Rolling out OpenMRS in Rwanda

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Background of EMR in Rwanda

- PIH-EMR in Peru
- HIV-EMR in Haiti and Rwanda
- Scale up of HIV treatment in Rwanda
- OpenMRS motivation
- The challenge of setting up in Rwanda
- Rollout plan
The PIH-EMR

- A secure (SSL) web based electronic medical record based on a relational database
- Open source, open standards
- Designed to be usable over low-speed dialup connections
- Bilingual: English/Spanish
- Data entry mainly in Lima, Peru
- 5100+ patients today
Clinical data collected

- The patient's clinical status
- Bacteriology results
- Drug sensitivity testing results
- The current drug regimen.
- Previous drug regimens.
- Bio-chemistry and hematology results
- Drug complications and adverse events.
- Chest x-ray (CXR) reports and digital images.
- Background data (occupation, housing, contacts)
Key Functions

- Clinical care
- Monitoring and reporting
- Drug supply management
- Socio-economic factors
- Research
Clinical functions
CD4 Counts

- CD4s done at labs in two clinic sites
- Results communicated to remote sites by email (paper results follow later)
- Doctors get email alerts when their patients’ CD4 counts are below 350

Subject: HIV-EMR: Today's Low CD4 Results
X-OriginalArrivalTime: 31 Oct 2003 04:29:08.0109 (UTC)
FILETIME=[865B63D0:01C39F67]

Resultats bas de CD4 de 29/10/2003
Commune = Thomonde

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>195</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>70</td>
</tr>
</tbody>
</table>
**Decision support tools for drug regime entry**

**Drug combinations**

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**Regime contre VIH:**
- D4T
- NTRI
- NNTRI / PI
- Date du début: 10 j. AVR. 2003

**Signe:** MD

**Etablir**

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**Allergies**

Si le patient prend plus de 5 médicaments, complétez cette forme plus d'une fois. *Spéciﬁez régime complété*

<table>
<thead>
<tr>
<th>Médicament, Dosage, et Unité</th>
<th>Date du début</th>
<th>Duration (jours)</th>
<th>Dose quotidienne</th>
<th>Matin/Midi/Nuit</th>
<th>Par semaine (1-7)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regime contre VIH</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stavudine (40 mg)</td>
<td>10 j. AVR. 2003</td>
<td>8</td>
<td>2.0</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Nevirapine (200 mg)</td>
<td>10 j. AVR. 2003</td>
<td>14</td>
<td>1.0</td>
<td>1.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Nevirapine (200 mg)</td>
<td>24 j. AVR. 2003</td>
<td>8</td>
<td>2.0</td>
<td>2.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**Ce patient est allergique à Nevirapine** *(voir Données de Base) (changer médicament)*

**INH Prophylaxis**

<table>
<thead>
<tr>
<th>Médicament, Dosage, et Unité</th>
<th>Date du début</th>
<th>Duration (jours)</th>
<th>Dose quotidienne</th>
<th>Matin/Midi/Nuit</th>
<th>Par semaine (1-7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isoniazide (100 mg)</td>
<td>10 j. AVR. 2003</td>
<td>8</td>
<td>3.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>
Using a Palm Pilot based system to collect smear and culture results from clinics (Peru)
Status of Palm System (Peru)

- The pilot in two health districts
- Data quality was compared between the paper register and the Palm system
- Delay in entering data into the system reduced:
  - baseline 54.8 days
  - control 64.4 days
  - intervention 6.2 days  (both comparisons $p<0.0001$)
- Frequency of data discrepancies reduced:
  10.1% to 2.8% ($p<0.0001$)
- Staff work load reduced by 40%
- Staff requested the system for all districts

Joaquin Blaya
# Prediction of drug requirements (Peru)

One month's medication for MDR-TB

## Analysis of monthly drug requirements

<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>(Amphic x 1 g)</td>
<td>47</td>
<td>47 x $0.3 = $14.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amikacin</td>
<td>(Amphic x 500mg)</td>
<td>0</td>
<td>0 x $0 = $0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amox/Clav</td>
<td>(Tablet x 500mg)</td>
<td>7786</td>
<td>7786 x $0.1936 = $1554.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amox/Clav</td>
<td>(Tablet x 1 g)</td>
<td>0</td>
<td>0 x $0.4 = $0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capreomycin</td>
<td>(Amphic x 1 g)</td>
<td>5887</td>
<td>5887 x $3.68 = $21864.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ciprofloxin</td>
<td>(Tablet x 250mg)</td>
<td>0</td>
<td>0 x $0.057 = $0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ciprofloxin</td>
<td>(Tablet x 500mg)</td>
<td>25095</td>
<td>25095 x $0.0284 = $712.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clarithromycin</td>
<td>(Tablet x 500mg)</td>
<td>1143</td>
<td>1143 x $3.09 = $3531.87</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Days in treatment for all patients 1996 - 2004

![Graph showing the proportion in therapy over days from 1996 to 2004.](image)
### Results of three years drug data for Peru

<table>
<thead>
<tr>
<th>Year</th>
<th>Doses (Millions)</th>
<th>Predicted/ Prescribed</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>2.6</td>
<td>117%</td>
<td>23%</td>
</tr>
<tr>
<td>2003</td>
<td>3.7</td>
<td>95%</td>
<td>6%</td>
</tr>
<tr>
<td>2004</td>
<td>3.4</td>
<td>98%</td>
<td>31% (21%)</td>
</tr>
</tbody>
</table>

*Darius Jazayeri, Katherine Kempton, Libby Levison*
Why OpenMRS

- A system that can be ported and configured:
  - many sites,
  - many work practices
  - many diseases
- New forms and reports do not need advanced programming
- Open API for collaboration and linking to other systems
- Open Source
- Not the sole proprietor of all the systems...
OpenMRS rollout plan

1. Development of standard forms
2. Creation of concepts for form items not already in the concept dictionary
3. Development of forms from schema
4. Development of standard reports
5. Data migration from existing EMR system
6. Set-up hardware and network infrastructure
7. Data management team
8. Train staff
Concept creation

- Be conservative – use existing concepts if possible but don’t modify them
- Ensure that the forms are well designed and reviewed
  - Poorly designed questions will create poor concepts
  - Create coded concepts to avoid making multiple similar versions of items like TB, Malaria etc.
<table>
<thead>
<tr>
<th>Id</th>
<th>992</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locale</td>
<td>English</td>
</tr>
<tr>
<td>Name</td>
<td>PREVIOUS DIAGNOSIS</td>
</tr>
<tr>
<td>Short Name</td>
<td>Previous Dx present</td>
</tr>
<tr>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>Synonyms</td>
<td></td>
</tr>
<tr>
<td>Class</td>
<td>Question</td>
</tr>
<tr>
<td>Datatype</td>
<td>Coded</td>
</tr>
<tr>
<td>Answers</td>
<td></td>
</tr>
<tr>
<td>DERMATITIS (119)</td>
<td></td>
</tr>
<tr>
<td>EPILEPSY (155)</td>
<td></td>
</tr>
<tr>
<td>SEXUALLY TRANSMITTED INFECTION (174)</td>
<td></td>
</tr>
<tr>
<td>DIABETES MELLITUS (175)</td>
<td></td>
</tr>
<tr>
<td>CANDIDIASIS (204)</td>
<td></td>
</tr>
<tr>
<td>HEPATITIS (29)</td>
<td></td>
</tr>
<tr>
<td>ANEMIA (3)</td>
<td></td>
</tr>
<tr>
<td>PNEUMONIA (43)</td>
<td></td>
</tr>
<tr>
<td>NEPHROPATHY (5025)</td>
<td></td>
</tr>
<tr>
<td>TUBERCULOSIS (58)</td>
<td></td>
</tr>
<tr>
<td>PERIPHERAL NEUROPATHY (821)</td>
<td></td>
</tr>
<tr>
<td>HERPES ZOSTER (836)</td>
<td></td>
</tr>
<tr>
<td>HYPERTENSION (903)</td>
<td></td>
</tr>
<tr>
<td>ENTEROPATHY (993)</td>
<td></td>
</tr>
</tbody>
</table>

Done
**Re-use of the same sub-concepts**

<table>
<thead>
<tr>
<th>Id</th>
<th>1375</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locale</td>
<td>English</td>
</tr>
<tr>
<td>Name</td>
<td>CLINICAL IMPRESSION QUESTION</td>
</tr>
<tr>
<td>Short Name</td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td>Clinical impression concept with coded answers for the possible diseases. May be linked to more detail on the diseases as part of a concept set.</td>
</tr>
<tr>
<td>Synonyms</td>
<td></td>
</tr>
<tr>
<td>Class</td>
<td>Question</td>
</tr>
<tr>
<td>Datatype</td>
<td>Coded</td>
</tr>
</tbody>
</table>
| Answers | MALARIA (123)  
WEIGHT LOSS GREATER THAN TEN PERCENT (1352)  
DIARRHEA ACUTE (1354)  
ENCEPHALOPATHY NON FOCAL (1361)  
CONVULSIONS OR FOCAL NEUROLOGICAL DEFICIT (1366)  
NODULAR RASH (1370)  
CHLAMYDIA TRACHOMATIS (1372)  
HERPES SIMPLEX GENITAL INFECTION (1373)  
SEXUALLY TRANSMITTED DISEASE OTHER (1374)  
VAGINITIS (139)  
SYPHILIS (223)  
PNEUMONIA (43)  
HIV STAGING - WEIGHT LOSS GREATER THAN TEN PERCENT (529) |
EMR Reports

- Standard reports for health ministry and funders
- Customized reports and data exploration tools
- Linking form generation and reporting
## Alerts generated from Rwanda HIV-EMR system this month

Overview of alerts for current patients

<table>
<thead>
<tr>
<th></th>
<th>&lt;57 kgs but on - 40 dose</th>
<th>&gt;63 kgs but on - 30 dose</th>
<th>low CD4, but no ARV</th>
<th>no weight in EMR</th>
<th>HIV+ but no CD4 in EMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rwinkwavu</td>
<td>5</td>
<td>1</td>
<td>12</td>
<td>60</td>
<td>68</td>
</tr>
<tr>
<td>Rukira</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>19</td>
<td>16</td>
</tr>
<tr>
<td>Rusumo</td>
<td>1</td>
<td>.</td>
<td>1</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Kirehe</td>
<td>1</td>
<td>.</td>
<td>.</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Mulindi</td>
<td>.</td>
<td>.</td>
<td>1</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Nyarubuye</td>
<td>2</td>
<td>.</td>
<td>.</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10</strong></td>
<td><strong>3</strong></td>
<td><strong>16</strong></td>
<td><strong>96</strong></td>
<td><strong>93</strong></td>
</tr>
</tbody>
</table>
Data migration from existing EMR

- Migration tools to automate translation
- Mapping files of existing database fields to OpenMRS concepts
- Mapping needs to be done by domain experts i.e. physicians, nurses, public health professionals
Hardware and infrastructure

- Where should the server be?
- What clients do we use?
- Local storage and synchronisation of data
- Backup systems
- Reliable low power clients
Internet access in Rwanda

“You guys are Crazy!”
Gates foundation, Haiti 2003

- Do we need it?
- How can we deliver it?
- What is the cost?
- What is the alternative?
- Low cost satellite systems and cellular networks
The HIV-EMR System

Linux Server
Oracle, Apache, Tomcat

CANGE

BOSTON

INTERNET

Web Browsers

Offline Application
stored cases

ROAMING DOCTOR

OTHER REMOTE SITES
Offline Application (Haiti)

- Internet may be unavailable for days
- Lightning season is particularly troublesome
- Offline EMR allows cases to be entered anytime, and cached for upload when the internet is available
Data management team

- Data manager
- Training system for data entry staff
- Data quality control
- Bridge with clinical staff for new forms and key data items
- Run the analysis and reporting systems
- PIH team lead by Patrick Manyika
Training of users and data management team

- Basic IT skills and hardware
- Basic medical knowledge and terminology
- Quality control and accuracy
- French and English skills?
Challenges

- Can we use the system for direct data entry as well as with paper forms and data entry staff?
- Installing the system in multiple sites and with users of varying experience
- Migrating data cleanly
- Open source benefits
- Interoperability,
- Edges of the initiative (Steve)
**MDR-TB**

- Key problem in many countries often linked to HIV in southern Africa
- Second disease type in OpenMRS
- Discussed tomorrow by Sharon Choi
Collaborators

- Brigham and Womens hospital/Harvard
- Regenstrief (US/Kenya)
- MRC (South Africa)
- WHO
- Baobab Health (Malawi)
- Rwandan government
- Peruvian HIV program
- Lesotho health ministry
Additional points

- Gates comment connectivity
- 100 laptop vs Gerry
- Cell phone and PDA
- Low cost satellite
- Supply chain and drug supply forecasting
- Palm project
- Open source benefits
- Interoperability, edges of the initiative