mHealth Revolutionizing Public Health: An Economic Study

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Convergence, Infrastructure, Services, and Policy

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Key recommendations

**Digitizing health records through mobile phones**
- Considerable cost savings can be made in the national health budgets
- There are significant efficiency gains in early detection of disease outbreaks
- Health records provide a valuable baseline for public health monitoring and planning

**Data protection and handling**
- To gain trust and assure security and privacy, additional measures need to be taken (e.g. data encryption)
- Data should be managed by the government health departments

**Adjustment of rules concerning paper work**
- To incentivise health workers to use mHealth solutions, existing paper work procedures need to be relaxed

**System-to-System interoperability**
- Health data should be standardized for sharing with internal and cross-boarder organizations
Why mHealth?

Remove the labor intensive paper work to reduce 07-30 day delays down to “minutes”

Re-engineer the limited disease activated passive surveillance to “comprehensive active surveillance”

Black arrows: current manual paper/postal system for health data collection and reporting

Red lines: RTBP mobile phone communication system for health data collection and reporting
Real-Time Biosurveillance Program (pilot)

Actors, processes, and information flow of the proposed data collection, event detection, and situational-awareness/alerting real-time program

1. Health records digitized by health workers in Thirupathur block using mobile phones.
2. Disease, symptoms, and demographic information transmitted across GSM mobile network to central database.
3. Data analysed by trained staff at the IDSP and PHC Departments.
4. Automated event detection algorithms process a daily ranked set of possible disease outbreaks, which are presented to IDSP and PHC staff.
5. List of possible outbreaks examined by IDSP and PHC staff to determine likelihood of an adverse event.
6. Confirmed adverse events disseminated to Medical Officers, HIs, nurses, and other health officials, within affected geographic area.
7. Condensed version of the alert pushed through SMS to get immediate attention of the recipients.
8. More descriptive message emailed and published on the web (also accessible through mobile phone).
Research Question: “Can software programs that analyze health statistics and mobile phone applications that send and receive the health information potentially be effective in the early detection and mitigation of disease outbreaks?”

**mHealthSurvey** a data entry software works on any standard Java mobile phone. A typical record contains the patient visitation date, location, gender, age, disease, symptoms, and signs. Data is transmitted over GPRS cellular networks.

**T-Cube Web Interface (TCWI)** is an Internet browser based tool to visualize and manipulate large spatio-temporal data sets. Epidemiologists can pin down a potential outbreak of, for instance, a gastrointestinal disease among children in the Sevanipatti PHC health division.

**Sahana Alerting Broker** (SABRO) allows for the generic dissemination of localized and standardized interoperable messages. Selected groups of recipients would receive the single-entry of the message via SMS, Email, and Web.
The research evaluation design in India and Sri Lanka

- 24 Health Sub Center Village Nurses
- 4 Public Health Center Sector Health Nurses, Health Inspectors, and Data Entry Operators
- 1 Integrated Disease Surveillance Program Unit of the Deputy Director of Health Services
- Thirupathur Block, Sivagangai District, Tamil Nadu, India

- 12 District/Base Hospitals and Clinics
- 15 Sarvodaya Suwadana Center Assistants
- 4 Medical Officer of Health divisions & 1 Regional Epidemiology Unit
- Kurunegala District, Wayamba Province, Sri Lanka
Progression of Dengue Fever outbreak in April – June 2009

First day an elevated global score noted, lead by region Kandy
Situation in Kandy intensified, together other regions
Southern Regions began to see increased cases
Southern region continue to see progression, while other region subsides
Dengue Fever Seasonal and spatial pattern

May 1, 2007

May 21, 2008

April 15, 2009

May 28, 2009

Aug 30, 2007
Most frequently occurring wide spreading infectious disease outbreaks

These findings are from TCWI's spatial scan algorithms

Common Cold, Sivaganga District – India, 18 outbreak episodes to date with over 23,188 cases.

Worm Infestation, Sivaganga District – India, 13 outbreak episodes to date with over 1,236 cases.

Dysentery, Sivaganga District – India, 5 outbreak episodes to date with over 1,541 cases.

Common cold is the most popular but gastrointestinal infectious are, relatively, the most visible

Cough, Kurnegala District – Sri Lanka, 11 outbreak episodes to date with over 12,100 cases.

Respiratory Tract Infection, Kurnegala District – Sri Lanka, 09 outbreak episodes to date with over 18,547 cases.

Tonsilitis, Kurnegala District – Sri Lanka, 07 outbreak episodes to date with over 5,086 cases.

Respiratory infectious diseases, a correlated with environmental factors, are the most common
Hypertension (High Blood Pressure) has a linearly increasing trend over the one year period in both countries with Females and Males over 45 years of age showing to be the most vulnerable. The trend in India shows an unusual increase between March and May 2010; while the reported cases are consistent throughout the year in Sri Lanka.

Diabetes-Mellitus has a linearly increasing trend over the one year period in both countries with Indians over 40 years of age and Sri Lankan over 45 years of age to be the most vulnerable groups.

Given that the Male to Female ratios, approximately, in Tamil Nadu, India and Kurunegala, Sri Lanka are both 1 : 1; statistics to date show females to be more susceptible to the above mentioned life style diseases.
Trends in selected Chronic disease

These findings are from TCWI's statistical estimation and pivot table analysis methods

**Arthritis and Rheumatoid-Arthritis** has a linearly stagnate trend over the one year period in both countries with Males over 45 years of age and Females over 35 years of age to be the most susceptible in India; similarly Males over 45 and Females over 31 years of age to be the most vulnerable groups.

**Asthma** has a linearly decreasing trend over the one year period in both countries; the trend shows the counts to increase during the rainy season, India: Sept’09-Jan’10 and Sri Lanka: Nov ’09-Jan ’10. In India, only males over 45 years of age are affected but females in all age groups are affected. Both Male and Female over 31 years of age are in Sri Lanka are equally vulnerable.

Given that the Male to Female ratios, approximately, in Tamil Nadu, India and Kurunegala, Sri Lanka are both 1 : 1; statistics to date show females to be more susceptible to the above mentioned life style diseases.
# TCO macro level costs and the marginal differences

## Monthly district macro-costs and percentages for existing paper-based and introduced RTBP

<table>
<thead>
<tr>
<th>Macro-cost</th>
<th>Existing (IN)</th>
<th>RTBP (IN)</th>
<th>(IN)</th>
<th>Existing (LK)</th>
<th>RTBP (LK)</th>
<th>(LK)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cost USD</td>
<td>% of total</td>
<td>Cost USD</td>
<td>% of total</td>
<td>Diff %²</td>
<td>Cost USD</td>
</tr>
<tr>
<td>System delivery</td>
<td>5.00</td>
<td>0.02</td>
<td>66.00</td>
<td>0.50</td>
<td>92.42</td>
<td>40.00</td>
</tr>
<tr>
<td>System Admin/support</td>
<td>400.00</td>
<td>1.50</td>
<td>470.00</td>
<td>3.57</td>
<td>14.89</td>
<td>60.00</td>
</tr>
<tr>
<td>Data center</td>
<td>130.00</td>
<td>0.49</td>
<td>236.00</td>
<td>1.79</td>
<td>44.92</td>
<td>283.00</td>
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<tr>
<td>Health facility</td>
<td>3,158.00</td>
<td>11.82</td>
<td>8,168.00</td>
<td>61.98</td>
<td>61.34</td>
<td>2,370.00</td>
</tr>
<tr>
<td>Health department</td>
<td>16,652.00</td>
<td>62.31</td>
<td>2,359.00</td>
<td>17.90</td>
<td>-605.89</td>
<td>7,120.00</td>
</tr>
<tr>
<td>Health worker</td>
<td>6,378.00</td>
<td>23.87</td>
<td>1,880.00</td>
<td>14.27</td>
<td>-239.26</td>
<td>8,633.00</td>
</tr>
</tbody>
</table>

System delivery, system support, and data center costs are < 7% of overall cost; hence the focus of the economic analysis is on the bulk: health facilities, health departments, and health workers.

### Explanation of marginal difference of RTBP macro cost > 20% than existing system

**System delivery ::** unable to get actual program design, development, and implementation cost, most likely funded by INGO, however, the per district monthly cost is very small.

**System Admin/Support ::** no established budget, each department spends money for repairs as and when needed. RTBP accounts for it.

**Data Center ::** India – DPH&PM system is one component of several managed by the National Information Center, in comparison to decentralizing the data centers to be managed at districts.

**Health Facilities ::** major portion of the cost is the new human resource bundled with technology for health record digitization.
Incremental Cost Effectiveness Ratios (ICER)

Going from Existing system to RTBP

**Data collection** – cheaper, more data, more attributes, data available same day *(No further analysis required)*

**Event Detection** – cheaper in Sri Lanka, almost same in India, real-time/automated event detection, reports at the touch of a button, globally accessible, no humans needed to feed data, better visualization and analystcs (no further analysis required)

**Alerting** – new investment and new concept but health workers will be better informed of the regional health status for preparedness and early response *(needs further analysis)*

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**ICER - India**

- **Existing**
  - Expensive & ineffective → resource unacceptable
  - Cheaper & ineffective → needs further analysis

- **RTBP**
  - Expensive & effective → resource unacceptable
  - Cheaper & effective → no further analysis

**ICER - Sri Lanka**

- **Existing**
  - Expensive & ineffective → needs further analysis
  - Cheaper & ineffective → needs further analysis

- **RTBP**
  - Expensive & effective → needs further analysis
  - Cheaper & effective → no further analysis

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**Graphs**

- **Monthly District Cost (USD)**
  - Existing: 25,000.00, 20,000.00, 15,000.00, 10,000.00, 5,000.00, 0.00
  - RTBP: 20,000.00, 15,000.00, 10,000.00, 5,000.00, 0.00

- **Number of Diseases (case records/Month)**
  - Existing: 77 (600), 117 (6175)
  - RTBP: 25 (70), 179 (22835)
Total Cost of Ownership by function and by entity

Comparison of expenses in relation to the data collection, event detection, and alerting components

- **Subsystems cost comparison India and Sri Lanka**
  - existing paper-based vs introduced RTBP

- ** Investments are very little or none on real-time event detection and alerting, ~ 88% in data collections**

- **RTBP can reduce TCO > 35%, moreover, increase timeliness, and introduce rapid detection and alerting**

- **Existing trend analysis is for long term planning only but with a lot of replicate data-entry at the various layers.**

Comparison of expenses in relation to the health facility, health department, and health workers

- **Digitization at the point of care removes bulk of the work at health department.**

- **Health facility investments are higher in RTBP because of bundling mHealth with new resource person.**

- **However, health facility cost increase < health department money saved; India: 61% < 86%, Sri Lanka: 72% < 87%**

- **Introducing new concept of situational-awareness empowers health workers**

[Existing (IN) = present system in India (Integrated Disease Surveillance Program); Existing (LK) = present system in Sri Lanka (Disease Surveillance and Notification Program); RTBP (IN), RTBP (LK) = Real-Time Biosurveillance Program in India and Sri Lanka, respectively]
Conclusions

- RTBP costs are less, benefits are greater, and efficiency gains are higher than the existing disease surveillance and notification systems.
- The laws and regulations must be changed to replace the legal paper forms and registers with Electronic Health Records (EHR).
- EHR trust, security, privacy, and unique identifiers must be addressed before a national implementation.
- Be ready to accept change; especially the paradigm of comprehensive disease and syndromic active surveillance.
- There is a severe cost associated with false alarms (false positives) and missed alarms (false negatives), not embedded in this economic analysis.