Computing and Global Health
Lecture 7
Treatment support and mobile devices

Winter 2015
Richard Anderson
Today’s topics

• Aditya Vashistha
  – Voice based messaging

• Treatment Support
  – Adherence
  – Protocol Support
  – Diagnostics

• Gadgets
  – Hijack
  – ODK Sensors
  – FoneAstra
  – Partopen
  – CellScope
  – ColdTrace
Readings and Assignments

• Readings
  – eIMCI
  – CellScope
  – Hijack

• Homework 6
  – Design an SMS syntax for cold chain reporting

• Homework 7
  – Paper prototype of medical protocol
    • Details TBD

• Homework 8
  – Open Data Kit

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 7, 2015</td>
<td>Overview</td>
</tr>
<tr>
<td>Jan 14, 2015</td>
<td>Surveillance</td>
</tr>
<tr>
<td>Jan 21, 2015</td>
<td>Tracking</td>
</tr>
<tr>
<td>Jan 28, 2015</td>
<td>Medical records</td>
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<tr>
<td>Feb 4, 2015</td>
<td>Logistics</td>
</tr>
<tr>
<td>Feb 11, 2015</td>
<td>Patient support</td>
</tr>
<tr>
<td>Feb 18, 2015</td>
<td>Treatment support</td>
</tr>
<tr>
<td>Feb 25, 2015</td>
<td>Health worker support</td>
</tr>
<tr>
<td>Mar 4, 2015</td>
<td>Behavior change</td>
</tr>
<tr>
<td>Mar 11, 2015</td>
<td>Finance</td>
</tr>
</tbody>
</table>
Homework 7: SMS Reporting
Homework 7: Solutions

<table>
<thead>
<tr>
<th>Data Record</th>
<th>Symbol</th>
<th>Complete Syntax</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly temperature</td>
<td>MT</td>
<td>MT (mm yy) [fridge letter] H [0-5] C [0-5]</td>
<td>MT a H 3 C 4 f H 0 C 0 c H 1 C 0</td>
</tr>
<tr>
<td>Monthly Stock</td>
<td>MS</td>
<td>MS (mm yy) [vaccine short code] [0-999]</td>
<td>MS pcv13 33 rv5 2</td>
</tr>
<tr>
<td>Stock Out</td>
<td>SO</td>
<td>SO [vaccine short code]</td>
<td>SO pcv13</td>
</tr>
<tr>
<td>Refrigerator Failure</td>
<td>RF</td>
<td>RF [fridge letter]</td>
<td>RF a b c</td>
</tr>
<tr>
<td>Refrigerator Repair</td>
<td>RR</td>
<td>RR [fridge letter]</td>
<td>RR a b c</td>
</tr>
<tr>
<td>Temperature failure</td>
<td>TF</td>
<td>TF [fridge letter]</td>
<td>TF d</td>
</tr>
</tbody>
</table>

**SUBMIT DATA**

These commands submit data to a central database. They all follow the same pattern: Command ID (CID), Facility ID (FID), Command Data (CDATA), and Terminator (“#”):

```
[CID][FID][CDATA]#
```

**FACILITY IDENTIFIER (FID)**

All data submissions require a prefix which identifies the province, district, and facility number in the form of:

```
[PD][DD][FF]#
```

For example, for facility # in district 17 in province 8, the FID would be 081708

**[help] OR**

- [optional 6 digit facility code] followed by
  - [digit: days high] [digit: days low] [character: a-z fridge ID]
  - [digit: quantity] [stock prefix non-digit character, e.g. pen for pentavalent vaccine]
  - [query] [stock or fridge prefix, e.g. a-z or pen for pentavalent vaccine]
  - [emergency] followed by
    - [any stock prefix]
    - [refrigerator]
    - [temperature]
Medication Adherence

• TB and HIV
  – Concerns about drug resistant strains

• Adherence obstacles
  – Side effects, inconvenience, perceived cure, stigma
Adherence

• Direct Observation Therapy
  – Health worker observes daily medication
    • Home or clinic
    • Considered burdensome
  – Variations
    • Family member observes
    • Pick up medication every few days

WHO TB Strategy
Pursue high-quality DOTS expansion and enhancement
1. Secure political commitment, with adequate and sustained financing
2. Ensure early case detection, and diagnosis through quality-assured bacteriology
3. Provide standardized treatment with supervision, and patient support
4. Ensure effective drug supply and management
5. Monitor and evaluate performance and impact
TB Drug Distribution

• Fingerprint scanning in drug distribution
  – Reduce record keeping and increase accuracy
  – Verification of drug pick up
  – Allow follow up of non-compliant
SMS Reporting

• Send confirmation code associated with each pill to a given number
Pill box notifications

- Pill box records openings
- Dispense a fixed amount each day
- SimPill – built in SMS modem and simcard
  - Automatic notifications
  - Initial development for low resource settings but commercialized for developed world
Delivery of health services

• Routine care delivered by Nurses or CHWs

• Problems to solve
  – Consistent delivery of services
    • Standards based
    • Competent
  – Availability
  – Appropriate escalation and referral
Vision versus reality
IMCI

- WHO Designed protocol on diagnosing/treating childhood illness
- Step through diseases with flow chart
- Target nurses/health workers
- Standardize care
IMCI

For ALL sick children ask the mother about the child's problem, check for general danger signs, ask about cough or difficult breathing, diarrhoea and then ASK: DOES THE CHILD HAVE FEVER?

**Does the child have fever?**

*(by history or feels hot or temperature 37.5°C or above)*

**IF YES:**

- Decide the Malaria Risk: High or low

**THEN ASK:**

- For how long?
- If more than 7 days, has fever been present every day?
- Has the child had measles within the last 3 months?
- Look and feel:
  - Look and feel for stiff neck.
  - Look for runny nose.
  - Look for signs of MEASLES
  - Generalized rash and
  - One of these: cough, runny nose, or red eyes.
- If the child has measles now or within the last 3 months:
  - Look for mouth ulcers.
  - Are they deep and extensive?
  - Look for discharging from the eye.
  - Look for clouding of the eyes.

**CLASSIFY** the child's illness using the colour-coded classification tables for fevers.

Then ASK about the next main symptom: ear problem, and CHECK for malnutrition and anaemia, immunization status and for other problems.

**EXAMPLE 11: CLASSIFICATION TABLE FOR LOW MALARIAS RISK AND NO TRAVEL TO A HIGH RISK AREA**

<table>
<thead>
<tr>
<th>SIGN</th>
<th>CLASSIFY X</th>
<th>IDENTIFY TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>All general danger</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sign high back</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes or new rash and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO results of fever</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malaria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All new cases of fever</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes or new PREGNANCY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHILDREN ONLY</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**EXAMPLE 6: CLASSIFICATION TABLE FOR DIARRHOEA**

<table>
<thead>
<tr>
<th>SIGN</th>
<th>CLASSIFY X</th>
<th>IDENTIFY TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two of the following</td>
<td></td>
<td></td>
</tr>
<tr>
<td>signs:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diarrhoea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fever</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe dehydration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For ALL sick children ask the mother about the child's problem, check for general danger signs, ask about cough or difficult breathing and then ASK: DOES THE CHILD HAVE DIARRHOEA?

**Does the child have diarrhoea?**

**IF YES:**

- For how long?
- Is there blood in the stool?
- Look and listen, feel:
  - Look at the child's general condition.
  - Look at the child's general condition.
  - Look for sunken eyes.
  - Offer the child fluid: is the child able to drink or drinking poorly?
  - Drinking urgently, thirsty?
  - Pinch the skin of the abdomen: does it go back very slowly (longer than 2 seconds) or slowly?

**CLASSIFY** the child's illness using the colour-coded classification tables for diarrhoea.

Then ASK about the next main symptoms: fever, ear problem, and CHECK for malnutrition and anaemia, immunization status and for other problems.
Tanzania e-IMCI Study

• Implement IMCI on a PDA

• Goal:
  – Demonstrate improved compliance to IMCI protocol
  – No increase in time of visits
Open Data Kit 1.0

• Collect
  – Forms based data collection application running on Android device

• XLSForm
  – Form creation tool reading in Excel spreadsheet

• Aggregate
  – Backend server to receive data
IMCI to ODK

- Convert IMCI Protocol to decision tree
- Encode in forms
- Establish branching logic
- Implement in spreadsheet
  - Compile to ODK

- Challenges
  - Extracting the decision tree
  - Verification of wording and workflow
  - Usability

- Medical review of IMCI
  - Difficulty in adapting protocol
  - Official approval of protocol
  - Determining correspondence of electronic and paper version
IMCI + Pulse Oximetry

• Measure blood oxygen level
• Low oxygen levels can indicate pneumonia
• Add blood oxygen level into pneumonia questions
• Pulse oximeter connected to mobile phone so readings entered automatically
Diagnostics

• Issues
  – Cost of test
  – Precision of test
  – Accuracy of test
    • Error profile
  – Action on positive test
  – Action on negative test
• Goals
  • Individual treatment
  • Public health goals

<table>
<thead>
<tr>
<th>Have disease</th>
<th>Don’t have disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>True Positive</td>
<td>False Positive</td>
</tr>
<tr>
<td>False Negative</td>
<td>True Negative</td>
</tr>
</tbody>
</table>
Lab Diagnostics

• Highly accurate tests
  – E.g., Enzyme-linked immunosorbent assay (ELISA)
  – Microscopy
• Requires infrastructure, trained staff, equipment
• Issues
  – Costs
  – Transport of samples
  – Delays in processing or notification
Lab Information System

- Internal lab management
- Tracking of samples and tests
- Interoperability with medical records
- Notifications
- Probably not much difference between developed and developing world
Rapid Diagnostic Tests

- **Point of Care Tests**
  - Deliver results without sending test to lab
  - Fast turn around
  - Limited test preparation

- **Lateral flow immunochromatographic assays**

- **Large number of tests available**
  - Blood, Urine
  - HIV, Malaria, Syphilis
ODK Diagnostics

- Nicki Dell, Gaetano Borriello
- Image analysis on Smartphone to read RDT
  - Computation done locally
  - Template to adapt to multiple tests
- Use cases
  - Enable lesser trained health workers to conduct tests
  - Support tests which are not frequently used
  - Supervision
  - Quality control
- Field trials
  - Zimbabwe
Gadgets
Hijack

- Sensor interface through audio jack
- EKG Interface
- Soil temperature monitor
- UBC Pulse Oximeter for iPhone
- HIV Diagnostic

Figure 14: The HiJack base platform, with a 1” x 1” footprint, offers power (>5 mW), analog (2x 12-bit), digital (1x GPIO), and serial (1x I2C and 1x UART) interfaces, exported via connectors, and all multiplexed over the headset port. This board provides the functionality needed to build a variety of external sensor interfaces for the mobile phone.
Smartphone for point of care diagnosis

- Recent press attention on HIV/Syphilis diagnosis by Columbia University
- Laboratory quality immunoassay
- Ultra low power
- Power from cell phone
  - iPhone = Battery
  - Signal processing on cell phone to generate results
ODK Sensors

• Build a user-level sensing framework with sensor drivers
  – No operating system modifications
  – Allows convenient reuse between applications

• Create a single sensor interface
  – Access wired, wireless, and built-in sensors
  – Support multiple sensors over multiple channels

• Focus on ease of deployment and development
  – Distribution through existing app store model
  – Reduce complexity
  – Without adverse effects on performance
Fone Astra

- Sensor connection to low cost phone
  - Phone for communication and output
- $25 board + $25 phone
- Temperature monitoring
Android Fone Astra

• Version 2 of FoneAstra replaced basic phone with Android phone
• Communication by bluetooth or USB
• Separate power for FoneAstra device
• Programmability and UI on phone
Milk Pasteurization

• Human milk pasteurization
• Replace high price pasteurizer with hotplate
• Temperature monitoring to ensure proper heating and verify quality
PartoPen

• Paper record of birth progress
  – Plot dilation versus time
  – Too slow, issue an alert

• Idea
  – Implement using a LiveScribe digital pen

• Deployment
  – Nurses in Kenya, in both training and practice
Cell Scope

• UC Berkeley project
  – Dan Fletcher, Bioengineering
  – Build a cheaper microscope for diagnostics
Cold Trace

- Remote temperature monitoring
- Connection through audio port to Android phone
- Deployments now rely on a single model of low cost Android phone
- Well engineered product with substantial support
- Need for multi sensor device
Next week

• Supporting the health worker