mHealth Applications

mHealth

- **eHealth**: healthcare practice supported by electronic processes and communication
- Mobile eHealth or **mHealth**: use of mobile telecommunication and multimedia technologies in health care delivery.
- While there are some projects that are considered solely within the field of mHealth, the linkage between mHealth and eHealth is unquestionable.
  - Example: an mHealth project that uses mobile phones to access data on HIV/AIDS rates would require an eHealth system in order to manage, store, and assess the data.
- **One way to see it**:
  - eHealth is a technology that supports the functions and delivery of healthcare
  - mHealth is primarily concerned about providing healthcare access (i.e., healthcare can better reach areas, people, and/or healthcare practitioners with previously limited exposure to certain aspects of healthcare).
mHealth

“... mobile technology is beginning to have a big impact on health care, especially in [developing] countries. ... Soon mobile technology could play a large role in detecting, mapping and responding to epidemics. A lot of information about a recent polio outbreak in Kenya became available because health workers were using hand-held devices to collect data that used to be recorded on paper forms.”

(Economist, April 10, 2008)

Global Health

- **Global health** refers to health problems that transcend national borders - problems such as infectious and insect-borne diseases that can spread from one country to another. It also includes health problems that are of such magnitude that they have a global political and economic impact.

http://www.familiesusa.org/issues/global-health/matters/
Global Health

• **Humanitarian reasons:** In 2005, an estimated 2.8 million people died from AIDS; more than 15 million children have been orphaned as a result of AIDS; more than 3 million people die annually from tuberculosis (TB) or malaria. (solve global health problems and avert needless suffering and preventable deaths).

• **Equity reasons:** Roughly 90 percent of the world’s health care resources are spent on diseases that affect 10 percent of the world’s population. (money and resources are distributed more fairly)

• **Direct impact reasons:** Infectious diseases can easily cross national borders and pose immediate threats in the U.S. (SARS, avian flu, and drug resistant TB). (address diseases that people in this country do not usually consider an immediate threat)

• **Indirect impact reasons:** Rising incidences of diseases like HIV/AIDS, malaria, and TB are increasing poverty and political instability in many countries. (political and economic stability/consequences)

Global health meets Global eHealth

• Health and eHealth/mHealth are inseparable due to the fact that health is knowledge-based and information intensive sector.

• Health is a global concern that is trans-border by definition and affects the world population. Resolving global health issues requires full participation of individuals in a person-centred healthcare system where mobile technology can help.

• ICTs including mobile communications have empowered the individual by allowing a two-way knowledge sharing at the convenience of the individual.
Health Applications

- mHealth “intervention”
  - An intentional use of mobile phones ‘for the specific purpose of modifying some health-related outcome or act.’ (Kaplan, 2006)
- Personal healthcare intervention
  - Medical personnel to patients
    - adherence to medication, immunization rates
  - Patients to medical personnel
    - Self reporting (e.g., blood glucose levels)
- Public health intervention
  - Wide area surveillance and notification

Urgent Need to Improve Health in Developing World

- 1 million die from effects of malaria each year
- 25% of children in developing countries are underweight and undernourished
- 1 woman dies each minute from pregnancy-related causes
- 2.5 Million people newly infected with HIV/AIDS each year
- 57 countries have critical shortages in health care workers
  - Total deficit of 2.4 million health professionals worldwide
Growing ubiquity of mobile phones is central to the promise of mobile technologies for health.

- 64% of all mobile phone users are in the developing world.
- By 2012, half of all individuals in remote areas of the world will have mobile phones.

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

By 2012, 50% of all individuals in remote areas of the world will have mobile phones.

80% of the world’s population live in an area with mobile phone coverage (expected to rise to 85% by 2010).
Benefits for Patients

Patient Health Outcomes

Effectiveness Gains
– Reductions in delays to patients receiving care
– Improved clinical outcomes

Health Systems Outcomes

Efficiency Gains
– Services delivered at reduced cost, increased speed

mHealth: Key Applications

• Education and Awareness
  – SMS/text messaging in support of public health and behavioral change campaigns.

• Data Collection and Record Access
  – Applications using mobile devices to enter and access patient data.

• Monitoring and Medication Compliance
  – Maintain care giver appointments or ensure medication regime adherence via one-way or two-way communications on mobile devices.

• Disease and Emergency Tracking
  – Use mobile devices to send and receive data on disease incidence, outbreaks and public health emergencies.

• Health and Administrative Systems
  – Allow access between mHealth applications and central health systems.

• Analysis, Diagnosis and Consultation
  – Support diagnosis and treatment through access to medical information or staff via mobile devices.
Meeting Health Needs Through a Broad Array of Applications

mHealth field is dynamic and range of applications being designed is constantly expanding.

Key applications for mHealth in developing countries are:

- Education and Awareness
- Remote data collection
- Remote monitoring
- Communication and training for healthcare workers
- Disease and epidemic outbreak tracking
- Diagnostic and treatment support

Impact of mHealth Projects

- Preliminary studies demonstrate mobile technology improves efficiency of healthcare delivery
- Figure illustrates early results from mHealth programs in developing world
Mobile Tech in Public Health

- Dissemination of Health Information
- Remote Data Collection Tool
- Consumer Interaction Point for Location-Based Health Information
- More focus on medical adherence for patients
- Feedback on quality of care
- Increased focus on interaction with at-risk populations
- More efficient ways to receive health information
- Location-based services

Why Phones in Rural Areas?

- Already widely prevalent in developing regions
- Usage familiar to rural users
- Powerful enough to be used for computing resources, rather than just communication – so possible PC replacement for vertical tasks
- Suitable for rural areas: low power, robust, cheaper, lower operating cost, use existing networks
- Integrated features: camera, GPS, audio
- Appropriate for use across multiple households
Rural Data Collection Problems

• Data frequently missing or incorrect or contradictory. E.g. sex is male but pregnant is yes on health form – very hard to validate after the fact
• Forms are very long and frequently incompletely filled – questions are not prioritized if partially filled
• Data collected not rich enough – no audio, pictures, GPS without specialized hardware (and also not integrated)

What Can Smartphones Offer ? (1)

• Immediate Validation
  – Correct data upon entry, and also crosscheck with other fields if dependencies exist
• Dynamic Forms
  – Reduce burden on health worker by asking only relevant question based on previous answers, thus reducing chances of errors
  – Also makes partially filled forms more useful
• Richer Data collection
  – Photos, audio input, GPS (entire medical record possible)
What Can Smartphones Offer? (2)

• Auditability
  – Audio samples can be used to double-check responses
• Transparency
  – Generating reports of and viewing system-wide statistics and data
• Operation in disconnected areas
  – Use only for computation, communication not necessary for collecting data on the field
• Synchronization of data
  – When connectivity is available, upload to central server over the cellphone network either through multiple SMSes, or data packets over GPRS, eVDO, etc.

Expected Results

• Increased data accuracy
• Improved data timeliness
• Reduction of burden on healthworkers
• Reduction of the number of times surveyors have to be re-sent back into the field to redo surveys because of errors
• Better organization of data
Dissemination of Health Information

Delivering Smoking Cessation Content with HME

http://www.hsaglobal.net/node/34

FrontlineSMS is free software that turns a laptop and a mobile phone into a central communications hub. Once installed, the program enables users to send and receive text messages with large groups of people through mobile phones.
FrontlineSMS

- [http://www.youtube.com/watch?v=FgtGbx-GKgo](http://www.youtube.com/watch?v=FgtGbx-GKgo)
- It does not require an Internet connection.
- It works with your existing plan on all GSM phones, modems and networks.
- It is laptop-based so it can be used on the road or during power outages.
- It stores all phone numbers and records all incoming and outgoing messages.
- All data lives on a local computer, not on servers controlled by someone else.
- It is scalable. Messages can be sent to individuals or large groups.
- It enables two-way communication, useful for fieldwork or during surveys.
- It is easy to install and requires little or no training to use.
- It can be used anywhere in the world simply by switching the SIM card.

Mobiles in Malawi

- A donated laptop, 100 recycled cell phones, and a copy of FrontlineSMS
- SMS-based communications network for a rural hospital and its community health workers in Malawi
- Allows hospital to respond to requests for:
  - rendering emergency medical care
  - tracking patients
  - recording HIV and TB drug adherence
  - staying updated on patient status
  - providing instant drug dosage/usage information
CDC in Kenya

- CDC/Kenya MOH project:
  - household morbidity survey:
    - paper vs. PDA
  - disease surveillance initiative:
    - SMS introduced
      - coded reporting
      - automated analysis
      - mass notification


"... PDA data quality is higher than paper data because of the ability to force data validation and skip routines in the field. Data collection-to-analysis time is reduced because your field staff become your data entry staff. PDA data collection is cheaper because there are no printing and paper costs and no data entry staff costs."

RTBP: Sri Lanka/India

- International Development Research Centre
  - Pan Asia Networking (PAN) Program
    - PANACEA project
      - Evaluating RTBP (LIRNEasia)
- mHealth-related research questions:
  - To what extent can mobile phones improve the timeliness and accuracy of reporting patient data from communities to regional/national epidemiology centers?
  - To what extent can mobile phones improve the timeliness and effectiveness of public health interventions? (i.e., notifications about infectious disease outbreaks)

- Side note: http://www.google.org/flutrends/
The ‘Last-Mile’

- Digitizing patient data
  - Test applications to support data acquisition
  - Assess standards for coding data
  - Identify unknown issues/examine known issues
- Transmitting patient data
  - Explore methods for sending data to centers
  - Examine notification and alert possibilities
  - Develop and assess procedures
  - Training and technology acceptance

Research Activities

- ICT development and testing
  - data entry application loaded on handset
- ICT deployment
  - introduce into selected communities
  - provide training and operating procedures
  - conduct beta tests and make changes as needed
- Evaluation
  - Routine data entry combined with simulations
  - Assessment criteria could include:
    - HCI aspects, interoperability, social acceptance
AIDS in South Africa

- Estimated 600,000 adults not receiving needed ARV treatment

The "gap" - 80% dead in 2 years

AIDS in South Africa

- Patient to doctor ratio is very high

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>Doctors per 1000</th>
<th>HIV+ per 1000</th>
<th>HIV+ per doctor</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Africa</td>
<td>0.489</td>
<td>215</td>
<td>439</td>
</tr>
<tr>
<td>Tanzania</td>
<td>0.023</td>
<td>88</td>
<td>3826</td>
</tr>
<tr>
<td>Rwanda</td>
<td>0.025</td>
<td>51</td>
<td>2040</td>
</tr>
<tr>
<td>United States</td>
<td>1.629</td>
<td>6</td>
<td>3.69</td>
</tr>
</tbody>
</table>
AIDS in South Africa

• Counselors use PDAs to determine who is healthy and who needs to see a doctor

Children’s Health

• This year almost 10 million children will die before reaching the age of 5
• Most live in low-income countries
• Almost 2/3 could be saved by the correct application of affordable interventions
• Every 6 seconds a child dies from a preventable cause
IMCI

- UNICEF, WHO and others develop medical protocols
- Integrated Management of Childhood Illness (IMCI)
- Address most common childhood illness
- Easy to use for lowly-trained health workers

IMCI

- Originally developed in 1992 by WHO and UNICEF
- Adopted by over 80 countries worldwide
- Integrated most common causes of childhood illness into a single approach
IMCI Example

Does the child have cough or difficult breathing?

**IF YES, ASK:**
- For how long?
- Look for chest indrawing.
- Look and listen for stridor.

**LOOK, LISTEN, FEEL:**
- Count the breaths in one minute.
- Look for chest indrawing.
- Look and listen for stridor.

**CLASSIFY COUGH or DIFFICULT BREATHING**

**CHILD MUST BE CALM**

- If the child is:
  - 2 months up to 12 months: 50 breaths per minute or more
  - 12 months up to 5 years: 40 breaths per minute or more

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IMCI Example

**SIGNS**
- Any general danger sign or
- Chest indrawing or
- Stridor in calm child.

**CLASSIFY AS**
- SEVERE PNEUMONIA OR VERY SEVERE DISEASE
- PNEUMONIA
- NO PNEUMONIA: COUGH OR COLD

**TREATMENT**
(Urgent pre-referral treatments are in bold print.)

- **SEVERE PNEUMONIA OR VERY SEVERE DISEASE**
  - Give first dose of an appropriate antibiotic.
  - Refer URGENTLY to hospital.*

- **PNEUMONIA**
  - Give an appropriate antibiotic for 5 days.
  - Soothe the throat and relieve the cough with a safe remedy.
  - Advise mother when to return immediately.
  - Follow-up in 2 days.

- **NO PNEUMONIA: COUGH OR COLD**
  - If coughing more than 30 days, refer for assessment.
  - Soothe the throat and relieve the cough with a safe remedy.
  - Advise mother when to return immediately.
  - Follow-up in 5 days if not improving.
**IMCI Example**

**Give an Appropriate Oral Antibiotic**

*FOR PNEUMONIA, ACUTE EAR INFECTION OR VERY SEVERE DISEASE:*

<table>
<thead>
<tr>
<th>FIRST-LINE ANTIBIOTIC:</th>
<th>SECOND-LINE ANTIBIOTIC:</th>
</tr>
</thead>
<tbody>
<tr>
<td>COTRIMOXAZOLE (trimethoprim + sulphamethoxazole)</td>
<td>AMOXICILLIN</td>
</tr>
<tr>
<td>Give two times daily for 5 days</td>
<td>Give three times daily for 5 days</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AGE or WEIGHT</th>
<th>ADULT TABLET</th>
<th>PEDIATRIC TABLET</th>
<th>SYRUP</th>
<th>TABLET</th>
<th>SYRUP</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 months up to 12 months (4 - 10 kg)</td>
<td>1/2</td>
<td>2</td>
<td>5.0 ml</td>
<td>1/2</td>
<td>5 ml</td>
</tr>
<tr>
<td>12 months up to 5 years (10 - 19 kg)</td>
<td>1</td>
<td>3</td>
<td>7.5 ml</td>
<td>1</td>
<td>10 ml</td>
</tr>
</tbody>
</table>

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**IMCI Barriers**

- Expense of training ($1150 -$1450)
- Not sufficient supervision
- Chart booklet
  - Takes a long time to use
  - Natural tendency to be less rigorous
  - Social pressure
e-IMCI

- Put IMCI protocol on PDA
- Guide health workers step-by-step through the protocol
- Data collection is a by-product of care
- Can handle more complex protocols
- Interface with other devices and EMR

e-IMCI Interface
**e-IMCI**

- Code based on South Africa HUPA project
- Windows Mobile 5.0
  - PDA/SmartPhone
- Contains cough, diarrhea, fever and ear pain questions and treatment
- First visit, ages 2 weeks to 5 years

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**Adherence**

- Measured adherence by 23 questions/investigations IMCI asks the practitioner to perform
- e-IMCI significantly improved adherence to the IMCI protocol
Timing

- No substantial increase in patient visit time
- Factors
  - Number of classifications
  - Interruptions

mHealth: Key Players & Incentives

<table>
<thead>
<tr>
<th>Player</th>
<th>Incentive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Care Provider</td>
<td>More efficient and effective delivery of health services</td>
</tr>
<tr>
<td>NGO</td>
<td>Advance organizational mission, attract funding</td>
</tr>
<tr>
<td>Foundations</td>
<td>Advance organizational mission</td>
</tr>
<tr>
<td>Government</td>
<td>More efficient health care provision, effective government</td>
</tr>
<tr>
<td>Equipment Provider</td>
<td>Device revenue generation, improved brand recognition</td>
</tr>
<tr>
<td>Service Provider</td>
<td>Revenue from service fees, increased subscriber base</td>
</tr>
<tr>
<td>Application Solutions Provider</td>
<td>Revenue from additional applications license fees</td>
</tr>
<tr>
<td>Content Management</td>
<td>Increase in volume of readership or revenue</td>
</tr>
<tr>
<td>Platform Provider</td>
<td>Revenue from sales</td>
</tr>
</tbody>
</table>
Most common reported mHealth Initiatives

- 50% in **emergency/disaster** situations;
- 50% in **health call centers** or **healthcare telephone helpline**;
- 45% for **surveillance/monitoring** programs;
- 40% for voice/text messages to achieve **treatment compliance**;
- 7 countries highlighted using mHealth for HIV/AIDS.

Barriers to mHealth Identified in Survey in African Countries

- 60% **Lack of Knowledge** about applications of mHealth and public health outcomes;
- 60% **Operating Costs** for voice communication, data transfer, electricity too high;
- 55% **Underdeveloped Infrastructure** such as unreliable mobile network;
- 50% **Policy** – country or regional eHealth policy does not include mHealth as an approach;
Comparison of barriers:
WHO African region and European region

Issues of Concern in mHealth

- **Cost and affordability.**
  - The average data TCO of $46 represents an average of 13% of the GDP/capita
  - People with $2 to $3 daily income spend 5-8% of their income for ICT, thus mobile data is unaffordable for most at the lower-and middle income classes. Cost: of handset, services and taxes.

- The currently 13% of GDP has to **go down to a maximum of 4-7 percent GDP** if we want it to succeed and to be sustainable.

- **Personal data safety and confidentiality** of users and their consent and awareness of the risks involved in access and use of mobile technology.
Issues of Concern in mHealth

• **Data exchange and interoperability.**
  – There is a lack of consensus on how to transmit data over different networks.
  – Unlike voice and SMS (the most commonly used data application), structured health data requires a different level of standardization and interoperability, both syntactic and semantic.
  – Standardization is a technology issue that is influenced by people's acceptance to comply (education, awareness, and perceived value).

mHealth Policy Aspects

• **Organizational policy aspects:**
  – **Assessment of health needs.** A problem looking for solution rather than a solution looking for a problem;
  – **Political commitment, leadership, and change management.** All stakeholders need to be involved, contribute and see the value of mHealth;
  – **Governance.** The set of policies, rules, responsibilities, and processes established in an enterprise to guide, direct, and control how the organization uses technologies to accomplish business goals;
mHealth Policy Aspects

Organizational policy aspects:

- **Legal and ethical frameworks** to govern responsibility, liability, vendor relations, licensing/leasing arrangements, and partnerships between providers, suppliers, vendors, donors, etc.

- **People before technology:**
  - Acceptability by citizens, patients, clients leading to user satisfaction;
  - Acceptability by care providers leading to better performance and job satisfaction;
  - Cultural considerations;
  - Training and awareness;
  - Communication of value;
  - Ownership by the community (users and providers);

- **Alliances, contracts and agreements.** Involving the right people and the right expertise from the organization to negotiate, sign, and commit resources and actions;

- **Evaluation.** A built-in mechanism for monitoring and evaluation with clear measurement of outcomes and indicators;

- **Continuous learning and improvement.** Learning and sharing of experience to avoid repeating mistakes;

- **Sustainability.** A plan indicating how to continue after the pilot.
mHealth Policy Aspects

- **Technology policy aspects:**
  - **The network(s):**
    - The solution fits in the national telecommunication network infrastructure;
    - Interoperability between different carriers;
    - Load balancing between mobile carriers and fixed lines network to carry data;
    - Services provided over the network (voice, data, multimedia, etc.)

mHealth Policy Aspects

- **Technology policy aspects:**
  - **The handhelds:**
    - Design of the handheld to meet the needs;
    - Functionality (right balance) without overloading vs. price
    - Multilingual;
    - Operating System to develop health applications;
    - Shelf life and fast obsolescence of models;
    - Personal choices
    - Etc.
mHealth Policy Aspects

• Technology policy aspects:
  – The applications:
    • One platform with multiple applications;
    • Data elements to include;
    • Ease of use of the interface (menu, voice, graphics);
    • Multilingualism;
    • Security and accessibility to the application from unauthorized users in case of loss, maintenance, upgrade, etc.;
    • Data storage and access via other applications such as web;
    • Etc.

The Mission of mHealth Association

• Promote mHealth nationally and internationally
• Serve as a resource on mHealth companies
• Create an mHealth ecosystem
• Manage regional mHealth projects
• Develop international mHealth network
• Coordinate mHealth standards and applications for infrastructure-challenged countries
• Become the coordinating body for the mHealth and eHealth industry
Current State and Horizon of mHealth

- Currently approx. 120 companies in mHealth
- Ready applications
  - Disease reporting in several countries
  - Disease management in US and Europe
    - Diabetes
    - Asthma
    - Smoking cessation
    - Dermatology
- Wide range of applications

10 Currently Used Mobile Phone Functions in Healthcare

1 Patient Communication
   - Before Visit:
     - Appointment
     - Agenda (Reason for Visit)
     - Patient Information (CCR) Data Set
     - General
     - Email
     - Medication Reminders
     - Questions (with photos if applicable)

2 Web-based Decision Support Resources
   Guidelines and Protocols
   Telemmedicine Guidance

3 Display Copy of Patient Information on Device for P-o-C
   - Navigation
   - Documentation

4 Disease Management
   - Diabetes
   - Epidemiology
   - Asthma
   - Smoking Cessation
   - More

5 Telemmedicine and Teaching Applications

9 Ambulance/EMS

8 Financial Applications
   - Charge Capture
   - Eligibility Checking
   - Payment
   - Other Financial Systems

10 Disease Reporting

7 Copy of Encounter Data to Patient’s Mobile Phone

6 Professional Communication
   Pharmacy, Colleagues, Lab, Hospital, Others
D-Tree International

- Non-profit based in Boston, MA
- Medical algorithms on mobile devices
- Help over-burdened health workers
- Gather data from the field

Dimagi

- For-profit software development firm based out of Boston, MA
- Strong social mission, particularly in health
  - Experience in low-resource settings
- Work with NGOs, governments, academic institutions…
Examples of Medical Monitoring Apps

- **BEAT** - Bluetooth ECG Heart Monitor/Alert system

- **iWander** - Dementia patient wandering detection

- **iFall** - Accelerometer based fall detection

- **iTrem** - Accelerometer based tremor detection
  - Georgia Tech Research Institute

- [http://www.youtube.com/watch?v=l2KSYsvRA5c](http://www.youtube.com/watch?v=l2KSYsvRA5c)

- [http://www.ted.com/talks/pattie_maes_demos_the_sixth_sense.html](http://www.ted.com/talks/pattie_maes_demos_the_sixth_sense.html)