Implementing E-Health Systems in Low-Income Countries

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Predecessors of OpenMRS

• The Mosoriot Medical Record
  – MS Access based EMR developed at AMPATH in Kenya in 2000
  – Supported primary care and later HIV care
Predecessors of OpenMRS

• The PIH-EMR
  – Web based EMR system developed for MDR-TB and then HIV care in 2000-2003
  – Deployed in Peru, Haiti and Rwanda
A broad range of requirements
• Multiple countries and languages
• Multiple diseases
• Variable, generally low technical expertise
• Uncertain funding
• Sharing best practices designs, code, meta-data
• Building a community around innovation
• Supporting more complex and strategic capabilities
• Building capacity and local ownership in low income settings
OpenMRS: a modular, open source, EMR platform

- Uses concept dictionary for data storage
- Modular design simplifies adding new functions and linking to other systems
- Released with open source license (April 2007)
- Core of paid programmers with growing community support
- Clinical use in over 60 countries
- Secure logins and auditing of data access and changes
- Developed as a collaboration of PIH, the Regenstrief Institute and the South African MRC

www.openmrs.org
OpenMRS distributions

KenyaEMR

www.openmrs.org
# List of OpenMRS Distributions

## General Purpose and Targeted Distributions

<table>
<thead>
<tr>
<th>Distribution</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OpenMRS Reference Application</td>
<td>General Purpose</td>
<td>Maintained by the OpenMRS community, this distribution demonstrates how the platform’s capabilities can be used to build an EMR. You could use this out-of-the-box as a facility EMR, but it (currently) doesn’t have the complete EMR feature set. Learn more...</td>
</tr>
<tr>
<td>Bahmni</td>
<td>General Purpose - Hospitals and Large Clinics</td>
<td>Maintained by ThoughtWorks and the Bahmni community, Bahmni is an out-of-the-box EMR and Hospital Information System that can be configured without programming. Learn more...</td>
</tr>
<tr>
<td>eSaude</td>
<td>Targeted - Mozambique</td>
<td>Developed by the Mozambique regional OpenMRS community, eSaude. A tailored distribution of OpenMRS to provide point of care clinical patient registration and healthcare workflows on tablets for the MOH public health facilities. Learn more...</td>
</tr>
<tr>
<td>Kenya EMR</td>
<td>Targeted - Kenya</td>
<td>Developed by I-TECH, KenyaEMR is a tailored distribution of OpenMRS which meets the requirements laid out in the Kenya Ministry of Health document: 2011 Kenya EMR Standards and Guidelines. Learn more...</td>
</tr>
<tr>
<td>UgandaEMR</td>
<td>Targeted - Uganda</td>
<td>UgandaEMR is the custom implementation of OpenMRS in Uganda which is mandated by the Ministry of Health. Learn more...</td>
</tr>
</tbody>
</table>
OpenMRS spread: > 60 countries
2016 OpenMRS Annual Implementers meeting, Uganda

460 attendees

2016 OpenMRS Implementers’ Conference

OMRS16 marked the 7th annual global summit and was the largest meeting ever recorded with over 400 delegates from 26 different countries. Photos can be seen at om.rs/16photos

Importance of Open Systems

- Transparency
- Data access vs lock-in
- Cost effectiveness
- Local ownership
- Safety and quality control
- Expanding innovative ideas
OpenMRS Rollout in Rwanda

- Started in 2009 based on PIH experience
- Funded by the Global Fund and USAID/CDC
- Over 300 clinics and hospitals
  - 254 sites MOH alone
  - 11 with “Rwanda Health Information Exchange”
  - 39 sites with PIH support
- Currently MOH sites limited to collecting HIV data with a few supporting primary care
- Many sites still “getting up to speed”
MOH Clinic in Rwanda using OpenMRS

MOH Rwanda
Key processes in HIV care

- Case finding and VCT
- Registration in pre-ART care
- Monitoring clinical & lab status
- Starting on ART
- Drug supply management
- Ensuring adherence to Rx
- Monitoring side effects and opportunistic infections

HIV Care Pathway or HIV Treatment Cascade
Key processes in HIV care

- Case finding and VCT
- Registration in pre-ART care
- Monitoring clinical & lab status
- Starting on ART
- Drug supply management
- Ensuring adherence to Rx
- Monitoring side effects and opportunistic infections

HIV Care Pathway or HIV Treatment Cascade

Patient numbers?
### Clinical consults sheet for HIV care

**Health Center:**

**Group:**

**Date Generated:** 01 Apr 2013

<table>
<thead>
<tr>
<th>IMB ID</th>
<th>Name</th>
<th>Age</th>
<th>Weight</th>
<th>BMI</th>
<th>CD4</th>
<th>Decline</th>
<th>Viral Load</th>
<th>Last TB result</th>
<th>ARV (current regimen and start date)</th>
<th>ACCOMPAGNATUER</th>
<th>ALERTS</th>
<th>PRESENT</th>
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</thead>
<tbody>
<tr>
<td>1000</td>
<td>AAAAA</td>
<td>37</td>
<td>63.0</td>
<td>27.3</td>
<td>796</td>
<td>41@06/Jul11</td>
<td>NEGATIVE</td>
<td>Triomune-30 @12/Apr08</td>
<td>BBBB</td>
<td>CD4 decline(80).</td>
<td></td>
<td></td>
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<tr>
<td>1001</td>
<td>BBBBB</td>
<td>36</td>
<td>59.0</td>
<td>25.9</td>
<td>1243</td>
<td>39@06/Jul11</td>
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<td>CD4 decline(117).WT decline(8%,4kg)</td>
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<td></td>
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<tr>
<td>1002</td>
<td>CCCCC</td>
<td>36</td>
<td>45.0</td>
<td>16.3</td>
<td>492</td>
<td>19@25/Oct12</td>
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<td>Triomune-30 @21/Aug06</td>
<td>CCCC</td>
<td>Very low BMI(13.9).</td>
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<td></td>
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<tr>
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<td>DDDDD</td>
<td>38</td>
<td>32.0</td>
<td>13.9</td>
<td>463</td>
<td>39@06/Jul11</td>
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<td>AZT+3TC+NVP @30/Oct07</td>
<td>CCCC</td>
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<td></td>
<td></td>
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<tr>
<td>1004</td>
<td>EEEEEE</td>
<td>33</td>
<td>54.0</td>
<td>24.3</td>
<td>864</td>
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<td>TDF 300+3TC+NVP @17/Mar11</td>
<td>DDDDD</td>
<td>CD4 decline(51).Low BMI(17.9).</td>
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<td></td>
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<tr>
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<td>FFFFF</td>
<td>49</td>
<td>53.0</td>
<td>17.9</td>
<td>393</td>
<td>NEGATIVE</td>
<td></td>
<td>AZT+3TC+EFV @06/May08</td>
<td>EEEE</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Data quality

• Critical issue for all eHealth projects
• Not just a problem in low income settings or poorly designed systems
• Impacts all uses of eHealth data including clinical care, operational/management and research
• A major issue with scale up of decision support systems
• Often found out late with painful consequences…
Sites running OpenMRS in Rwanda

Red: MOH
Green: PIH
Purple: RHIE
CDC Operational Research Grant in Rwanda: Goals

- To determine the **performance, data quality and usability** of the OpenMRS system in the field
- To measure the **costs** of implementing and sustaining the system in the field
- To evaluate the **clinical impact** of the system on adult HIV care

“Evaluation of the clinical impacts and costs of eHealth in Rwanda using innovative frameworks and local capacity building”
Process evaluation of OpenMRS

- System Monitoring Tool
- Survey of OpenMRS users
- Formal data quality assessment (LQAS)
- Key informant interviews
- User observation

*Process evaluation of complex interventions: Medical Research Council guidance BMJ 2015; 350 doi: https://doi.org/10.1136/bmj.h1258*
System Monitoring Tool (SMT)

OpenMRS module that monitors 3 key functions:

- Server uptime during clinic hours
- System usage – new encounters and observations
- Data completeness for key variables: Viral load and CD4
- Logs versions of OS and software
- Data uploaded to DHIS2 instance daily when internet available, or manually in offline sites
<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>Facility</th>
<th>OpenMRS Uptime (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gatonde CS</td>
<td>28/02/2017</td>
<td>291</td>
<td>100</td>
</tr>
<tr>
<td>Gahanga CS</td>
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<td>31</td>
<td>79</td>
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<tr>
<td>Mwezi CS</td>
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<td>266</td>
<td>13</td>
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<tr>
<td>Mataba CS</td>
<td>28/02/2017</td>
<td>294</td>
<td>10</td>
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<tr>
<td>Kizibere CS</td>
<td>28/02/2017</td>
<td>120</td>
<td>41</td>
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<tr>
<td>Mukoma CS</td>
<td>28/02/2017</td>
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<td>29</td>
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<tr>
<td>Gisakura CS</td>
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<tr>
<td>Muramba CS</td>
<td>28/02/2017</td>
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<td>35</td>
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<tr>
<td>Karengera CS</td>
<td>28/02/2017</td>
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<tr>
<td>Rambura CS</td>
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<tr>
<td>Hanika I</td>
<td>28/02/2017</td>
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<td>52</td>
</tr>
<tr>
<td>Kivumu(rutsiro) CS</td>
<td>28/02/2017</td>
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<td>37</td>
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<tr>
<td>Ruhuha CS</td>
<td>28/02/2017</td>
<td>458</td>
<td>100</td>
</tr>
<tr>
<td>Save CS</td>
<td>28/02/2017</td>
<td>66</td>
<td>7</td>
</tr>
<tr>
<td>Karambi CS</td>
<td>28/02/2017</td>
<td>258</td>
<td>37</td>
</tr>
</tbody>
</table>

SMT data downloaded from DHIS2, (Michael Mugisha)
## SMT data summary (demo)

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>Server performance</th>
<th>OpenMRS Usage</th>
<th>Data quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gahanga CS</td>
<td>12/12/2016</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Jali CS</td>
<td>12/12/2016</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Kivumu CS</td>
<td>12/12/2016</td>
<td>Red</td>
<td>Red</td>
<td>Yellow</td>
</tr>
<tr>
<td>Busanza CS</td>
<td>12/12/2016</td>
<td>Green</td>
<td>Yellow</td>
<td>Green</td>
</tr>
<tr>
<td>Kiyanza CS</td>
<td>12/12/2016</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Gituku CS</td>
<td>12/12/2016</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Bitenga CS</td>
<td>12/12/2016</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
</tbody>
</table>
The PRISM Framework, example of a “log frame”

Anwer Aqil, Theo Lippeveld and Dairiku Hozumi. Health Policy and Planning 2009;24:217–228
Barriers to the success of an electronic pharmacovigilance reporting system in Kenya. An evaluation three years post implementation

Oscar Ogoro, Sarah Kibira, Jenny Freeman, Hamish Fraser

*Example study of eHealth system performance in the field*
The arrow shows point of introduction of the Electronic Reporting System
UMC – Uppsala Monitoring Centre
Methods

- Online survey of 115 pharmacists public hospitals in 4 districts
- Follow up by Whatsapp and email
- 103 responses, 89.5%
- Asked about factors affecting uptake of PV system identified in literature and how modifiable they were, plus section for free text comments
### Survey results

**Factors** | **Respondent Ratings in %** | **Chi-squared statistic on 4 d.f., p-value**
--- | --- | ---
**Most Likely**
Lack of internet access provision at the workplace | 36.9 | 37.9 | 4.9 | 13.6 | 6.8 | 54.04, p < 0.001
Unreliable internet coverage at the workplace | 37.9 | 31.1 | 10.7 | 13.6 | 6.8 | 38.31, p < 0.001
The existence of a paper based system as an alternative for reporting | 27.2 | 32.0 | 17.5 | 12.6 | 10.7 | 17.73, p = 0.001
Lack of a culture of pharmacovigilance reporting | 34.0 | 21.4 | 17.5 | 23.3 | 3.9 | 24.43, p < 0.001
Lack of support/incentives from management to use the system for reporting | 22.3 | 37.9 | 19.4 | 11.7 | 8.7 | 26.85, p < 0.001
Extra cost of electronic reporting (internet data costs) | 24.3 | 35.9 | 8.7 | 16.5 | 14.6 | 22.68, p < 0.001
Extra time involved in using the system to submit the reports | 15.5 | 41.7 | 19.4 | 13.6 | 9.7 | 32.97, p < 0.001
Difficulty downloading and installing the App versions of the system | 21.4 | 30.1 | 15.5 | 17.5 | 15.5 | 7.73, p = 0.102
Difficulty in accessing the system online | 13.6 | 31.1 | 22.3 | 20.4 | 12.6 | 11.52, p = 0.021
Lack of awareness of existence of the electronic reporting system | 25.2 | 15.5 | 13.6 | 26.2 | 19.4 | 6.56, p = 0.161
Difficulty in navigating the system when reporting | 10.7 | 32.0 | 21.4 | 15.5 | 20.4 | 13.07, p = 0.011
Limited access to computers at my workplace | 18.4 | 23.3 | 7.8 | 25.2 | 25.2 | 11.22, p = 0.024
Lack of an option for anonymous reporting in the system | 11.7 | 20.4 | 15.5 | 23.3 | 29.1 | 9.48, p = 0.050
**Least Likely**
Dislike of computer technology | 3.9 | 8.7 | 11.7 | 31.1 | 44.7 | 61.13, p < 0.001

_Agoro O, et al 2017 – under revision for JAMIA_
Participating pharmacists comfort with IT
KDS Framework

Conceptual Framework for Development of Comprehensive e-Health Evaluation Tool

Shariq Khoja, Hammad Durrani, Richard E. Scott, Afroz Sajwani, Usha Piryani

TELEMEDICINE and e-HEALTH JANUARY 2013 DOI : 10.1089/tmj.2012.0073
Call to Action on Global eHealth Evaluation

Consensus Statement of the WHO Global eHealth Evaluation Meeting,
Bellagio, September 2011

“To improve health and reduce health inequalities, rigorous evaluation of eHealth is necessary to generate evidence and promote the appropriate integration and use of technologies.”
Monitoring and Evaluating Digital Health Interventions

A practical guide to conducting research and assessment

http://apps.who.int/iris/bitstream/10665/252183/1/9789241511766-eng.pdf
Acknowledgement

- University of Leeds
- EU Horizon 2020
- US Centers for Disease Control
- Partners In Health
- Brigham and Women hospital
- Harvard Medical School
- Rockefeller Foundation
- International Development Research Centre, Ottawa