Innovative Chest X-ray solutions

supporting

TB prevalence studies

WHO Task Force meeting on TB impact Measurement

Prepared by
CheckTB!

Drs. Wessel Eijkman and Drs. Frank van Doren
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- Introduction
- Urgent need
- Radiology for prevalence studies
- CAD4TB project
- Identify potential obstacles & next steps
CheckTB!  Introduction

✓ **Mission CheckTB!**:
  Support intensified case finding and infection control by facilitating access to innovative digital TB screening & diagnostics through ...

✓ **Strategy CheckTB!**:
  ... bridging needs & solutions ...

✓ **Tactics CheckTB!**:
  ... by informing and connecting stakeholders, designing & financing projects and creating breakthrough services with partners
Urgent need
Enhance case detection

TB prevalence studies requested by WHO

TB: #1 killer of AIDS patients with often high false smear -

Limited lab facilities and radiologists in low resource countries

TB highly contagious disease and growing drug resistance

Urgent need for enhanced TB screening & diagnostics!

Low sputum detection rate; no TB rapid test expected before 2012

40% of TB cases is not detected Worldwide
“Limitations on the wider use of *chest X-rays*, such as non-availability at peripheral health facilities and the difficulty of interpreting results, even by trained physicians, need to be addressed.”

“*Chest X-ray* plays an important role in the diagnosis of TB and non-TB chest diseases common among people living with HIV.”

“*Chest X-rays* play a significant role in shortening delays in diagnosis.”

“Avoiding films by using digital *Chest X-ray* is an important advantage; Digital technology has a potential to solve most CXR problems”

Radiology for prevalence studies

Chest X-ray: analogue restrictions

- Medical
  - insufficient expert staff to interpret images
  - ordinary X-ray systems use high dose
  - poor readability of sometimes > 50% of images

- Technical/Quality
  - costly: often € 3 per image or more
  - poor image or viewer quality
  - inadequate film developing
  - delay between X-ray exposure and image availability
  - image archiving labour intensive, at times inaccurate
  - chemical waste causes environmental damage

Need to address restrictions through innovation
Radiology for prevalence studies

Chest X-ray: direct digital solutions

- **Medical**
  - remote diagnosis using GSM network possible
  - computer aided diagnosis w.i.p.
  - slot scan allows low dose
  - 95+% readability of images achievable

- **Technical/Quality**
  - low cost per image; € 0.29 – 1.1
  - consistent high quality image
  - image immediately available; s/w tools to read
  - easy storage and instant access to archived images
  - no film developing nor chemicals needed
Radiology for prevalence studies

Analogue vs. digital: cost per image

Assumptions: system price digital euro 150,000; analogue 60,000; depreciation period 12 years; operation 250 days/year 5 days per week, cost per film 35x43cm euro 1.1; developing cost euro 0.1; archiving and storage films euro 0.3; readability analogue 65%, digital 97%;
# Radiology for prevalence studies

## Analogue vs. digital: summary

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Analogue</th>
<th>Direct Digital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote diagnostics possible</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Low dose –slot scan-</td>
<td>yes/no</td>
<td>yes</td>
</tr>
<tr>
<td>High readability/image quality</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Low cost per image</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Immediate image availability</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Picture Archiving &amp; Communication System</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Data management tools</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Film development elimination</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Clean technology/chemical free</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>&lt; Euro 100K initial investment</td>
<td>yes</td>
<td>no</td>
</tr>
</tbody>
</table>
Radiology for prevalence studies

Sputum–direct digital radiology-culture

- Immediate (accuracy) 100% (speed)
- 1 or more days (accuracy) 60% (speed)
- 6 to 8 weeks (accuracy) 100% (speed)

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Creating new solutions for prevalence studies

Remote diagnosis capability

New solutions for large scale prevalence or screening

Digital: fast; easy view, store, transmit, monitor; decimates variable image cost

Mobile, sturdy, low dose

Computer Aided Diagnosis for CXR images
Ability to make, store, diagnose and send CXR’s from virtually any venue with the Odelca-DR platform.

- Camera & X-ray unit
  - Camera: pixels 2780 x 2652
  - Detector dimensions 47 x 46 cm
  - X-ray slot scan technique, low dose
  - Few components

- PACS, VPX/TB viewer with CAD
  - Dedicated archive and diagnostic viewer
  - Computer Aided Diagnosis

- Energy
  - Latest technology in inverters and battery
  - Charged by electricity, generator, solar or wind
Radiology for prevalence studies
Self supporting unit

- **Transport**
  - Compact system of 120 kg
  - Mobile 20 ft container fully equipped
    - Local available truck can be used
    - Unique lifting device for local flexibility

- **Communication**
  - Connection to a central database where all images are stored using PACS
  - No geographic limits
  - low band width transmission over GSM network or Internet (25 seconds for 250K chest image)
  - Quality control program image diagnosis possible
  - Interaction with NTP recording system
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Radiology for prevalence studies

Self supporting unit

1. OdelcaDR camera
2. X-ray generator
3. Rittal cabinet with battery/inverters
4. OdelcaDR server with GPRS/UMTS connection
5. Airco
Direct Digital technology empowering prevalence studies:

- User configured analysis tools in extensive archives
- Search filters with 25 criteria enabling data analyses on:
  - study date, geographic region, cohort, age group,
  - study description, patients name, male/female,
  - sputum results, culture results, HIV/AIDS, etc.
- Example of data search results:
  - children not older than 15 years who had a CXR in
    the last 12 months in the capital city;
  - number of false smear negative patients with positive CXR.
Radiology for prevalence studies
Nation wide concept

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Radiology for prevalence studies
Access pricing 2009 digital radiology

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<table>
<thead>
<tr>
<th>Total net system price (x € 1,000) Odelca-DR* FOB Rotterdam/AMS*</th>
<th>Base</th>
<th>LIC</th>
<th>LMIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic system</td>
<td>150</td>
<td>125</td>
<td>135</td>
</tr>
<tr>
<td>Complete mobile system**</td>
<td>200</td>
<td>170</td>
<td>185</td>
</tr>
</tbody>
</table>

**) prepared 20ft container; excl. truck, incl. battery; details given in appendix A of template

<table>
<thead>
<tr>
<th>Total net service price (x € 1,000) per Odelca-DR system*</th>
<th>12 months</th>
<th>36 months</th>
<th>60 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive services</td>
<td>Free</td>
<td>18</td>
<td>40</td>
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</table>

*) Valid for orders placed until January 1st, 2010 by NTP’s, NGO’s or the in-country principal recipients (for Global Fund, USAID, Pepfar or ECHO) and UN organisations directly at Delft Imaging Systems. Order confirmation is subject to availability of local services and pre-approval by manufacturer of final destination country. Comprehensive installation and maintenance services prices for 24 or 60 months are on the basis of pre-payment. Integrated PACS included in price.
Radiology for prevalence studies
Addressing critical success factors

X-ray System:
- Safety: low dose and radiation protection
- Size & weight (needs to fit in a truck)
- Robustness
- Output at least 40 images per hour
- Preferably digital to avoid need for chemicals

Truck/transport system:
- Usable for all areas of the survey, all road types

Power issues:
- Power generator needs to be movable
  - Large generators are bulky and consume lots of fuel;
  - Generator of 10 KW can be lifted easily

Service contract:
- Training and maintenance; response time
- Spare parts availability in-country

Source: KNCV WORKING DOCUMENT ON CHEST X RAY EQUIPMENT FOR USE IN TB PREVALENCE SURVEYS September 2008
CAD4TB project:

- Existing prototype with 85% sensitivity and 50% specificity on data base of 500 images with 200 TB cases.
- Project objective: 90+% sensitivity and 80+% specificity Worldwide.
- Research subsidy from Dutch government granted with support from CheckTB!
- Scientific cooperation set up amongst:
  - University of Utrecht: developer of CAD
  - University of Cape Town Lung Institute: developer of CRRS;
  - University of Stellenbosch, Desmond Tutu Lung Institute and Zambart: TB research institutions;
  - Delft Imaging Systems: Producer of Odelca-DR and PACS
  +
  - IUATLD as future co-owner of the Dbase.
Earlier developments

Examples of automated texture analysis and automated lung field segmentation
New reading & recording methodology to support CAD
Summary

✓ **Direct Digital X-ray** will effectively improve access to accurate and fast TB prevalence studies, screening & diagnostics for countries in urgent need.

✓ **Direct Digital X-ray** decimates cost per image and its “green technology” eliminates the chemical waste issue.

✓ **Direct Digital X-ray** offering remote diagnosis allows for TB case detection in areas without radiologists on site.

✓ **Direct Digital X-ray** computer aided diagnosis can revolutionize case detection in countries with low resources.
We welcome comments and questions!

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