A/Prof. Terry J. Hannan
MBBS;FRACP;FACHI;FACMI

UNDERSTANDING e-HEALTH AND WHY WE NEED IT.

“To improve care you have to measure it. Information management is care” (Don Berwick)
• Clinical computing 1976-2011.
• Current/Future data demands on CDM
• Technology of clinical computing
  • Storage, interoperability and standards, forms, data capture, CPOE.
• Translocating health information technologies MMRS-AMPATH-OpenMRS.
• Effective CDS tools (MSAccess) show how HIT and CDS works.
• Meeting the needs of scalability.
• Role of the internet, WWW, m-Health to meet the demands of modern health care. [VIDEOS]
Some Definitions.

Information is not a necessary adjunct to care, it is care, and effective patient management requires effective management of patients’ clinical data.

*Donald M. Berwick President and CEO, Institute for Healthcare Improvement*

There is no health without management, and there is no management without information.

*WHO-Gonzalo Vecina Neto, head of the Brazilian National Health Regulatory Agency*

Information is necessary to provide and manage health care at all levels, from individual patients to health care systems to national Ministries of Health (MOH). *W.Tierney. Dir. Regenstrief Institute.*

So what is eHealth?

*The World Health Organization (WHO) definition:*

“e-Health is the combined use of electronic communication and information technology in the health sector.”
Health Informaticians.

“Informaticians should understand that our first contribution is to see healthcare as a complex system, full of information flows and feedback loops, and we also should understand that our role is to help others "see' the system, and re-conceive it in new ways.”

E. Coiera. April 2009, Centre for Health Informatics, Institute of Health Innovation, University of New South Wales, Australia
Functions of Clinical Informaticians

Clinical informaticians use their knowledge of patient care combined with their understanding of informatics concepts, methods, and tools to:

- Assess information and knowledge needs of health care professionals and patients;
- Characterize, evaluate, and refine clinical processes;
- Develop, implement, and refine clinical decision support systems;
- Lead or participate in the procurement, customization, development, implementation, management, evaluation, and continuous improvement of clinical information systems.
1. **Information:** captured directly at computer terminals located at the point of each transaction, not on pieces of paper.

2. **Information** captured at a terminal or automated device: anywhere in the hospital should be available immediately, if needed, at any other terminal.

3. The **response time** of the computer should be rapid-blink times.

4. The computer should be **reliable and accurate**.

5. **Confidentiality** should be protected.

6. The **computer programs** should be friendly to the user and reinforce the user’s behavior.

7. There should be a **common registry** for all patients.
Goals of implementation.

1. Eliminate logistic problems of paper record-clinical data timely, reliable, complete.

2. Reduce the work of clinical bookkeeping-no more missed Dx, or forgotten preventive care.

3. Information ‘gold’ within medical records available to clinical, epidemiological, outcomes and management research.
Four key functions of electronic clinical decision support systems

"Administrative":
Supporting clinical coding and documentation, authorization of procedures, and referrals.

"Managing clinical complexity and details":
Keeping patients on research and chemotherapy protocols tracking orders, referrals follow-up, and preventive care.

"Cost control":
Monitoring medication orders; avoiding duplicate or unnecessary tests.

"Decision support":
Supporting clinical diagnosis and treatment plan processes; promoting use of best practices, condition-specific guidelines, population-based management.

http://www.openclinical.org/dss.html
What can technology do NOW!

The Regenstrief Medical Record System. IJMI 54 (1999)

Retrieval times - Fast (blink times)
Data and information - Comprehensive
Data storage - Long-term-lifelong
Data applications - Introspective of total database

Data storage -
200 million coded observations
3.25 million narrative reports
15 million prescriptions
212,000 ECG tracings
More than 1.3 million patients

Access -
1300 medical nurses
1000 physicians
220 medical students
Across health care institutions (16)
Data access more than 628,000 / month
FIGURE S-4 Data advances in medicine.
Burning Platform: Overwhelming Complexity

Sets of Facts per Decision

Proteomics and other effector molecules
Functional Genetics: Gene expression profiles
Structural Genetics e.g. SNPs, haplotypes
Decisions by Clinical Phenotype

Other complex decision making activities and errors!

ADVERSE EVENTS

3.7% HOSPITALISATIONS
27.6% DUE TO NEGLIGENCE
70.5% DISABILITY OF < 6 MONTHS
2.6% PERMANENT DISABILITY
13.6% DEATH

“Lawyers generally believe that investigation of substandard care only begins with the medical record; that in many instances the medical record even conceals substandard care; and that substandard care is not reflected in, or “discoverable” in the medical record.”
Very little change since 2000!

In 2003, the RAND Corporation - on average patients receive recommended care only 54.9% of the time. (Leape, 2005, McGlynn et al., 2003).

Of what we do in routine medical practice, what proportion has a basis in published scientific research?

1. Williamson (1979) <20%
2. OTA (1985) 10-20%
3. OMAR (1990) < 20%
4. B. James (2007) 20-40%

The rest is opinion That doesn’t mean it is wrong -- much of it probably works but it may not represent the best patient care

## Landmark Clinical Trials and Their Current Rate of Use

<table>
<thead>
<tr>
<th>Clinical Procedure</th>
<th>Landmark Trial</th>
<th>Current Rate of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flu Vaccine</td>
<td>1968</td>
<td>64% (2000)</td>
</tr>
<tr>
<td>Thrombolytic Therapy</td>
<td>1971</td>
<td>20% (2000)</td>
</tr>
<tr>
<td>Pneumococcal Vaccine</td>
<td>1977</td>
<td>53% (2000)</td>
</tr>
<tr>
<td>Beta blockers after MI</td>
<td>1982</td>
<td>92.5% (2001)</td>
</tr>
<tr>
<td>Mammography</td>
<td>1982</td>
<td>75.5% (2001)</td>
</tr>
<tr>
<td>Cholesterol screening</td>
<td>1984</td>
<td>69.1% (1999)</td>
</tr>
<tr>
<td>Fecal occult blood test</td>
<td>1986</td>
<td>20.6% (1999)</td>
</tr>
</tbody>
</table>

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MEDICAL COSTS RISING RAPIDLY..
Annual increase 1986-91
Medical Costs = 14.1%
• Inflation = 3.8%
Medical costs rising 4 times faster than inflation.

Increases in health expenditures per capita across different countries are actually fairly similar—averaging about 3 percent a year adjusted for overall inflation. Taking a Walk on the Supply Side: 10 Steps to Control Health Care Costs Karen Davis. USA DOH Mar. 2005.

…IMPACTING BUSINESSES...
Health care spending
Percent of pretax profits
• 1965 = 8.4%
• 1980 = 27.3%
• 1990 = 61.1%

….AND GOVERNMENT FINANCES..
Health care spending
Percent of total government expenditures
• 1980 = 10.7%
• 1985 = 11.5%
• 1988 = 12.8%
• 1990 = 14.0%
Dis-proportional use of Acute care services (CKD) 5% of CKD – bed days.

<table>
<thead>
<tr>
<th>Disease Group</th>
<th>Patients in Group</th>
<th>Acute Inpatient Separations in Group</th>
<th>Acute/Rehab Days in Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVD</td>
<td>66.2%</td>
<td>56.2%</td>
<td>52.0%</td>
</tr>
<tr>
<td>DM-CVD</td>
<td>17.9%</td>
<td>22.3%</td>
<td>22.9%</td>
</tr>
<tr>
<td>DM</td>
<td>11.4%</td>
<td>6.6%</td>
<td>6.2%</td>
</tr>
<tr>
<td>CVD-CKD</td>
<td>2.0%</td>
<td>6.2%</td>
<td>7.6%</td>
</tr>
<tr>
<td>CKD-CVD-DM</td>
<td>1.4%</td>
<td>6.8%</td>
<td>9.1%</td>
</tr>
<tr>
<td>CKD</td>
<td>1.0%</td>
<td>1.5%</td>
<td>1.6%</td>
</tr>
<tr>
<td>DM-CKD</td>
<td>0.1%</td>
<td>0.4%</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

5% of patients 19% of days
Gap analysis: Duplicate testing common in cluster group (CKD)

Proportion of Patients and Duplicate Lab Tests in each Disease Group, 2005.

<table>
<thead>
<tr>
<th>Disease Group</th>
<th>Patients in Group</th>
<th>Duplicate Tests in Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVD</td>
<td>66.2%</td>
<td>47.5%</td>
</tr>
<tr>
<td>DM-CVD</td>
<td>17.9%</td>
<td>18.2%</td>
</tr>
<tr>
<td>CKD-CVD</td>
<td>11.4%</td>
<td>10.2%</td>
</tr>
<tr>
<td>DM</td>
<td>2.0%</td>
<td>10.5%</td>
</tr>
<tr>
<td>CKD-CVD-DM</td>
<td>1.4%</td>
<td>9.4%</td>
</tr>
<tr>
<td>CKD</td>
<td>1.0%</td>
<td>3.1%</td>
</tr>
<tr>
<td>DM-CKD</td>
<td>0.1%</td>
<td>1.1%</td>
</tr>
</tbody>
</table>

5% of patients 25% of duplicate tests
Gap analysis: Duplicate testing
~$4.5 M (~$4.50/test)

Duplicate Lab Tests* by Group, BC, 2005.

# Duplicate Lab Tests in 2005 = 1.14M
COST = $4.55M

* duplicate test defined as same test within 30 days
## Table 3. Duplicate laboratory test by type and attendant costs (within 30-day period) (source: MSP Billing Data)

<table>
<thead>
<tr>
<th>Lab text</th>
<th>Number</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haematology profile</td>
<td>126,436</td>
<td>$1,588,392</td>
</tr>
<tr>
<td>Haemoglobin (A1C)</td>
<td>10,208</td>
<td>$145,070</td>
</tr>
<tr>
<td>Ferritin (serum)</td>
<td>4,670</td>
<td>$116,423</td>
</tr>
<tr>
<td>Creatinine (serum/plasma)</td>
<td>107,993</td>
<td>$112,502</td>
</tr>
<tr>
<td>Potassium (serum/plasma)</td>
<td>93,950</td>
<td>$97,786</td>
</tr>
<tr>
<td>Urinalysis (macroscopic)</td>
<td>24,808</td>
<td>$94,938</td>
</tr>
<tr>
<td>Sodium (serum/plasma)</td>
<td>83,177</td>
<td>$86,562</td>
</tr>
<tr>
<td>Microalbumin</td>
<td>4,322</td>
<td>$85,098</td>
</tr>
<tr>
<td>Glucose semiquantitative</td>
<td>22,466</td>
<td>$74,816</td>
</tr>
<tr>
<td>Urea (serum/plasma)</td>
<td>61,055</td>
<td>$63,837</td>
</tr>
<tr>
<td>Total duplicate tests</td>
<td>747,286</td>
<td><strong>$2,969,085</strong></td>
</tr>
<tr>
<td>Group</td>
<td>% Patients (2005)</td>
<td>Year 2003</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>CVD</td>
<td>33.9%</td>
<td>$298</td>
</tr>
<tr>
<td>DM</td>
<td>46.2%</td>
<td>$122</td>
</tr>
<tr>
<td>DM + CVD</td>
<td>12.3%</td>
<td>$137</td>
</tr>
<tr>
<td>CKD + CVD + DM</td>
<td>1.2%</td>
<td>$38</td>
</tr>
<tr>
<td>CVD + CKD</td>
<td>1.5%</td>
<td>$40</td>
</tr>
<tr>
<td>CKD</td>
<td>12.9%</td>
<td>$26</td>
</tr>
<tr>
<td>DM + CKD</td>
<td>1.2%</td>
<td>$15</td>
</tr>
<tr>
<td>Total cost</td>
<td></td>
<td>$675</td>
</tr>
</tbody>
</table>
After Hours Resource Utilisation - 1998/99 (PRH0s-UK.)

87% Unnecessary out-of-hours tests
80% Diagnostic uncertainty
79% Medico-legal protection
66% Avoid leaving work for colleagues
71% Prevent criticism from staff (especially Consultants)
76% Lessen anxiety and reduce stress levels
71% Agreed attempts should be made to reduce unnecessary testing

Unnecessary out-of-hours biochemistry investigations--a subjective view of necessity.
“The variation phenomenon in modern medicine - the observation of differences in the way apparently similar patients are treated from one health care setting to another.”

D. Blumenthal. Editorial NEJM 331:1994;1017-8
IHC TURP QUE Study-COST VARIATION

Average Hospital Cost

<table>
<thead>
<tr>
<th>Attending Physician</th>
<th>Dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1500</td>
</tr>
<tr>
<td>B</td>
<td>1549</td>
</tr>
<tr>
<td>C</td>
<td>1568</td>
</tr>
<tr>
<td>D</td>
<td>1543</td>
</tr>
<tr>
<td>E</td>
<td>1618</td>
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<td>F</td>
<td>1697</td>
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<td>G</td>
<td>1913</td>
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<td>H</td>
<td>2233</td>
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<td>I</td>
<td>2140</td>
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<td>J</td>
<td>2156</td>
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<tr>
<td>K</td>
<td>1598</td>
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<tr>
<td>L</td>
<td>1269</td>
</tr>
<tr>
<td>M</td>
<td>1164</td>
</tr>
<tr>
<td>N</td>
<td>1552</td>
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<tr>
<td>O</td>
<td>1556</td>
</tr>
<tr>
<td>P</td>
<td>1662</td>
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</tbody>
</table>
IHC TURP QUE Study-Average LOS variation

Average Length of Stay

<table>
<thead>
<tr>
<th>Days</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>P</th>
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<tbody>
<tr>
<td>0</td>
<td>3.8</td>
<td>3.8</td>
<td>3.3</td>
<td>3.1</td>
<td>3.9</td>
<td>3.9</td>
<td>4.5</td>
<td>4.6</td>
<td>4.9</td>
<td>4.6</td>
<td>4.6</td>
<td>3.2</td>
<td>2.7</td>
<td>3.4</td>
<td>4.3</td>
<td>4.5</td>
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</tbody>
</table>
IHC TURP QUE Study - Grams excised vs. Time variation

GRAMS AND MINUTES

SURGEON - and variation within each surgeon's practice

MEDIAN SX TIME
MEDIAN GMS

GRAMS AND MINUTES

SURGEON - and variation within each surgeon's practice
Reasons for practice variation

♦ Complexity

* How many factors can the human mind simultaneously balance to optimize an outcome?  -- Alan Morris, MD
* "The complexity of modern American medicine exceeds the capacity of the unaided human mind"  -- David Eddy, MD

♦ Lack of valid clinical knowledge  (poor evidence)

♦ Subjective judgment / uncertainty

* Subjective evaluation is notoriously poor across groups or over time
* Enthusiasm for unproven methods  -- Mark Chassin, MD

♦ Human error  -- humans are inherently fallible information processors  -- Clem MacDonald, PhD
<table>
<thead>
<tr>
<th>SERVICE</th>
<th>REIMBURSEMENT VARIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>XRAYS</td>
<td>400 %</td>
</tr>
<tr>
<td>ECG</td>
<td>600 %</td>
</tr>
<tr>
<td>LAB SERVICES</td>
<td>700%</td>
</tr>
</tbody>
</table>

Wennberg J. Gittelsohn A. Science;1973;182:1102-8
Variation over time - has it improved?

Per capita Medicare spending varies considerably from region to region. The effect of greater Medicare spending on quality of care and access is not known.

- Using end-of-life care spending as an indicator of Medicare spending
- Geographic regions into five quintiles of spending and examined costs and outcomes of care for:
  - hip fracture
  - colorectal cancer
  - acute myocardial infarction.

Outcomes:
Residents of high-spending regions received 60% more care but did not have better quality or outcomes of care.

Implications: Medicare beneficiaries who live in higher Medicare spending regions do not necessarily get better-quality care than those in lower-spending regions.

– The Editors

The Implications of Regional Variations in Medicare Spending. Part 1: The Content, Quality, and Accessibility of Care. Elliott S. Fisher, MD, MPH; David E. Wennberg, MD, MPH; The´ re`s e A. Stukel, PhD; Daniel J. Gottlieb, MS; F.L. Lucas, PhD; and ´ Etoile L. Pinder, MS. Ann Intern Med. 2003;138:273-287.
Figure 3.
The Relationship Between Medicare Spending and Quality of Care, by State, 2004

(Composite measure of quality of care)


Notes: The composite measure of the quality of care, based on Medicare beneficiaries in the fee-for-service program who were hospitalized in 2004, conveys the percentage who received recommended care for myocardial infarction, heart failure, or pneumonia. Spending figures convey average amounts by state.
GEOGRAPHIC VARIATIONS IN PHARMACY SPENDING

• ~20% Medicare spending
• Varies substantially among hospital-referral regions
  • Highest-spending region spending 60% more per beneficiary on pharmaceuticals than the lowest.
  • Variation in both drugs prescribed and number of prescriptions/month
  • Physicians in higher-spending areas - more drugs and more expensive drugs.

Medical spending varies more across hospital-referral regions than drug spending.

**Geographic Variation in the Quality of Prescribing.** Yuting Zhang, et.al.
November 18, 2010
Variation 2008
The wide variation in medical prices within U.S. markets that creates an opportunity for transparency to reduce spending. This variation exists even for relatively common procedures.

New Hampshire-2008
Average payment for arthroscopic knee surgery - $2,406 with a standard deviation of $1,203 in hospital settings and $2,120 with a standard deviation of $1,358 in nonhospital settings.


Massachusetts-
Median hospital cost in 2006 and 2007 for magnetic resonance imaging (MRI) of the lumbar spine, performed without contrast material, ranged from $450 to $1,675.2

CCDSS TOOLS IN CLINICAL MEDICINE-REQUIREMENTS

1. ALERTING
2. REMINDING
3. INTERPRETATION
4. ASSISTING
5. CRITIQUING
6. DIAGNOSING
7. MANAGING
8. KNOWLEDGE ACCESS

Physician inpatient order writing on microcomputer workstations-effects on resource utilisation. WM Tierney and others. JAMA 1993;269:379-383
Physician inpatient order writing on microcomputer workstations—effects on resource utilisation. WM Tierney and others. JAMA 1993;269:379-383

$3 million per year savings—(USA $65b)
Foreign or Familiar territory?
Age
Gender
Previous computer experience
-NOT factors in usage
[W. Slack 1976 and 2010]
USA adults > 50 years - 54% use Internet (38% in 2002)
25% high speed Internet access (5% in 2002)
Greatest use 50-69 yrs. Rapid fall > 70 years

Of those > 50 years who use Internet
- 87% use email
- 81% use Google
- Average 9 hrs/week on line

“The idea of being able to discover your own world is very exciting ... the computer enables us to stay in the work force longer.”

Senior Netizens - D. Kadlec, TIME, February 12, 2007
Cause and effect of potential causes of ADEs. (From L. Grandia. IHC, Utah - with permission)
Cause and effect of potential causes of ADEs. (From L. Grandia. IHC, Utah-with permission)

60% Administration errors Occur between written orders and nurse administration

**Drug Administration Errors**
- Nurse
- Physician
- Pharmacist

**Physiologic Factors**
- Age
- Weight
- Physicid
- Gender
- Renal
- Electrolyte
- Past Allergic Reaction
- Race
- Absorption
- Drug/Lab
- Race

**Pharmacological Factors**
- Drug/Drug
- Expected
- Drug/Food
- Hemal
- Brand name vs. Generic

**Ordering Errors**
- Spelling
- Transcribing
- Dosage
- Scheduling
- Route
- Order missed

**Patient**
- Psychic
- Neural
- Compliance

**Physician**
- Patient
- Physician
- Pharmacist
- Dietician
Computerized surveillance of adverse drug events in hospital patients

“Most hospitals rely on spontaneous voluntary reporting to identify adverse events, but this method **overlooks more than 90%** of adverse events detected by other methods.............**Retrospective chart review** improves the rate of adverse event detection but is **expensive and does not facilitate prevention.”

VA’s Success with Decision Support

STUDY DESIGN
• Computer-based EMR system
• Patients discharged January 1, 1988 to December 31, 1994
• 162,196 patients
• Goal: to determine clinical and financial outcomes of the antibiotic practice guidelines implemented through the computer system
Overall antibiotic use: decreased 22.8%
Mortality rates: decreased from 3.65% to 2.65%
Antibiotic-associated ADE: decreased 30%
Antibiotic resistance: remained STABLE
Appropriately timed preoperative a/biotics: 40% to 99.1%
Antibiotic costs per treated patient: decreased $122.66 to $51.90
Acquisition costs for antibiotics: fell 24.8% to 12.9%
($987,547) to ($612,500)

Our case-mix index which measures patient acuity levels **INCREASED** during this period, meaning we were treating sicker and sicker patients while better utilizing the delivery of antibiotics.

Amarasingham found impressive relationships between the presence of several technologies and complication and mortality rates and lower costs.

The specific technologies evaluated included order entry, clinical decision support, and automated notes.

Higher order entry scores were associated with 9% and 55% decreases in mortality rate for patients with myocardial infarction and coronary artery bypass surgery, respectively.

The results for decision support were impressive: higher decision support scores were associated with:

• 21% decrease in the risk of complications.
• Perhaps of most interest from the informatics perspective was the impact of automated notes, which were associated with a 15% decrease in the risk of fatal hospitalizations among all causes.


Not all HIT are beneficial.

There were also some instances in which relationships in the opposite direction were found; for example, electronic documentation was associated with a 35% increase in the risk of complications in patients with heart failure, though this may have been present because it was easier to find these events since better documentation was present.


Questions.

1. Are the technologies—computer order entry, decision support, and clinical documentation—sufficiently mature that hospitals should be adopting them now? Bates: the answer is a clear yes for large hospitals. For smaller hospitals, which use a different set of vendors, the answer is less clear, but studies are currently under way that should provide additional information regarding this.

2. For clinical documentation, the benefits are still only beginning to be determined and are likely to be spread across a wide range of areas, but this will likely prove to be beneficial as well.

Bates DW. REPRINTED) ARCH INTERN MED/VOL 169 (NO. 2), JAN 26, 2009
WWW.ARCHINTERNMED.COM
Do the negative consequences of implementing HIT in hospitals overwhelm or wash out the positive ones?

Current evidence is that they do not overall.

EVALUATION is critical with technology after implementation and making multiple changes to it—points that are all too often ignored.

Bates DW. ARCH INTERN MED/VOL 169 (NO. 2), JAN 26, 2009
Figure 2  PDA form example.
Figure 1  Peruvian laboratory structure, and workflow of the bacteriology data collection team with the current paper system (white lines) and with the PDA-based system (red lines).
PIH-EMR data

PIH-EMR: Electronic Medical Record

View Patients
- Search for a patient
- List All Patients

Data Entry
- Search for a patient
- Create a new patient

Analyze Patients
- Analyze
- Monthly Report Work

Data Administration
- Data Administration
- Merge patients
- Find DST or Bacteriology

Smears
- Cultures
- Drug sensitivity

Biochem.
- Hematology

Registration form
- History/exam
- Previous Rx
- Previous Dx
- Contacts

Follow up Chest X-ray

Drug regimens Pharmacy
Figure 1
An example a clipboard with PDA. Photograph shows the form of interviewing through a PDA put into a clipboard.

Figure 3
Data entry form. On the left, the original paper form; on the right, the electronic equivalent able to deliver data directly to the central repository.

Figure 2
e-Chasqui main patient page. This page shows the patient's full bacteriological history on the left sidebar and with bolded sample date for the sample whose results were being displayed on main part of page.
A web-based laboratory information system to improve quality of care of tuberculosis patients in Peru: functional requirements, implementation and usage statistics.

- March 2006-2007
- 29,944 smear microscopy
- 31,797 culture and 7,675 drug susceptibility test results have been entered.
- Over 99% of these results have been viewed online by the health centres.
- High user satisfaction
- Heavy use has led to the expansion of e-Chasqui to additional institutions.
- In total, e-Chasqui will serve a network of institutions providing medical care for over 3.1 million people.
- The cost to maintain this system is ~US$0.53 per sample or 1% of the National Peruvian TB program's 2006 budget.
PIH-EMR Impact

- Over 12,500 records of patients who have received MDR-TB treatment in Peru
- eChasqui module showed significant reductions in delays in delivering drug sensitivity test results to physicians
- Order entry system shown to reduce errors in drug regimens
- Drug forecasting tools reduced the errors in predicting medication requirements six months in advance

Fraser et al, AMIA fall symp. 2006, 264-268
Limited resources

- 40 million PLWA (People Living With AIDS)
What are the information management needs here?
MMRS data (2 years)  
63,728 visits

<table>
<thead>
<tr>
<th>Diagnoses</th>
<th># Visits</th>
<th>Drugs</th>
<th># Visits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaria</td>
<td>17,495</td>
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<tr>
<td>URI</td>
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### MMRS data (2 years)

**63,728 visits**

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At every monthly check-up patients are given their charts and hand-carry them to the nurse, clinical officer and other providers they are seeing that day. Updates to the chart are made at each station.

Clinical officers like Lillian Boit provide most patient care and maintain charts. "The electronic record-keeping system allows us to provide care to more people and take better care of patients", she says.

At every monthly check-up patients are given their charts and hand-carry them to the nurse, clinical officer and other providers they are seeing that day. Updates to the chart are made at each station.
An innovative home-care programme using handheld computers is also being piloted in the region. Monica Korir, who is living with HIV and is trained as an outreach worker, interviews Paul Ekorok, 52, at his home in Captarit village and records his answers.

WHO/Evelyn Hockstein
Outreach workers download completed forms into Mosoriot clinic's data management system daily. Automated alerts flag any alarming new symptoms to the attention of the responsible clinical officer, or when a patient has missed an appointment so that outreach workers can find out what is wrong.
OpenMRS Western Kenya - cumulative visits 11/01-09/09

Figure 1 - Cumulative patients enrolled and visit records
Besides antiretroviral drugs (which are provided by USAID), care by AMPATH cost only $175/patient/year in 2007 and is now less than $100/patient/year in 2009.


In addition to the monthly, quarterly, and annual reports required by funding and agencies and the MOH, the AMRS also provides data to a robust multidisciplinary research program:

Researchers from more than a dozen North American universities and Moi University currently have more than 30 ongoing studies in East Africa, supported by >$26 million in grants from U.S. federal granting agencies and various foundations.
Salina- “Rattling bones syndrome”
Salina on anti-retroviral therapy
A response to HIV
HIV is a treatable disease, but treating millions requires information management.
OpenMRS is...

- An Electronic Medical Record System - web based
- A data model
- An API
- An HIV system
- A TB system
- A Primary Care system
- A developer community
- An implementer community

... and more.
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)
Multiple uses-flexibility of a platform approach
OpenMRS sites – Spring 2010

http://openmrs.org/wiki/Summary_of_OpenMRS_Implementation_Sites
Implementation Time Frames and support.

It took us about 6 weeks … to configure our ER and Surgery modules in OpenMRS. … Thanks again to Andy at MVP and James at HAS among others for considerable guidance and support … There are only a couple of us working on this project at MSF with limited resources, and without the help of the implementers group we would have been stopped in our tracks.

On June 1 we went live with the production database in Port au Prince. … the system is run by local staff with limited technical training. … Overall we have been impressed with the stability of OpenMRS on Linux; server reboots are sometimes necessary once or twice a day because of Tomcat memory errors. With three months of data in the system now and stability and output tried and true … Thanks. John John Brooks. Médecins Sans Frontières (MSF)/Doctors Without Borders
Figure 1. Design Goals used for the AMRS

**Collaboration** – systems need to be developed openly and built upon a common infrastructure, the sharing of “best of breed” modules can best occur within a shared infrastructure

**Scalability** – the infrastructure must not only handle thousands of patients and hundreds of thousands of observations, but also be scalable to tens of thousands of patients and millions of observations

**Flexibility** – systems must support not only HIV-centered care, but also general medical care, since clinical care is not limited to HIV care

**Rapid form design** – data collection needs are a moving target; therefore, form design and deployment must allow for continual change

**Clinically useful** – feedback to providers and caregivers is critical – if the system is not clinically useful, it will not be used

**Use of standards** – to maximize the flexibility and extensibility of the system

**Support high-quality research** – via non-ambiguous, coded data

**Web-based with support for intermittent connections** – developing countries do not always have reliable power or internet connections, but when available, internet-based technologies offer increased scalability

**Low cost** – if the system is to be widely available and adaptable in developing countries, cost must not prohibit adoption. Ideally, the nuts and bolts of the system should be downloadable for free.
Collaborators and Funders

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