Portable Health Clinic: A Pervasive Way to Serve the Unreached Community for Preventive Healthcare

Ashir Ahmed, Sozo Inoue, Eiko Kai, Naoki Nakashima and Yasunobu Nohara

Speaker: Ashir Ahmed
Associate Professor, Department of Advanced Information Technology, Kyushu University, Japan
Agenda

• UnReached People

• Affordable and Usable Healthcare System

• Portable Clinic and GramHealth: Experimental Results and discussion
## The Unreached Community

<table>
<thead>
<tr>
<th>The Unreached</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 billion people live on less than $2.50/day</td>
<td>Poverty</td>
</tr>
<tr>
<td>1 billion people unable to read</td>
<td>Education</td>
</tr>
<tr>
<td>1.5 million children die of diarrhea each year</td>
<td>Health</td>
</tr>
<tr>
<td>1.6 billion people live without electricity</td>
<td>Energy</td>
</tr>
</tbody>
</table>

Can power of ICT change these facts?
Collaboration with Grameen Since 2007

• Development of Technologies based on Social Needs
• Social Business to provided social services to the target community in a business way
• Healthcare is a focused area of joint-research
E-Health services for unreached community in low-resource settings
Low-resource setting (unreached community)

- Doctors don’t want to stay in rural/remote areas
- Quality hospitals don’t sustain without a stable income
- Transportation cost is bigger than treatment cost
Bangladesh case: Health Consultancy over mobile phone since early 2000

1. A patient calls a **hotline number**.
2. The call is **redirected** to a call center doctor.
3. The patient-doctor conversation starts.
4. The doctor provides **three types of services**.
5. The conversation is **archived in CDR**
Two Case studies

<table>
<thead>
<tr>
<th></th>
<th>789 Service</th>
<th>Tele health 10600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provider</td>
<td>GrameenPhone (a mobile phone operator)</td>
<td>JBFH (a hospital)</td>
</tr>
<tr>
<td>Calls per day</td>
<td>15,000 calls</td>
<td>500 calls</td>
</tr>
<tr>
<td>Call center doctors</td>
<td>200 doctors / three shifts</td>
<td>10-15 doctors / three shifts</td>
</tr>
<tr>
<td>Price</td>
<td>5 cents per minute</td>
<td>Free for farmers</td>
</tr>
</tbody>
</table>
### Amazing Facts from Doctor-Patient conversation analysis

- **Caller Patient:** 60%, Relatives: 40%
- **Age distribution of the patient:**
  - 0-10 years: 29%
  - 11-20 years: 15%
  - 21-30 years: 24%
  - 31-40 years: 17%
  - 41-50 years: 9%
  - 50+ years: 7%
- **Sex:**
  - Male: 67%
  - Female: 33%
- **Location:**
  - Rural: 30%
  - Urban: 70%
- **Call completion:**
  - Complete: 68%
  - Incomplete: 32%
- **Time of call:**
  - Day (8:00-15:30): 57%
  - Evening (15:30-23:00): 18%
  - Night (23:00-8:00): 25%
- **Time occupancy of a single call:**
  - Introduction phase: 8%
  - Diagnosis phase: 27%
  - Advice phase: 67%
- **Consultancy about:**
  - Disease related: 79%
  - Preventive healthcare related: 21%
- **Type of advices:**
  - Prescribed medicine: 54%
  - Advice: 28%
  - Referred to specialist/hospital: 17%
- **Patients:**
  - Follow up: 17%
  - New: 83%
- **Major diseases consulted:**
  - Gastro-intestinal: 22%
  - Respiratory: 17%
  - Reproductive: 10%
  - Skin: 10%

**Data Source:** Tele health 10600 (Case-2)

**Duration:** December, 2009

**Total Records:** 10000

**Selected Records:** 400

33% patients are females → Solves another social problem of female

17% follow up patients → Popular !!!
Advantages and Technical Challenges

• **Social and Business Aspect**
  • Female patients can stay anonymous for female diseases. Amazing Privacy!!
  • Access to basic healthcare by millions of unreached patients

• **Technical Challenges**
  • Bad quality of communications. Incomplete calls.
  • Doctors cannot see to past records for *repeated patients*
  • Doctors can not make a good clinical decision, no diagnostic tools at the patient side to provide health data
OUR RESPONSES
Added two components

Portable Clinic

Patient @Home

GSM Net

Doctors @Call Center

GramHealth

© Ashir Ahmed, 2013
Energy and communication infrastructure issue
The prototype used in field

- Barcode reader
- Name cards with barcode
- Thermo meter
- Buttery
- Mobile modem
- Paper and pen
- Android terminal
- Urine tester tape (protein, sugar)
- Pulse oximeter (Oxygen in blood)
- Blood sugar meter
- Blood pressure
- Weight scale
- Measure (Height, Waist, Hip)
- Weight scale
- Blood pressure
- Name cards with barcode
- Blood sugar meter
- Pulse oximeter (Oxygen in blood)
- Thermo meter
- Buttery
- Mobile modem
- Paper and pen
- Android terminal
- Urine tester tape (protein, sugar)
- Measure (Height, Waist, Hip)

© Ashir Ahmed, 2013

Low cost vs. Accuracy
### Accuracy of the sensors: Concept of Triage for easier/useful explanation

![Color Coding Legend]

- **Red**: Safe
- **Green**: Risky
- **Yellow**: Safe
- **Orange**: Risky

#### Parameters and Thresholds

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Red (Safe)</th>
<th>Orange (Risky)</th>
<th>Yellow (Safe)</th>
<th>Green (Risky)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Blood Pressure (mmHg)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 90 mmHg</td>
<td>&lt; 90 mmHg</td>
<td>90 mmHg &lt; 100 mmHg</td>
<td>100 mmHg &lt; 160 mmHg</td>
<td>160 mmHg &lt; 180 mmHg</td>
</tr>
<tr>
<td>≥ 140 mmHg</td>
<td>≥ 140 mmHg</td>
<td>140 mmHg &lt; 160 mmHg</td>
<td>160 mmHg &lt; 180 mmHg</td>
<td>180 mmHg &lt; 200 mmHg</td>
</tr>
<tr>
<td><strong>Blood Sugar (mg/dl)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 100 mg/dl</td>
<td>&lt; 100 mg/dl</td>
<td>100 mg/dl &lt; 126 mg/dl</td>
<td>126 mg/dl &lt; 200 mg/dl</td>
<td>≥ 200 mg/dl</td>
</tr>
<tr>
<td><strong>Postprandial Blood Sugar (mg/dl)</strong></td>
<td>&lt; 140 mg/dl</td>
<td>140 mg/dl &lt; 200 mg/dl</td>
<td>200 mg/dl &lt; 300 mg/dl</td>
<td>≥ 300 mg/dl</td>
</tr>
<tr>
<td><strong>Urine test</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SpO2</strong></td>
<td>≥ 96%</td>
<td>93% &lt; 96%</td>
<td>90% &lt; 93%</td>
<td>&lt; 90%</td>
</tr>
</tbody>
</table>
Health Checkup Site

Blood Pressure & Blood sugar

Health checkup

Pulse oxymeter

Height, waist, hip & weight

Urine test

Registration & questionnaire

Female Patient

Telemedicine & Tele-prescription

Matching by sex because of Islam

System support and data management
BigData in GramHealth

1. Registration
2. Health checkup
3. Tele Consultancy
4. Prescription & Suggestion

Vital Data
Clinical Data
Conversation Data
Prescription Data

8527 records by March, 2013
Collaborator: N. Nakashima, Kyushu University

© Ashir Ahmed, 2013
Yellow marked patients!!

Health Status

- Urban (n=3032), 34.9%
- Rural (n=2728), 31.4%
- Suburban (n=2890), 33.3%

- 64.3%
- 16.9%
- 16.3%
- 2.4%
Results: People in sub-urban areas are healthier?
# GramHealth: Portable Health Clinic
A GramWeb Healthcare Initiative For Unreached Community

## Health Check-up Report

<table>
<thead>
<tr>
<th>Name:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age:</td>
<td>Reg. No:</td>
</tr>
<tr>
<td>Sex:</td>
<td>Health Status:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Height</th>
<th>Weight</th>
<th>BMI</th>
<th>Waist</th>
<th>Hip</th>
<th>Waist-Hip Ratio</th>
<th>Body Temperature</th>
<th>Oxygenation of Blood</th>
<th>Blood Pressure</th>
<th>Blood Glucose</th>
<th>Urinary Glucose</th>
<th>Urinary Protein</th>
<th>Urinary Urobilinogen</th>
<th>Pulse Rate</th>
<th>Anrhythmia</th>
</tr>
</thead>
<tbody>
<tr>
<td>148 cm</td>
<td>79.06 Kg</td>
<td>36.09</td>
<td>108 cm</td>
<td>102 cm</td>
<td>1.06</td>
<td>97.12 °F</td>
<td>98 %</td>
<td>139/94 mmHg</td>
<td>10.5 (PBS)</td>
<td>- (+/−)</td>
<td>- (+/−)</td>
<td>- (+/−)</td>
<td>80 (60 - 99 beats/min)</td>
<td>Normal</td>
</tr>
</tbody>
</table>

### C/C:

- #H/O DM # LBP # KNEE JOINT PAIN

### Rx

1) Tab. Ostocal D
   1-3-0 খায়ার পর (2 মাত্র)

2) Tab. Comet 1 mg
   0-1-0 খায়ার আগে (চনা)

3) Tab. Napa 500 mg
   3-1-1 খায়ার পর (2 দোজ)
   রাতে হয় ২ দোজ খাবে ভয়া পেতে।

### Parasmma:

>নয়নু হয়ে কাজ করবে না। শেষপার্থি ব্যহার করবে না। আধুনিক জাতীয় খাবার খাবে না ।

>প্রথমেই ভাববে পরিষেবার কাজ করবে এবং সংস্কৃতি হলে নকটনের বিপরে বাতাসের সাথে ভাববে একটি করবে।

>চারুদ্রু ও অতিরিক্ত মূল্য সরলে খাবার কম খাবে।

>দৃঢ় হয় তখন খাবার না।

### Prescription Data

### Investigation Data

### Clinical Data

### Doctor's Suggestion

### Doctor’s Name

### Patient-doctor conversation records
Analysis of BigData will produce Trending:
- Disease pattern
- Geographical distribution
- Cohort characteristics

Invaluable resource for the Data mining researchers
(1) Registration Data
(2) Check-up Data
(3) Conversation Data
(4) Prescription Data

Processing and Analysis

- Data linking, Medical Info generation
- External API ICD-xx, SNOMED

Processing

- Hiding Personal Data, Structuring
- Language Translation, Structuring
- Interpretation, Structuring

Applications

- Info-med
- CDSS

© Ashir Ahmed, 2013
Results (sensors) at the first visit

N=8527
Results (numbers per site and sex) at the first visit
Rates of Individual result (per site, sex) at the first visit

Rural (n=2486)  SubUrban (n=2978)  Urban (n=3063)  Female (n=3326)  Male (n=5201)
Name: [redacted]  
Age: 30  
Reg. No.: 12082510  

Height: 162 cm  
Weight: 62.45 kg  
BMI (18.5 - 25): 23.80  
Waist: 86 cm  
Hip: 94 cm  
Waist-Hip Ratio: 0.91  
Body Temperature: 99.11°F  
Oxygenation of Blood: 98 %  
Blood Pressure: 149 / 89 (90 - 120 / 60 - 80)  
Blood Glucose: 7.17 (FBS)  
Urinary Glucose: ++  
Urinary Protein: ++  
Urinary Urobilinogen: ++  
Pulse Rate: 92 (50 - 100 beats/min)  
Atrial Fibrillation: Normal

C/V:  
40 Back pain for long time / joint pain.

Rx:  
1 Tab. Colchicine D  
1 Tab. (1 mg)  

Doctor Name: diruba sharmin shanta  
BMDC Reg. No: A49950  
Email: ehealth@gramweb.net  
Cell: 01713311525
Health records at the patient side?

An Electronic gadget for -
- MFI (Micro Finance Institution)
- FHR (Family Health Record)
- Electronic Money Transfer
- Future options

© Ashir Ahmed, 2013
Collaboration Opportunities for Reverse Innovation

Developing Countries

Local Orgs (NGO, Industries)

Unmet Needs

Joint Experiment

UnReached People

Social Problems

Our Lab

Projects

Technology Development

Prototype Development

Business Model

Social Business Venture

Japan

Leap frog Technology

Research Orgs (Academia, Industry)

Product Development
Unreached: Beyond the BOP

- **Socio-economic**
  - Low income, Low skills
  - Compromised infrastructure
  - Under developed countries

- **Natural Disasters**
  - Low/high income, low/high skills
  - Compromised infrastructure
  - Both developed and developing countries

- **Political**
  - Low/High income, Low/high skills
  - Compromised infrastructure
  - Both developed and developing countries
Conclusion

🌟 Problems
- Impossible to run hospital in remote areas.
- Difficult to easily increase the number of doctors

🌟 Research Challenges
- Usability of the devices by low-literate community health assistants
- Logics/Rules for Clinical Decision

🌟 Advantages of portable clinic
- Saves doctor precious time
- Charity vs. Business aspect

🌟 Reverse Innovation and Policy/ Privacy Issue
THANK YOU