Overview

- Healthcare communication methods
- General overview of telemedicine
- Real time, store-and-forward and home care
- Current successful areas
  - Teledermatology, telepathology, teleradiology, teleultrasound
- Evaluation of telemedicine
- Web based Telemedicine and EMR systems

Healthcare Communication

- Synchronous communication
  - direct conversation, telephone, video conference, page(?)
  - require full attention of all parties at same time
- Asynchronous communication
  - letter, email, store-and-forward telemedicine
  - allows flexible, efficient use of expert time

Communication technologies

- Phone
- Email
- Instant messaging
- Web based systems inc. EMRs
- Internet video conferencing
  - MS Netmeeting
  - PictureTel/Polycon systems
- ISDN based video conferencing
- Remote control and surgical robotics

Telemedicine: basic requirements

- Expert advice available from a distance but not locally
- Problem able to be described sufficiently clearly for a safe medical opinion
- Adequate time for assessment

Types of Telemedicine

- Real time video link
- Store-and-Forward telemedicine
- Home healthcare and monitoring

Traditional Video Telemedicine

- Specialized video conferencing equipment e.g. VTEL, PICTURETEL
- Multiple ISDN lines (2, 4, 6 +), each line 64Kbits
- Special imaging attachments for ophthalmoscopy, otoscopy, endoscopy etc.
- Audio attachments include electronic stethoscope

Early Telemedicine Examples

Nebraska Psychiatric Institute University of Nebraska, College of Medicine, Omaha, Nebraska (US)

In 1959, Cecil Whittson established the first functional telemedicine program. This program focused on psychiatric patient care and medical

education. For patient care, telemedicine was used to conduct group therapy. The system was also used to instruct medical students by connecting clinics and classrooms.

Logan Airport Medical Station, Massachusetts General Hospital Boston, Massachusetts (US)

- In April 1968, MGH established a microwave video link between the hospital and Boston's Logan Airport.
- Intended to provide immediate access to a physician without requiring one to be permanently assigned to the airport.
- More than 1000 patient examinations were conducted.

Project SHARE Canada and East Africa

- A satellite network was established in January 1986 that allowed for interactive video conferencing between medical facilities in Newfoundland, Canada and Kenya or Uganda.
- Connection allowed for:
  - formal medical education and lectures
  - telemedicine consultations (which included EEGs),
  - international medical collaboration and research.

Home Health Care

- Increasing use of home care due to rise in chronic diseases and desire to reduce length of hospital stay and costs
- Data communication between hospital and home cheap and simple with Internet/Web
- Automated data collection devices available e.g. for BP, blood glucose, peak respiratory flow rate etc.

Home Monitoring Projects

- Cardiac arrhythmia monitoring with “cardio-memo”
- Diabetics: data on glucose control, diet or video discussion
- Asthmatic control with peak flow meter connected to palm PC
- Heart failure patients: control of fluid balance with data from weight, symptoms etc.

Fax and Telephone: Simple Alternatives

- Telephone interviews and follow-up
- Mailing x rays, slides, samples, photos
- Faxing ECGs and other investigation results
- Mailing digital images on CDROM

“Traditional” Telemedicine

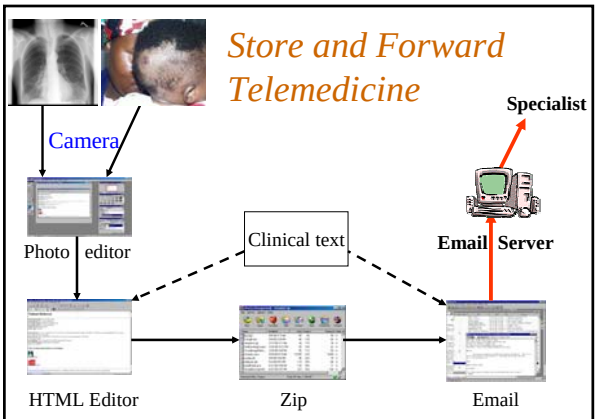
- Real-time transmission of video
- Specialist must be present during consult
- Requires high bandwidth:
  - usually dual ISDN or T1 line
- Good for conferences/teaching
- Expensive and time consuming

Store-and-Forward Telemedicine

- Summarize case in text (usually email)
- Take images with digital camera (or still video)
- Send case to specialist center, usually by email
- Specialist reviews case when convenient

(discussed in more detail later)

Store and Forward Telemedicine



Teleradiology

- Mainstream application in telemedicine
- Images are acquired with a digital system e.g. a CT scanner or imaged with a high resolution laser scanner
- DICOM format used to exchange images between devices
- Radiologist doesn't care if image is from the same hospital or other side of the world

Modern Teleradiology System

Teleradiology in remote sites

- Severe lack of expertise: no radiologist in 13? African countries (source WHO)
- Many remote hospitals have x-ray equipment but only general physicians
- Copying and mailing x-rays is expensive and slow

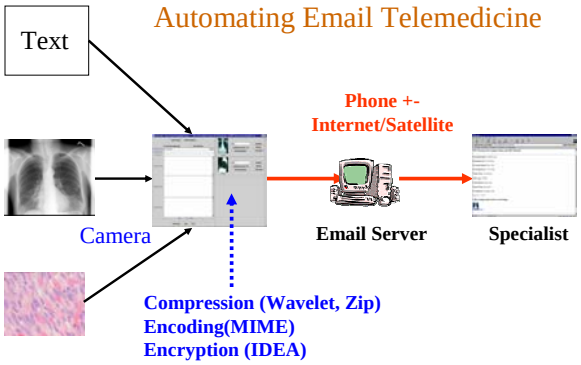
Digital radiology (US)

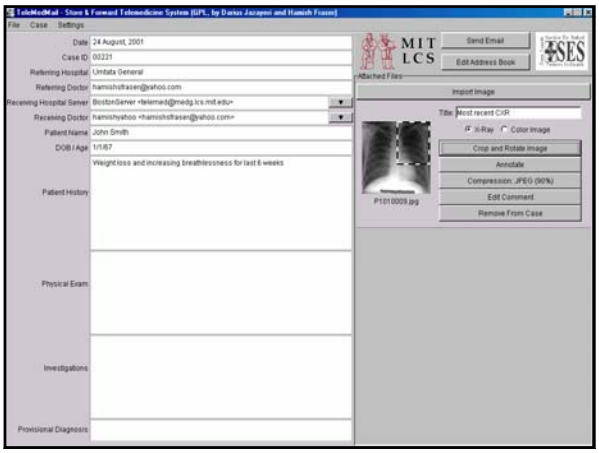
- Typical high resolution image: CXR
- 2,048 x 2,560 pixels x 12 bits
  = 60M bits uncompressed (grayscale)
- JPEG compression 10-20:1 = +-450K
- Wavelet compression 20-30:1 = +-300K
- DICOM standard for x-ray transmission

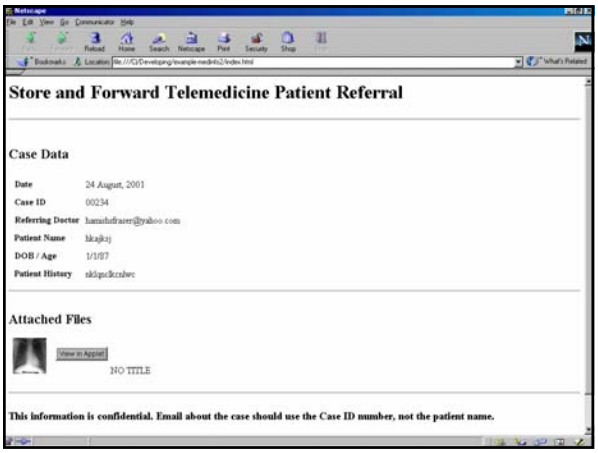
Low-cost digital radiology

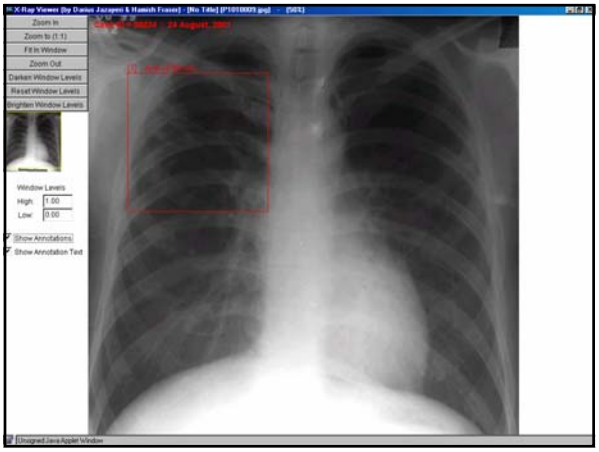
- Modern digital cameras provide 2048 * 2048 (4M) pixels or better
  - ACR recommendations 2048 * 2048
- Images are generally output in JPEG format or loss-less TIFF files (Soon JPEG2000 we hope)
- Cameras are cheap ($300-$500), portable, robust and relatively easy to use
- The same camera can be used for multiple clinical images types

Automating Email Telemedicine









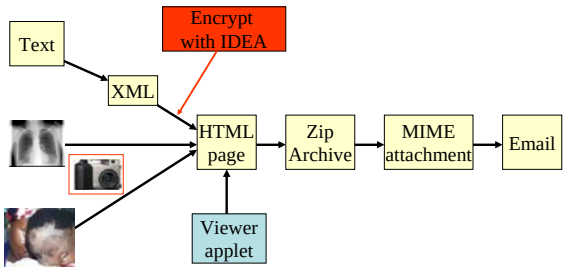
Case and image transmission

- JPEG images 300KB approx.
- Text and images zipped together and encrypted for transmission
- Case can be sent to a personal email account or to a Web server

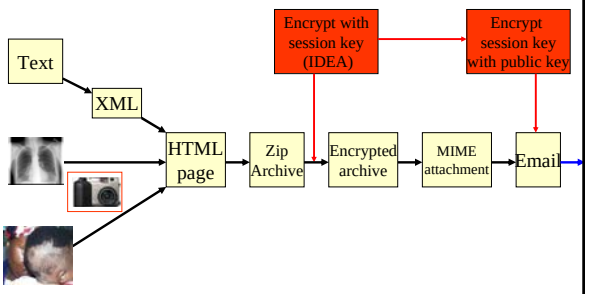
TeleMedMail: modes of operation

- Peer to peer (via email), 2 modes
  1. Encrypted text with password
  2. Unencrypted (for teaching or internal use)
- Via web server
  - Fully encrypted zip archive
  - Password protected web site
  - EMR database for case management

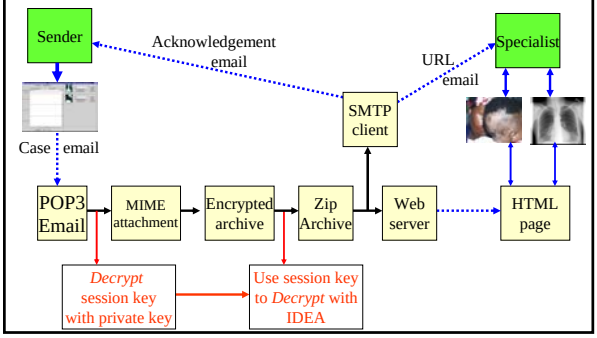
Sending cases peer to peer as email attachments



Sending cases to the server system



TMM receiver: Web-based case viewing



The Java viewer for x-rays and other images (displaying Russian X-ray and text)

Telepathology

- Pathologists often send slides to sub-specialists for a second opinion
- Sometimes relatively rapid opinions are required e.g. for biopsy results
- Digital cameras are available to attach to microscopes and capture high-quality images
- Selected images can be emailed to a specialist center with other clinical details

Telepathology Equipment

UNITRA - AFIP PROJECT

Slide courtesy of Prof. Lech Banach

IPath Server

- Server for exchange and review of image based case reports especially pathology
- Can take input from the web or from TeleMedMail
- Nice image management tools
- Running in Zurich, Nigeria and Solomon Islands

Telecardiology

- ECGs sent by fax or email of image
- CXRs
- Teleultrasound
- Heart sounds?

Tele-herpetology

Teledermatology

- Diagnosis mostly:
  history, visual inspection and biopsy
- Biopsy can be mailed in some cases
- High resolution color images required
- Real time interaction not necessary

Teledermatology

- Used over several years with video, and now digital still cameras
- Moderate resolution requirements 850x650
- May be accompanied by biopsy
- Web based systems used in some sites including Boston, USA

Teledermatology in a Rural Family Practice
D O'Mahony, L Banach, D H Mahapa et al

Teledermatology Request

FROM: Dr Don O'Mahony, Port St Johns
omahonyd@cybertrade.co.za
DATE: 12/7/1999
NAME:
SEX: F
AGE: 53 yrs
HISTORY: Painful ulceration of lower lip since May 1999. She states that she had "pink spots" on her face in May 1999 but these resolved on a course of tablets (? prednisone). No history of bullae. No previous skin disease. No skin lighteners nor medication. T-totaller.
EXAMINATION: Erosion with pink elevation of exposed skin. Skin biopsy done on 09/12/99 and sent to Dr. Banach at Umtata
DIAGNOSIS: ? localized pemphigus.
PICTURES:

Home Heart Failure Care

- Close monitoring of fluid status and treatment in heart failure reduces admissions and improves quality of life
- Use of web based architecture to connect patients at home and their physician/nurse
- Daily monitoring of weight, BP, pulse and symptoms such as breathlessness, oedema
- Advice on diuretic dosage, diet, need for urgent assessment

Columbia University Home Diabetes Care

- Informatics for Diabetes Education and Telemedicine IDEATel
  - synchronous videoconferencing over standard telephone lines
  - electronic transmission for fingerstick glucose and blood pressure readings
  - secure Web-based messaging and clinical data review
  - access to Web-based educational materials

Telephone and voicemail systems

- Friedman, Boston University, support for hypertension management
- NHS Direct nurse based patient triage
- Voixiva inc. telephone based data collection and reporting for infectious diseases in Peru
- Support for home care for HIV in Capetown, South Africa

Mobile phone tracks heartbeats

Remote care

The device works by monitoring the microwaves transmitted by a mobile.

Some of the microwaves bounce back to the phone from the chest, heart and lungs of the person using it.

Researchers sure of benefits of telemedicine

The add-on module picks up these signals to produce a pattern of the user's heart beat and breathing.

Tele-ultrasound

- Ideal imaging method for many problems in Obstectrics & gynaecology, cardiology Gastroenterology, and renal medicine
- Safe, painless, no radiation
- Low running costs and significant but falling hardware costs
- Good images not always available

Tele-ultrasound

- Moderate operator training requirements but reading images requires expertise
- Relatively low resolution images
- Cardiology and fetal medicine requires motion video
- Equipment can be bulky and expensive for newer imaging techniques

Portable ultrasound machine suitable for echocardiograms

Courtesy Dr Pandian
Tufts-New England Medical Center

Tele-ultrasound in Fetal Medicine

(Mary Dalton, Tufts University, Boston)

- Fetal ultrasound performed in local clinics
- Images reviewed in real time by expert physician
- 4 or 6 ISDN lines (256 or 384 KBS)
- Adequate quality at 256 but movement artifacts in some cases

(Telemedicine Journal 1998)

Evaluation of Telemedicine

- Why use telemedicine?
- Getting past the first grant phase
- Keep it simple and problem driven
- Beware of enthusiasts! (like us...)

Formal Evaluation

- We MUST perform clinical evaluations of informatics and telemedicine interventions
- Include effects on patient outcomes, workflow and sustainability
- Compare with simple alternatives
  - mailing photos or CDROMs,
  - telephone or fax
  - Training more staff to do specialist's work

Legal Issues

- Medical licensing
- Qualifications
- Safety of telemedicine techniques
- Payment

Teledermatology: Example (Krupinski et al)

- Still digital camera 832 x 608 pixel, 24 bit color (video cameras less effective)
- 4 dermatologists, 308 cases, (104 had biopsy)
- Each case had history and up to 5 images sent
- Mean review time of 22.6 seconds (3 - 167)

Results

Image quality

- Good or excellent color 93%
- Good or excellent sharpness 83%

Agreement between readings

- Photo vs. biopsy 76%
- Photo vs. direct exam 84%
- Direct exam vs. biopsy 89%

A simple telemedicine system using a digital camera

Peter Corr*, Ian Couper†, Stephen J Beningfield‡ and Maurice Mars*

*Departments of Radiology and Physiology, University of Natal; †Manguzi Hospital, KwaZulu Natal, and Department of Family Medicine, Medunsa, Pretoria; ‡Department of Radiology, University of Cape Town, South Africa

Summary

Radiographs on a viewing box were photographed at a remote hospital in South Africa using a digital camera with a resolution of 1024 × 768 pixels at 24-bit colour depth. The resultant images were stored in JPEG format and transmitted as email attachments to be read on a PC monitor by radiologists in Durban and Cape Town. Twenty-seven images were received, of which 23 were of diagnostic quality (85%). The mean file size was 120kByte. For quality control purposes, 100 chest radiographs were photographed at a base hospital and read by a radiologist blinded to the diagnosis. In this study 96 images were of diagnostic quality (96%) and the correct diagnosis was made in 90 cases (94%). Incorrect readings were made in six cases (6%): small pulmonary nodules (less than 1 cm in diameter) were missed in five cases and in one case early apical tuberculosis was missed. Digital camera technology permits simple, inexpensive telemedicine. Limited spatial resolution is a concern when reading chest images with small pulmonary nodules and infiltrates.

Journal of Telemedicine and Telecare 2000; 6: 233–236

Evaluation of the Diagnostic Accuracy of Chest X-rays Acquired Using a Digital Camera for Low-Cost Teleradiology

Agnieszka Szot (former research fellow HST medical informatics program)

Methods

- Ninety-one upright postero-anterior chest x-ray images were collected.
- Each image was photographed on a light box with an Olympus C3030 camera on a tripod
- Images were compressed by JPEG and JPEG2000 (wavelet) compression
- Digital images were displayed using the TeleMedMail viewer

Evaluation study design

- 93 Chest X rays were assessed by 3 radiologist and 1 pulmonologist
- Images were acquired with a 3 Megapixel digital camera and compressed by 2 algorithms:
  - JPEG at 15:1 ----------400KB
  - JPEG 2000 at 60:1 ----------120KB
- Each reader assessed the digital images and latter the original films for 8 typical features of TB
- Assessments were compared to a gold standard based on two independent radiologists reading the films

Image features used in the study

X-ray feature	Number of occurrences
Infiltration/consolidation	33
Cavities	13
Pneumothorax	13
Lymphadenopathy	12
Pleural effusion	20
Calcifications	15
Scarring	27
Nodule or mass	31
Normal chest x-rays *	22
TB cases	17

Comparison of plain and JPEG images per feature

Feature	AUC plain	AUC JPEG	Difference	p value
Infiltration/ consolidation	0.842	0.861	-0.019	0.6349
Cavities	0.907	0.892	0.015	0.8367
Pneumothorax	0.922	0.911	0.012	0.8408
Lymphadenopathy	0.710	0.741	-0.030	0.7340
Pleural effusion	0.789	0.891	-0.102	0.1276
Calcifications	0.779	0.938	-0.159	0.0297
Scarring	0.766	0.736	0.030	0.5580
Nodule or mass	0.862	0.855	0.007	0.8667

Comparison of plain and JPEG2000 (wavelet compression) images per feature

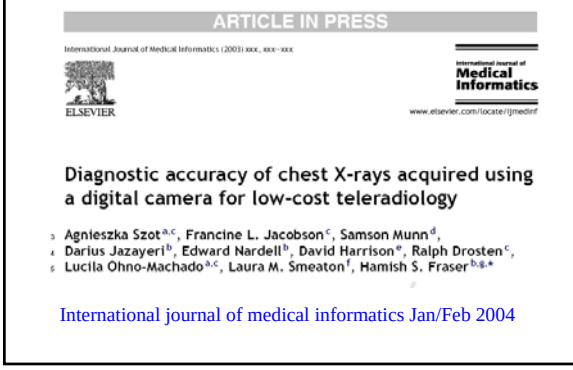
Feature	AUC plain	AUC JPEG	Difference	p value
Infiltration/ consolidation	0.842	0.854	-0.012	0.7951
Cavities	0.907	0.834	0.074	0.3489
Pneumothorax	0.922	0.859	0.063	0.3839
Lymphadenopathy	0.710	0.710	0.000	1.0000
Pleural effusion	0.789	0.850	-0.061	0.4204
Calcifications	0.779	0.831	-0.052	0.4926
Scarring	0.766	0.730	0.037	0.5797
Nodule or mass	0.862	0.832	0.030	0.5200

Discussion

- No detectable difference in detection of abnormalities on the 2 digital image formats v.s. the original image (for 91 images)
- For this application it appears that adequate diagnostic quality is provided by the digital camera for the diagnosis of TB and similar conditions
- This is a practical technique applicable in clinics with few resources
  - JPEG2000 has great potential to reduce file sizes

Limitations

- The power of the study may be inadequate to detect smaller differences
  - More images would strengthen conclusions
- Inadequate dynamic range of the cameras for certain films
  - requires careful choice of exposure
  - Better cameras or scanners
- Better gold standard for some diagnoses
  - e.g. Ct scan result could strengthen conclusions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Diagnostic accuracy of chest X-rays acquired using a digital camera for low-cost teleradiology

Agnieszka Szot[a,c], Francine L. Jacobson[c], Samson Munn[d], Darius Jazayeri[b], Edward Nardell[b], David Harrison[e], Ralph Drosten[c], Lucila Ohno-Machado[a,c], Laura M. Smeaton[f], Hamish S. Fraser[b,g,*]

International journal of medical informatics Jan/Feb 2004

Lessons from this study

- Few telemedicine studies rigorously assess the quality of diagnoses performed at a distance
- Appropriate statistics must be used to measure diagnostic performance
- There are trade off between study power and generalizability
- Do the research finding apply in the environments where the system may be based?

Telemedicine and the Web

Telemedicine and the Web

- Merging of two systems
- Move to all digital standards
- Ability to transform and enhance data
- Asynchronous telemedicine
- Partners in Health TB network discussed on Wednesday

Medical Information Management

- Telemedicine is a flavor of medical informatics
- You still require a good electronic medical record
- Storage and transmission of medical data is important in one building or across the world
- A branch of medical informatics?

Carabayllo, Lima, Peru Nov. 2000 (Photo F. Loya)

Requirement for EMR

- Delivery of complex clinical management in resource-poor areas
- Monitor the rapid scale-up of a pilot project from 75 to thousands of patients
- Support clinical research in one of the largest cohorts of MDR-TB patients
- Monitor and improve resource allocation for complex and expensive drug management
- Detection of changes in DST patterns that may indicate amplification of resistance in a group of patients

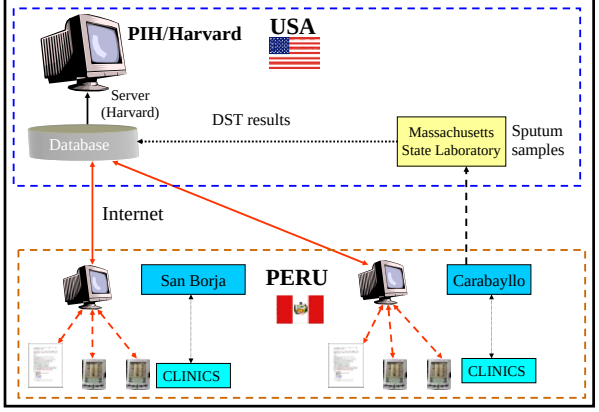
Information management for a project to treat drug resistant TB in Peru

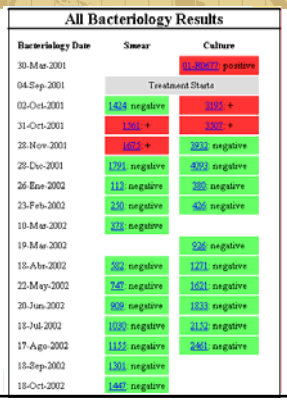
- Paper charts in multiple sites
- Laboratory results from Massachusetts faxed to Peru
- Patient lists in multiple databases and "Excel databases"
- Drug requirements assessed from spreadsheet of patients medications
- Extensive use of email

The PIH-EMR

- A secure (SSL) web based electronic medical record using a relational database
- Standard technology, open source, open standards
- Designed to be usable over low-speed dialup connections
- Bilingual: English/Spanish
- Views for
  - Clinical care
  - Drug management
  - Analysis for patient monitoring and research

Locations of clinics and IT systems

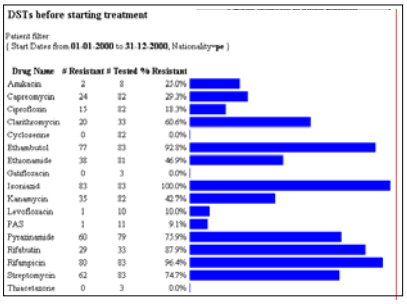




Drug sensitivity tests (one patient)

Date / Sample ID	14-Dic-2000 01.R0230	03-Abr-2001 01.r0712	03-Abr-2001 01.R0712	01-Ago-2001 01.R1378	20-Ag -2001	30-Abr-2002 sent
INH02-baja	Resistant	Resistant	Resistant	Resistant	Treatment Starts	Pendiente
INH1-alta	Resistant	Resistant	Resistant	Resistant		Pendiente
INH5	Resistant	Resistant	Resistant	Resistant		Pendiente
EMB/ETB	Resistant	Resistant	Resistant	Resistant		Pendiente
SM-baja	Resistant	Resistant	Resistant	Resistant		Pendiente
SM-alta	Sensitive	Sensitive	Sensitive	Sensitive		Pendiente
KM	Resistant	Resistant	Resistant	Resistant		Pendiente
CS	Sensitive	Sensitive	Sensitive	Sensitive		Pendiente
CM	Resistant	Resistant	Resistant	Sensitive		Pendiente
Ethio	Resistant	Not Tested	Resistant	Resistant		Pendiente
CIP/CPX	Sensitive	Sensitive	Sensitive	Sensitive		Pendiente
RIF	Resistant	Resistant	Resistant	Resistant		Pendiente
PAS	Sensitive	Sensitive	Sensitive	Sensitive		Pendiente
Amk	Not Tested	Resistant	Not Tested	Not Tested		Pendiente
LFX	Sensitive	Not Tested	Sensitive	Sensitive		Pendiente

Aggregate drug sensitivity test results



Access to Patient summaries by PDA (Avantgo)

Resumen Paciente

Fecha	Directo	Cultivo
1999-07-14	contam	pos
1999-12-04	++	++
1999-12-07	Rx Starts	
2000-01-05	neg	++
2000-02-01	+	contam
2000-02-29	neg	
2000-03-01	neg	+
2000-04-04	neg	neg
2000-05-06	neg	neg

Bacteriology results

Resumen Paciente

Resultados DST

Fecha	07-99	08-00
INH02-baja	R	R
INH1-alta	R	N
INH5	R	N
EMB/ETB	R	R
SM-baja	S	R
SM-alta	S	N
KM	S	N
CS	S	N

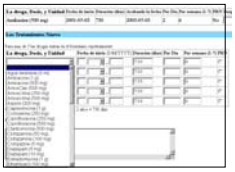
Drug sensitivity test results

Poster: Yasin Z, Choi S, Fraser HS, AMIA Fall Symp. 2002

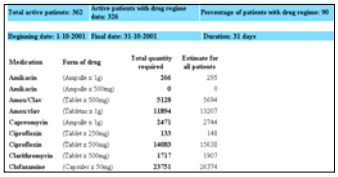
Prediction of drug requirements (morbidity)

One months medication for MDR-TB

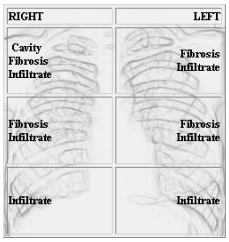
Drug regimen entry form



Analysis of monthly drug requirements



CXR reporting and digital images



THE CHALLENGE:
HIV treatment in the developing world

- 6 million people need ARV treatment today
- Currently about 300,000 receiving treatment
- How do we expand treatment rapidly to achieve the 3x5 goal (3M by 2005)?

HIV treatment data requirements

- Patient demographic (registry)
- Patient status
- Clinical status
- Investigations
- Drug regimen
- Drug supplies

Partners In Health/Zanmi Lasante Project

- Haiti is the poorest country in the Western hemisphere. The rural central plateau where we work is its most impoverished region.
- Haiti's 6% adult HIV prevalence rate is the highest in the western hemisphere.
- There are very few doctors—especially in rural areas—and only dirt roads, which are often impassable in the rainy season.
- Few towns have telephones. There is no cellphone coverage outside the capital area.

Treating HIV with ARVs

- Careful monitoring of clinical progression, side-effects, and lab results.
- Community Health Workers see patients daily. Doctors see patients monthly.
- Daily administration of three antiretrovirals, and supplementary medicines.
- Stockouts can engender drug-resistance.
- Emergency drug orders can cost many times the price of drugs ordered in advance through international agencies (e.g. IDA)

Rapid Large-Scale Expansion

- Haiti received $66M from the Global Fund to fight AIDS, Tuberculosis, and Malaria, including $13M to be administered by ZL.
  - Scale-up to 5000 or more patients
  - Five sites instead of one, some without laboratories
- Increased requirements:
  - More doctors
  - Larger quantities of medications
  - Additional clinic and laboratory infrastructure
  - Better information systems
  - Effective communications between sites

Electronic Communications

- It is impossible to provide the highest standard of care without an affective means of communication
  - Consults on difficult cases
  - Communicating lab results quickly
  - Locating doctors
  - Scheduling transfers and emergency surgery

Internet link at Thomonde expansion site

These sites use low cost Satellite connections and both generators and solar power systems

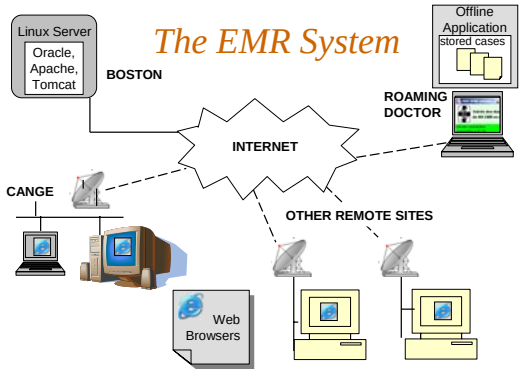
Informatics in a Developing Country?

- "You guys are crazy!"
  -A Clinton Foundation representative, when told of our plan to use an Internet-based system
- But the Internet brings practical advantages:
  - One email can avert a 3-5 hour drive, or prevent an unnecessary patient transfer.
  - Doctors unfamiliar with HIV treatment need support and advice
  - Averting one emergency drug purchase can pay for the satellite infrastructure at a site
  - Centralized data management drastically simplifies IT needs at more remote sites.

EMR Design

- Secure web-based electronic medical record
- Based on EMR for Multiple-Drug Resistant Tuberculosis in Peru
- RedHat Linux server in Boston
- Oracle 9i Database
  - Will be swapped for (free) PostgreSQL
- Apache, Tomcat, OpenSSL

The EMR System

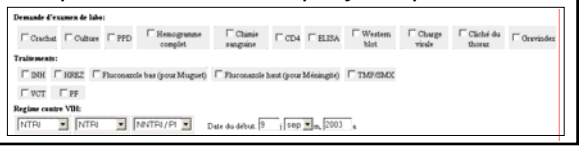


EMR Intake Data

- Demographic and socioeconomic data

Medication check lists

- Medication regimens are selected from a check list which then generates the individual items
- Investigations can also be checked and printed out to accompany the patient



The regimens selected

Decision support tools for drug regime entry

Drug combinations

Allergies

CD4 Counts

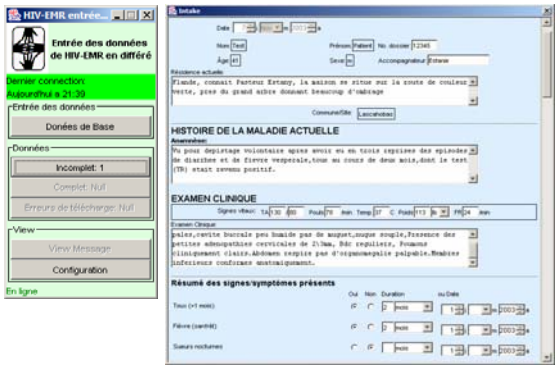
- CD4s done at labs in two clinic sites
- Results communicated to remote sites by email (paper results follow later)
- Doctors get email alerts when their patients' CD4 counts are below 350

```
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
[redacted]  :       195
[redacted]  :         9
[redacted]  :        70
```

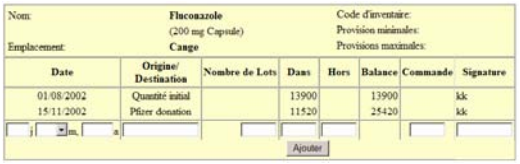
Offline Application

- The internet may be unavailable for days at a time
  - Lightning season is particularly troublesome
  - It is difficult to get replacements parts
- Java Offline application allows cases to be entered anytime, and uploaded when the internet is available.
  - java.net package simplifies HTTP and SSL
  - javax.crypto package simplifies security
- Easily configurable via XML descriptor files
  - Easy to add new forms to match the web interface
  - Supports data constraints, warnings, and alerts



Drug Management

- Based on WHO paper stock cards
- Inflows and outflows to Cange warehouse entered into EMR
- Flags and warnings when drug stocks fall too low



Drug Needs Analyses

- Calculate future drug needs from physician-entered regimens to predict necessary orders
- Compare calculated needs to actual usage based on stock card values
- Single application for drug management and drug prescribing allows cross checks of data quality

Current status

- It is possible to install a sophisticated network across multiple remote sites in one of the poorest parts of the world, to support the treatment of a complex and prevalent disease.
- Remote Haitian physicians are entering cases and doing online order entry daily.
- This can be a model for similar projects, but we must still do more:
  - Record more follow-up data, and ancillary medications
  - Add more sophisticated decision-support
  - Share the system (Open Source)

ROLE OF TELEMEDICINE

Why Use Telemedicine?

- Because it is the only alternative?
- Because it is better?
- Because it is cheaper?

The Only Alternative

- In remote areas e.g. Antarctica, Andes, Amazon etc.
- On board ships
- On planes (cost of diversion $20-30,000)
- On the battlefield
- In prisons? (US prison population 2 million, half the population of Norway…)

Providing Care in Rural Areas

In the traditional mode of providing care there are two solutions.

1) Either provide more health services to the remote site by full-time or part-time medical staff
2) Transport the patients from the remote site.

Either option is expensive.

Because it is better

Many times, once the physician and patient see each other, the decisions are made very quickly. But the fact that delays of days or weeks have passed since the first presentation allows for disease progression and many times a more aggressive (and expensive) course of treatment.

Because it is cheaper

- Ha Ha!

- Video is expensive
- Use appropriate technology

Cost effectiveness reviews

- A systematic review found that the best evidence for the effectiveness of telemedicine was in some of the studies on
  - Teleradiology (especially neurosurgical)
  - Telemental health
  - Transmission of echocardiographic images
  - Teledermatology
  - Home telecare

Hailay D, Roine R, Ohinmaa A. Systematic review of evidence for the benefits of telemedicine. *J Telemed Telecare* 2002; **8** (suppl 1)**:** 1–7.

Future Trends

- Rapidly falling costs of hardware and bandwidth
- Better imaging devices and data compression
- Increasing use of Internet and Web approaches
- "Contracting out" of radiology or dermatology?
- Increasing digitization of medical equipment
- Appropriate technology for developing countries

iChat AV
Videoconferencing
for the rest of us.