



*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

*Fraser HSF, et al, Proc AMIA Symp 2006: 264-268*



# PIH-EMR data

Partners In Health      MDR-1B Medical Record      Socios En Salud  
 Home Page      Report an error      No New Messages      Logout

## PIH-EMR: Electronic Medical Record

0 Errors today  
 1 Errors this week (View)

[Español](#) Hello Hannah Fraser (Name: Email/Password, Preferences)



View Patients	Data Entry
Search for a patient: <input type="text"/> <input type="button" value="Search"/>	Search for a patient: <input type="text"/> <input type="button" value="Search"/>
List All Patients: <input type="button" value="Peruian patients"/> <input type="button" value="Haitian patients"/> <input type="button" value="Brazilian patients"/>	Create a new patient: <input type="button" value="New patient"/>
Analyze Patients	Data Administration
Monthly Report Work: <input type="button" value="Monthly Report Work"/>	Monthly Administration: <input type="button" value="Monthly Administration"/>
	Merge patients: <input type="button" value="Merge"/>
	Find DST or Bacteriology: <input type="button" value="Search"/>



Smears  
 Cultures  
 Drug sensitivity

Biochem.  
 Hematology

Registration form  
 History/exam  
 Previous Rx  
 Previous Dx  
 Contacts



Follow up  
 Chest X-ray



Drug regimens  
 Pharmacy



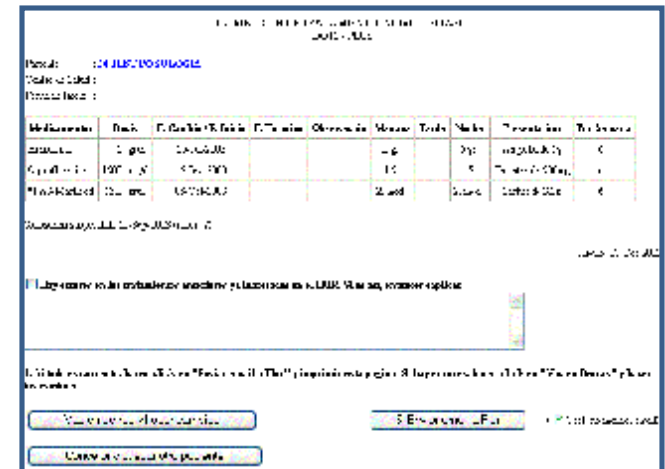
# Drug order entry system evaluation



Percentage of medication in errors in EMR per patient.

Date/Site	Callao active	Lima Este control
December 02	17.4%*	8.6%**
April 03	3.1%*	6.9%**

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



*Most errors were delays in updating regimens*

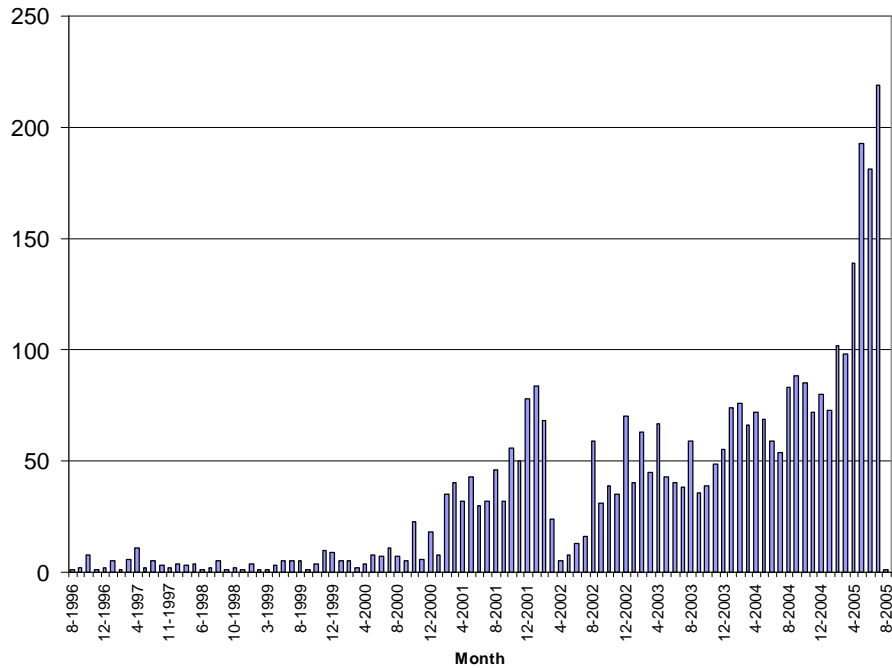
*Choi S, et al. Proc. Medinfo2004, 11: 202-206.*

# Predicting MDR TB drug needs

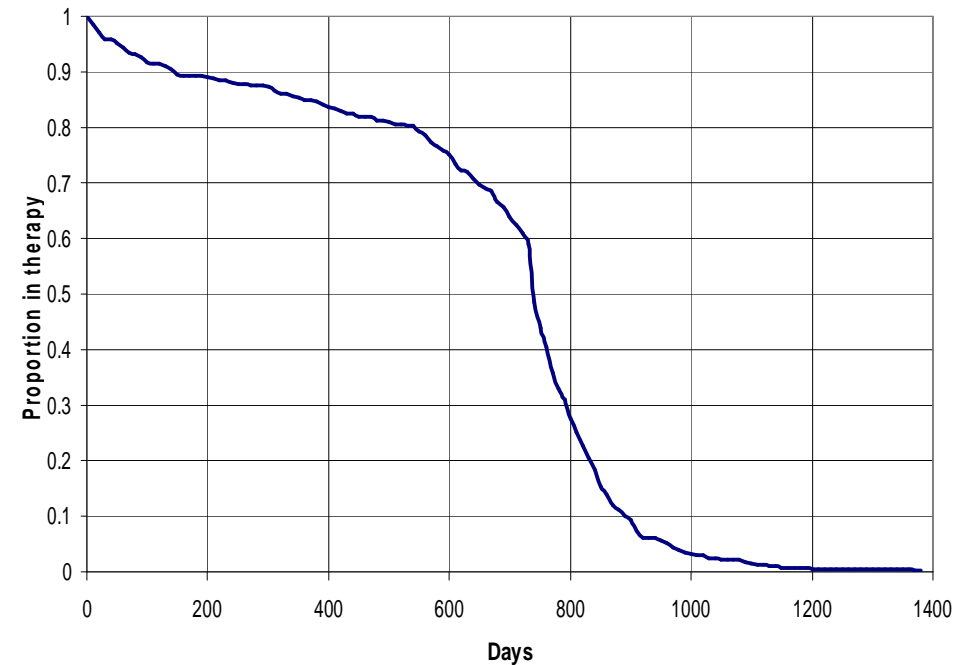


Beginning date: 01-Dic-2004		Final date: 01-Ene-2005			
Medication	Form of drug	Total quantity required	Estimate for all patients	Price per unit	Total cost for this drug
Amikacin	(Ampulle x 1g)	47	47 x	\$0.3 =	\$14.1
Amikacin	(Ampulle x 500mg)	0	0 x	\$0.0 =	\$0
Amox/Clav	(Tablet x 500mg)	7786	7786 x	\$0.1996 =	\$1554.09
Amox/Clav	(Tablet x 1g)	0	0 x	\$0.4 =	\$0
Capreomycin	(Ampulle x 1g)	5887	5887 x	\$3.68 =	\$21664.16
Ciprofloxacin	(Tablet x 250mg)	0	0 x	\$0.057 =	\$0
Ciprofloxacin	(Tablet x 500mg)	25095	25095 x	\$0.0284 =	\$712.7
Clarithromycin	(Tablet x 500mg)	1143	1143 x	\$3.09 =	\$3531.87

Patient recruitment 1996-2005



Length of time in treatment





# Quantification for MDR TB drugs

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

predicted/prescribed for 13 drugs

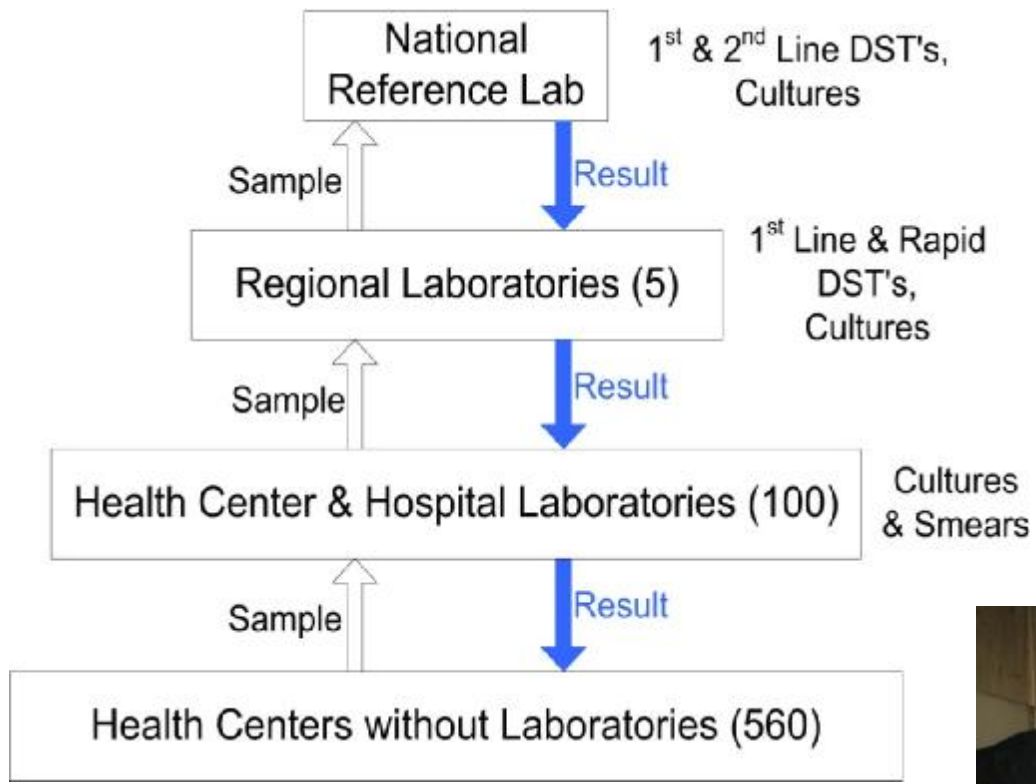
Year	2002	2003	2004	2005	Mean all years
Mean	97.4%	100.1%	97.0%	94.1%	97.2%
St Dev	15.4%	3.4%	10.9%	7.8%	

*(two 6 month estimates are combined for each year).*

# Tracking and communicating smear, culture and DST results



Menu Principal
<a href="#">Buscar Paciente</a>
<a href="#">Buscar Muestra</a>
<a href="#">Ver todos los resultados</a>
<a href="#">Resultados</a>
<a href="#">Verificar datos</a>
<a href="#">Transferir</a>
<a href="#">Controladores de PE</a>
<a href="#">Calidad de Datos</a>
<a href="#">Datos de Pruebas no Verificados</a>
<a href="#">Registrar a E-CHASQUI</a>
<a href="#">Resultados Externos</a>
<a href="#">Transferir Resultados</a>



# *Palm Project: evaluation study results*

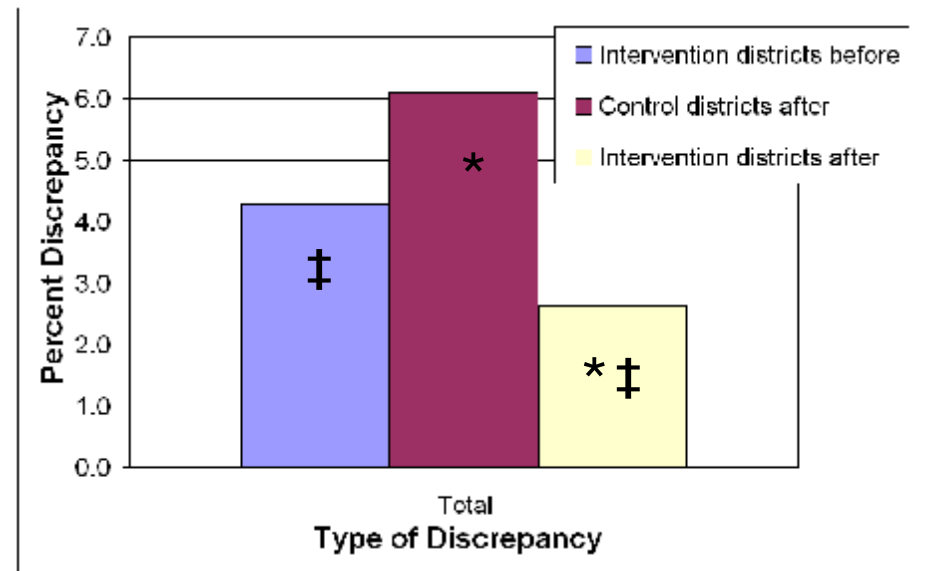
Median processing time

Frequency of Errors

	<b>Intervention Districts days (n)</b>	<b>Control Districts days (n)</b>
<b>Pre-Palm</b>	<b>30.5 (4876)*</b>	<b>30.8 (5954)</b>
<b>Post-Palm</b>	<b>7.7 (2890)*†</b>	<b>22.7 (3263)†</b>

\* p<0.001

† p<0.001



\* p < 0.001

‡ p = 0.055



# *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)



Partners In Health




Regenstrief  
Institute



Medical research  
council SA



# OpenMRS-TB

**MDR TB**

**Find Patient(s)**  
Find Patient(s):   Include Retired  
[next 5](#) 1 to 5 of 11

	Identifier	First	Middle	Last	Age	Gender	Birthdate	Health Center
1	11003090-D	Catherine	Test	██████	13	F	~ 05/31/1995	Kirehe
2	999994	Ellen	Test	██████	26	F	08/24/1982	Nyarubuye
3	999995	Jaime	Test	██████	44	M	05/10/1964	
4	22036976-D	Jim	Test	██████	46	M	~ 12/31/1961	Rwinkwavu
5	44006563-G	Joia	Test	██████	27	F	~ 12/31/1980	Mulindi

**Create Patient**  
To create a new person, enter the person's name and other information below first to double-check that they don't already have a record in the system.  
Name:   
Birthdate:  or Age:   
(Format: mm/dd/yyyy)  
Gender:  Male  Female

**View All MDR-TB Reports**  
[WHO MDR-TB Annual Report of Treatment Results](#)  
[WHO Form 07 Quarterly Report](#)  
[WHO Form 08 6-month report](#)  
[WHO Form 09 Annual Report](#)  
[Lesotho Case Finding Report](#)  
[Lesotho MDR-TB HIV Report](#)  
[Lesotho Treatment Outcomes Report](#)

**View Drug Requirements**  
[drug requirements for next month](#)  
[number of patients taking each drug](#)

- 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.

Status	Form Entry	Drug Regimen	Bacteriologies	DSTs	Contacts
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[Add New Bacteriology](#)

sample collection date	smear	culture
Jan 2, 2008	+	+
Apr 2, 2008	+	+
Apr 3, 2008	MDR-TB PROGRAM START DATE	
Apr 10, 2008	TUBERCULOSIS DRUG TREATMENT START DATE	
May 1, 2008	++	
May 6, 2008	+	++
		+++
May 10, 2008	-	-
	MULTI-DRUG RESISTANT TUBERCULOSIS CULTURE STATUS: CONVERTED	
Jun 11, 2008	-	-



# *Downloading OpenMRS program and source code*



Main OpenMRS site:

[www.openmrs.org](http://www.openmrs.org)

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

MDR-TB implementation with Windows XP installer:

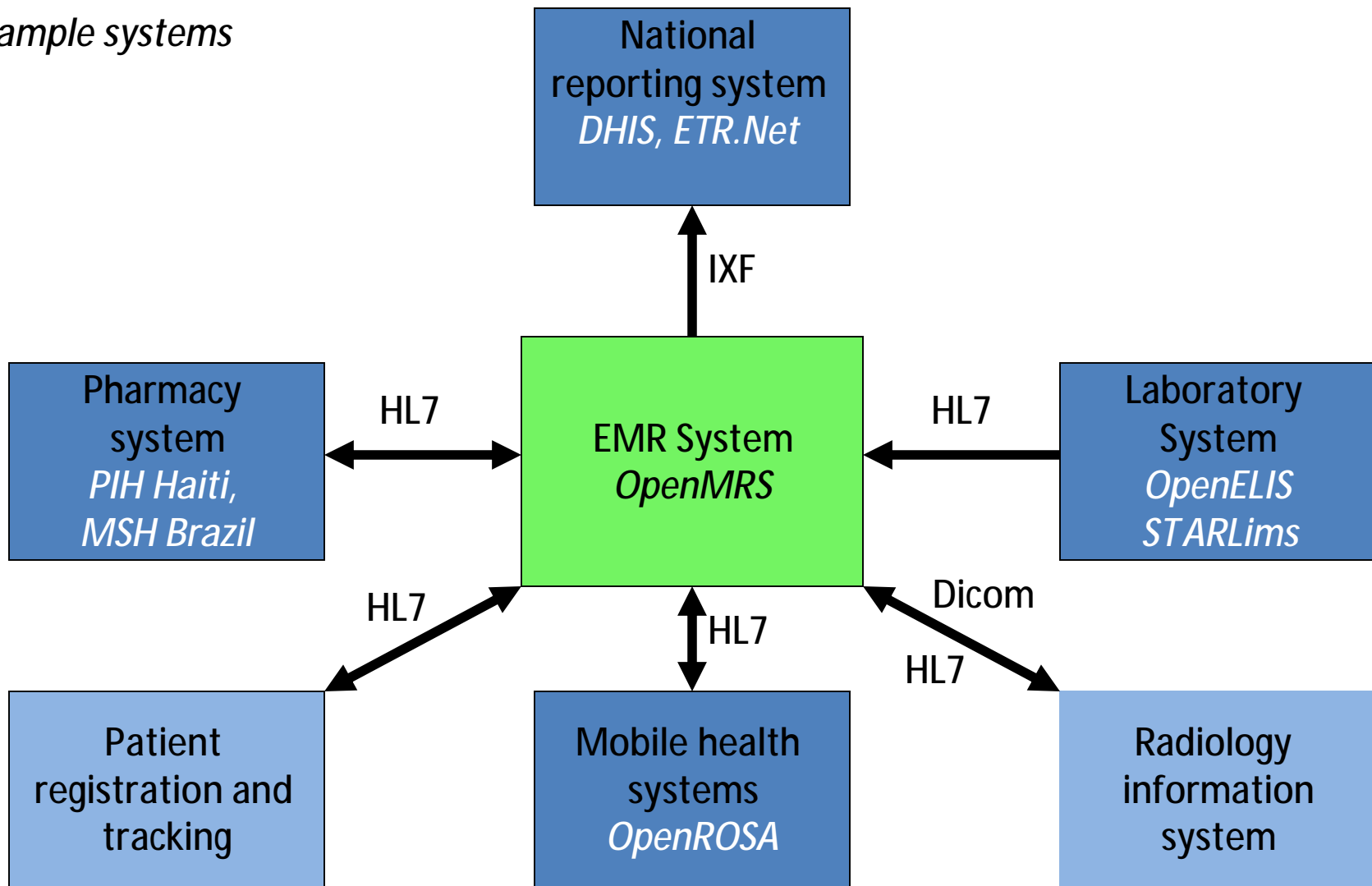
[resources.openmrs.org/mdrtb/OpenMRS\\_install\\_mdrtb.zip](http://resources.openmrs.org/mdrtb/OpenMRS_install_mdrtb.zip)



# Architecture for integrated national medical information system



Example systems





## *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



