Knowledge Management (IT): What do we need and what do we have?

Part 2

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Overview

• The need for excellent information management for treatment scale up
• Existing tools:
  – PIH-EMR,
  – drug supply chain management and forecasting
  – Laboratory reporting tools
• Evidence of benefits of existing systems
• Standards based systems for creating national eHealth systems: OpenMRS
The PIH-EMR (2001 – present)

- A secure (SSL) web based electronic medical record using a relational database
- Standard technology, open, shared code
- Designed to be usable over low-speed dialup connections
- Bilingual: English/Spanish
- Views for
  - Clinical care
  - Drug management
  - Analysis for patient monitoring and research
  - Laboratory reporting and quality control
- Over 10,500 patients started or completed RX

Smears
Cultures
Drug sensitivity

Biochem.
Hematology

Registration form
History/exam
Previous Rx
Previous Dx
Contacts

Follow up
Chest X-ray

Drug regimens
Pharmacy
Drug order entry system evaluation

Percentage of medication in errors in EMR per patient.

<table>
<thead>
<tr>
<th>Date/Site</th>
<th>Callao</th>
<th>Lima Este</th>
</tr>
</thead>
<tbody>
<tr>
<td>active</td>
<td>control</td>
<td></td>
</tr>
<tr>
<td>December 02</td>
<td>17.4%*</td>
<td>8.6%**</td>
</tr>
<tr>
<td>April 03</td>
<td>3.1%*</td>
<td>6.9%**</td>
</tr>
</tbody>
</table>

*P = 0.0075  \[**P = 0.66,\]
Wilcoxon signed-rank test

Most errors were delays in updating regimens

Predicting MDR TB drug needs

Patient recruitment 1996-2005

Length of time in treatment

- **Medication**
- **Form of drug**
- **Total quantity required**
- **Estimate for all patients**
- **Price per unit**
- **Total cost for this drug**

<table>
<thead>
<tr>
<th>Medication</th>
<th>Form of drug</th>
<th>Total quantity required</th>
<th>Estimate for all patients</th>
<th>Price per unit</th>
<th>Total cost for this drug</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amikacin</td>
<td>Ampoule x 1g</td>
<td>47</td>
<td>47 x $0.3</td>
<td>$14.1</td>
<td></td>
</tr>
<tr>
<td>Amikacin</td>
<td>Ampoule x 500mg</td>
<td>0</td>
<td>0 x $0.0</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>Amox/Clav</td>
<td>Tablet x 500mg</td>
<td>7786</td>
<td>7786 x $0.196</td>
<td>$154.09</td>
<td></td>
</tr>
<tr>
<td>Amox/Clav</td>
<td>Tablet x 1g</td>
<td>0</td>
<td>0 x $0.4</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>Capreomycin</td>
<td>Ampoule x 1g</td>
<td>5887</td>
<td>5887 x $3.60</td>
<td>$21564.16</td>
<td></td>
</tr>
<tr>
<td>Ciprofloxin</td>
<td>Tablet x 250mg</td>
<td>0</td>
<td>0 x $0.057</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>Ciprofloxin</td>
<td>Tablet x 500mg</td>
<td>25095</td>
<td>25095 x $0.0284</td>
<td>$712.7</td>
<td></td>
</tr>
<tr>
<td>Clarithromycin</td>
<td>Tablet x 500mg</td>
<td>1143</td>
<td>1143 x $3.09</td>
<td>$3551.87</td>
<td></td>
</tr>
</tbody>
</table>
Quantification for MDR TB drugs

- Recruitment rate
- Time in treatment
- Proportion of patients on each drug

Predicted/prescribed for 13 drugs

<table>
<thead>
<tr>
<th>Year</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>Mean all years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>97.4%</td>
<td>100.1%</td>
<td>97.0%</td>
<td>94.1%</td>
<td>97.2%</td>
</tr>
<tr>
<td>St Dev</td>
<td>15.4%</td>
<td>3.4%</td>
<td>10.9%</td>
<td>7.8%</td>
<td></td>
</tr>
</tbody>
</table>

(two 6 month estimates are combined for each year).
Tracking and communicating smear, culture and DST results
# Palm Project: evaluation study results

## Median processing time

<table>
<thead>
<tr>
<th>Intervention Districts days (n)</th>
<th>Control Districts days (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-Palm</strong></td>
<td></td>
</tr>
<tr>
<td>30.5 (4876)*</td>
<td>30.8 (5954)</td>
</tr>
<tr>
<td><strong>Post-Palm</strong></td>
<td></td>
</tr>
<tr>
<td>7.7 (2890)*†</td>
<td>22.7 (3263)†</td>
</tr>
</tbody>
</table>

* p < 0.001
† p < 0.001

## Frequency of Errors

- * p < 0.001
- ‡ p = 0.055

*Blaya JA, et al, IJID 2008, in press*
Requirement: a general purpose medical record system architecture

- Simple to setup
- Local users can create EMR forms and reports
- Web based (but can also be run locally)
- Open standards for data exchange
- Fully open source
  - supported by a community of programmers
  - using best ideas and software from many projects
  - can run on multiple computing platforms

- Able to be setup, modified and owned by the countries where we work, not just a “present from the US” but a full transfer of technology, skills and ownership
OpenMRS: Open Source, modular EMR system

- Modular design simplifies adding new functions and linking to other systems
- Supports multiple languages
- Uses concept dictionary for data storage
  - Allows sharing of data dictionaries and joint reporting across sites
- Source code released to public with open source license (April 2007)
• We created new forms, reports and workflows based on:
  • WHO guidelines for MDR-TB treatment
  • seven-year experience with the PIH-EMR in Peru
• Also supports the treatment of HIV and soon other diseases in the same system
Bacteriology data

Bacteriology management tools include a customizable timeline of smears, cultures, treatment status dates, culture conversion dates, and other clinical observations.

<table>
<thead>
<tr>
<th>sample collection date</th>
<th>smear</th>
<th>culture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 2, 2008</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Apr 2, 2008</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Apr 3, 2008</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Apr 10, 2008</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>May 1, 2008</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>May 6, 2008</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>May 10, 2008</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Multi-drug resistant tuberculosis culture status: converted</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Downloading OpenMRS program and source code

Main OpenMRS site:
www.openmrs.org

In use in 11 countries, supported by a community of programmers on 5 continents

MDR-TB implementation with Windows XP installer:
resources.openmrs.org/mdrtb/OpenMRS_install_mdrtb.zip
Architecture for integrated national medical information system

Example systems

- National reporting system
  - DHIS, ETR.Net
  - IXF

- Pharmacy system
  - PIH Haiti, MSH Brazil
  - HL7

- EMR System
  - OpenMRS
  - HL7

- Patient registration and tracking
  - OpenROSA
  - HL7

- Mobile health systems
  - OpenROSA

- Laboratory System
  - OpenELIS
  - STARLims
  - HL7
  - Dicom

- Radiology information system
  - HL7
Open standards and interoperability

• It is essential the systems are designed with compliance with open standards

• One size doesn’t fit all!

• Leverage the expertise and experience of groups in each area:
  – Laboratory, Pharmacy, EMR, Reporting and surveillance

• Business as usual is hundreds of incompatible systems with limited functionality and high cost
Conclusions

• Information systems have an essential role in scale-up of MDR-TB treatment

• Successful systems have been in use for several years including Peru, Brazil, Romania, Philippines, etc.

• There are studies showing benefits from such systems in process and delivery of care as well as reporting

• Open standards for data exchange are essential in scaling information systems and reducing costs.

• Open source software allow the creation of better, more available tools and allow local communities to build and modify them
Collaborators and Funders

- Partners In Health
- Regenstrief institute
- World Health Organization
- Centers for Disease Control
- Brigham and Women hospital
- Harvard Medical School
- University of KwaZulu-Natal
- Millennium Villages Project
- International Development Research Centre
- Rockefeller Foundation
- Fogarty International Center, NIH
- Google Inc