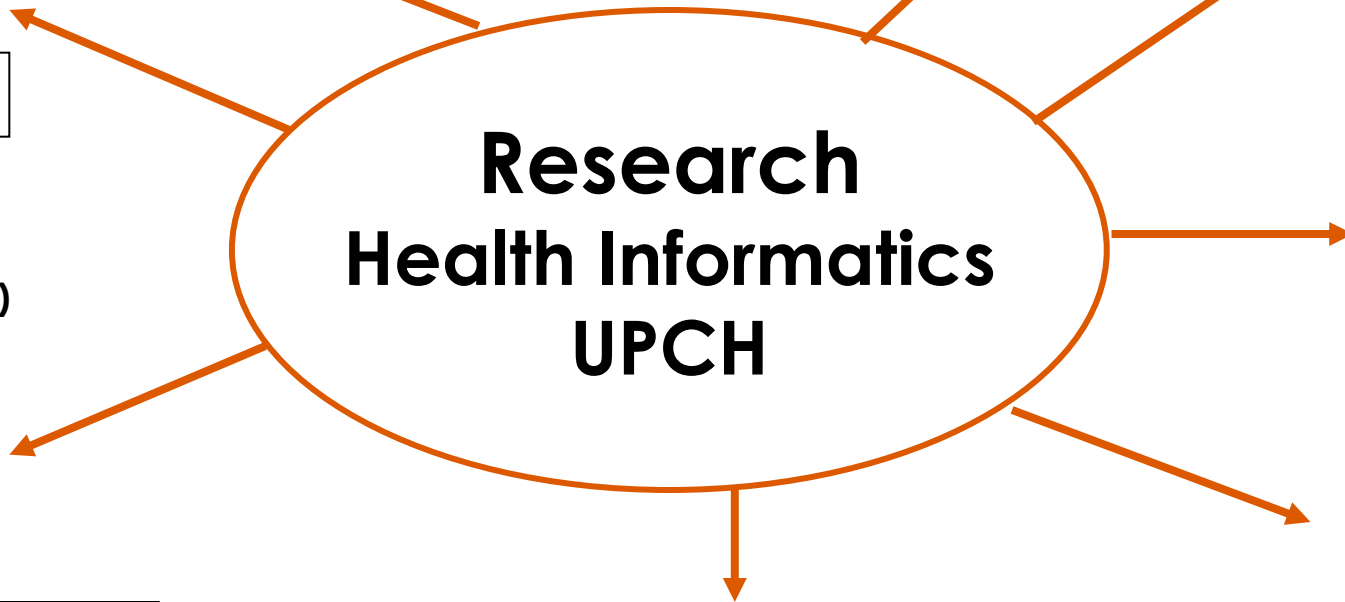
HIV in Peru

20-93,000 HIV (+)
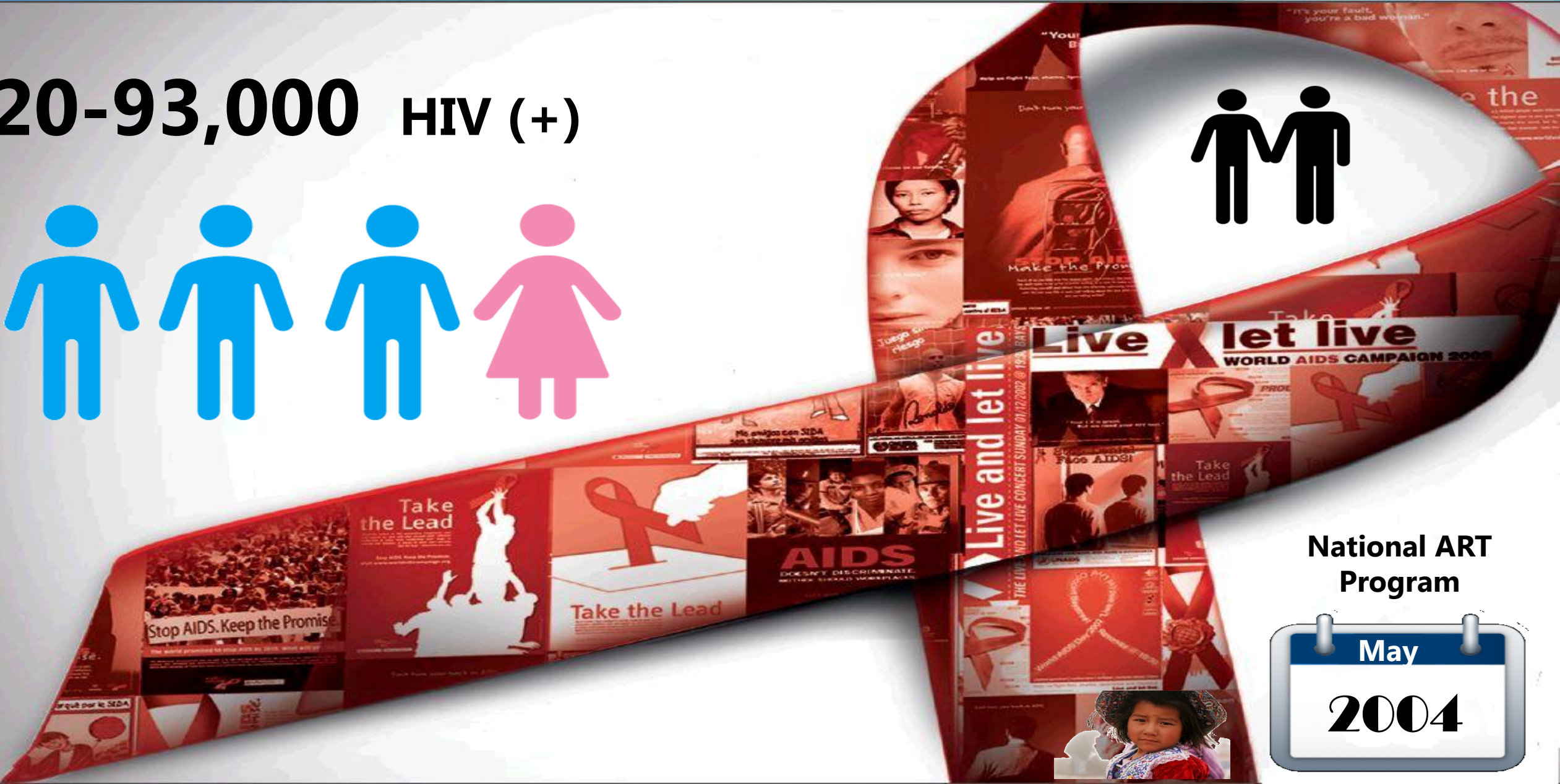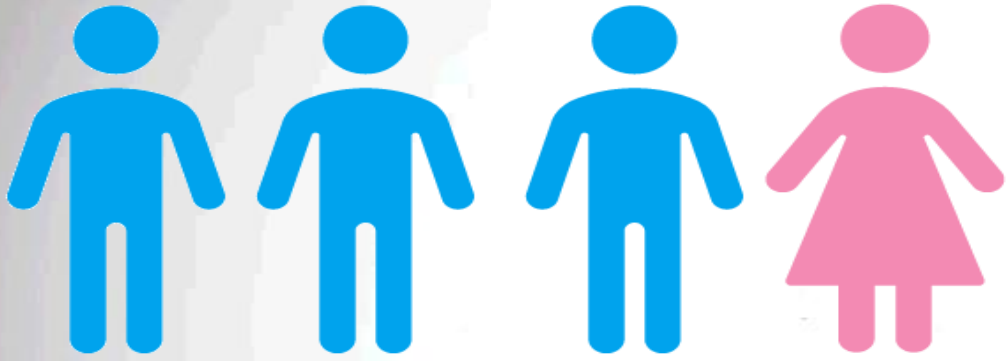
National ART Program

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

Mills E. PLoS Med 2006;3(11):e438

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.

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

Focus groups

Pilot evaluation

Randomized controlled trial

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

Less intrusive

Less interrupting than receiving a phone call

SMS over a 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

Marcus B. Contemp Clin Trials 2007; 28(1): 90-104.
Pinto B. Am J Prev Med 2002; 23(2): 113-120.

Confidentiality issues are very important in any strategy that uses cell phones in healthcare (1)

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)

(1) Lester R. AIDS 2006; 20(17): 2242-2244.
(2) Curioso W. THPE0793. 17th Int. AIDS Conf. 2008; Mexico.

Cell phone reminder system as a friend

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)

(1) Milch RA. Am J Hosp Palliat Care 1996;13:46–8.

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**

Fogg BJ. Increasing persuasion through mobility.
In: Fogg BJ, Eckles D. Mobile Persuasion –
20 Perspectives on the Future of Behaviour Change.
Stanford Captology Media, Special First Printing, Stanford University, 2007.

Focus groups: Conclusion

• 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
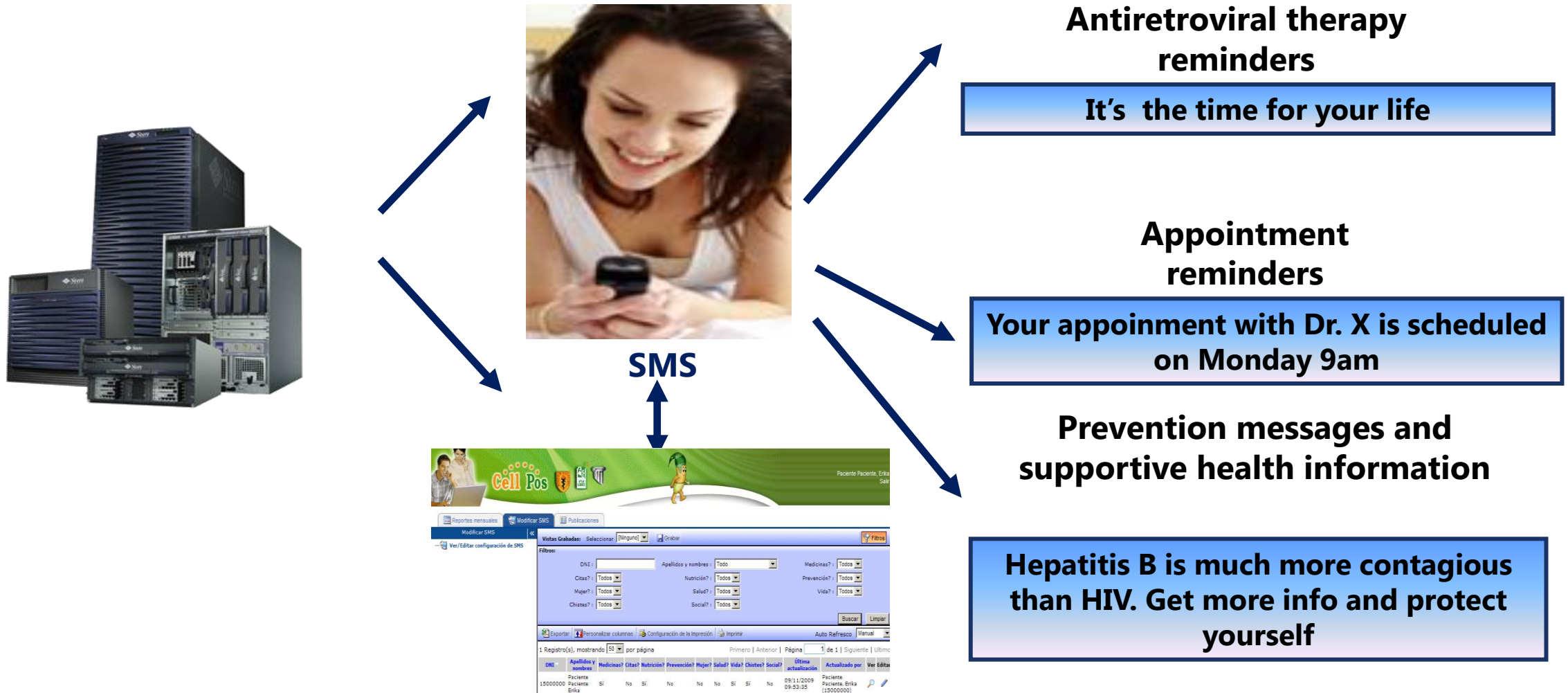
Focus groups

Pilot evaluation

Randomized controlled trial

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

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

SMS

Antiretroviral therapy reminders

It's the time for your life

Appointment reminders

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

Prevention messages and supportive health information

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

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

Focus groups

Pilot evaluation

Randomized controlled trial

Randomized controlled trial

Randomize

Arm 1: Cell phone system + standard of care

Arm 2: Standard of care

One year

mHealth Challenges
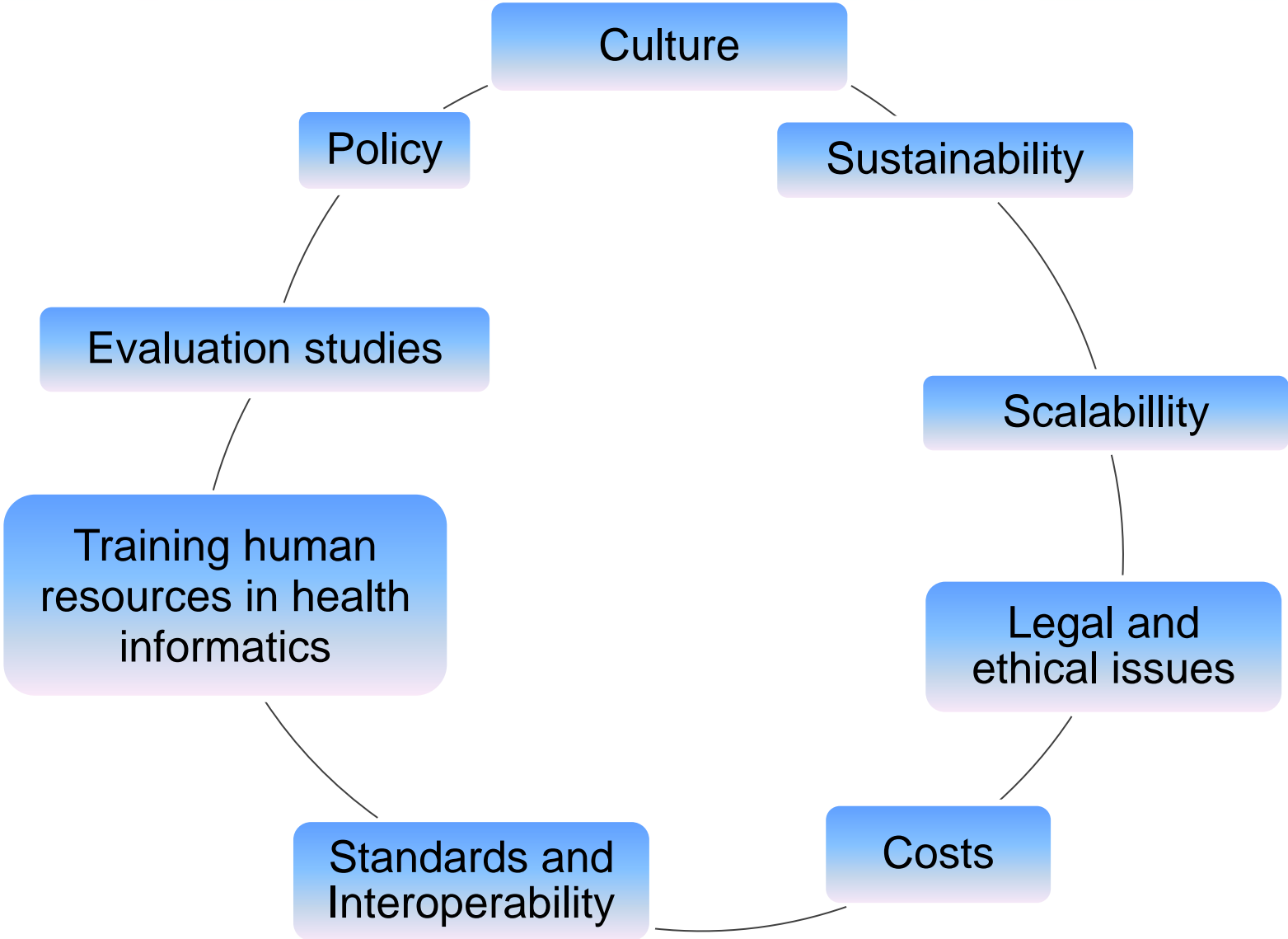
By Walter H. Curioso and Patricia N. Mechael

Enhancing 'M-Health' With South-To-South Collaborations

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informatics at the University
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mHealth and Telemedicine
Advisor for the Millennium
Villages Project at Columbia
University in New York City.

QUiPU

Andean Global Health Informatics
Research and Training Center

http://www.andeanquipu.org

Curioso WH, Mechael PN. Enhancing 'M-Health' With South-To-South Collaborations. Health Affairs (Millwood) 2010;29(2):264-7.

Thanks!

Walter H. Curioso, MD, MPH
wcurioso@uw.edu

Example Projects

Promoting gender equity in 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

Training for front-line, low-literacy health providers

Roni Rosenberg, Rahul Tongia, Jahanzeb Sherwani
Carnegie Mellon University

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

MediNet: Mobile Health System for Diabetics and Cardio Disease

Rural monitoring of patients with heart disease and diabetes

Permanand Mohan, Salys Sultan, Ahad Deen
The University of the West Indies, Trinidad and Tobago

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

Treatment adherence monitoring for rural diabetics

Jiao Ma, Cynthia LaRouge,
St. Louis University

Joseph Flaherty
VA Hospital

Project Goals:

- Enable robust elderly to manage diabetes
- Enable self-monitoring and adherence proscriptive homecare plans in rural settings

Project Status:

- Focus groups and pilot complete
- Deployment plans underway in St. Louis
- Sichuan Province for next deployment

Public Awareness Tool in at-risk populations

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

Portable low-cost imaging for healthcare

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

Portable low-cost imaging for healthcare

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

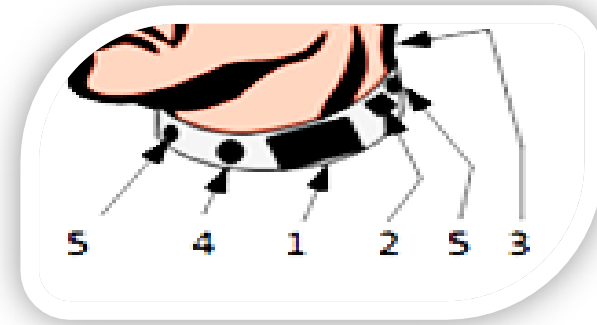## Current Project Status:

- BMGF funding to extend prototype

Current Prototype - High Magnification CellScope

Cell Phone   Optics   Focus Knob   Sample Stage

Sample Slide

Sickled Cells   Malaria Infected RBCs   Normal RBCs
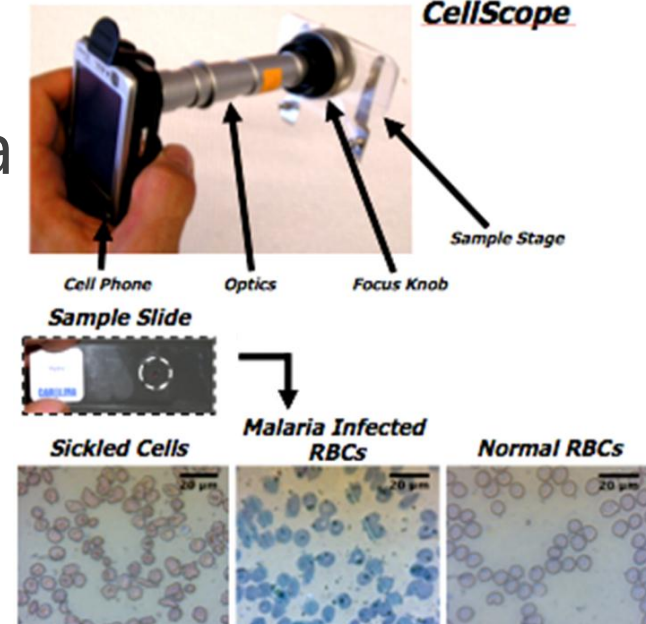
Monitoring Obstructive Sleep Apnea

Minimally Invasive Sleep Monitoring

Mike Sinclair, Kristin Tolle
Microsoft Research

- 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

Questions?