Innovative Chest X-ray solutions supporting TB prevalence studies

WHO Task Force meeting on TB impact Measurement

Prepared by CheckTB!

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Contents

- 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 highly contagious disease and growing drug resistance

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

Limited lab facilities and radiologists in low resource countries

40% of TB cases is not detected Worldwide

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Urgent need for enhanced TB screening & diagnostics!

TB prevalence studies requested by WHO

TB highly contagious disease and growing drug resistance

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

Worldwide

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

TB prevalence studies requested by WHO

TB highly contagious disease and growing drug resistance

Urgent need for enhanced TB screening & diagnostics!
“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
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%;
### Characteristics of Analogue vs. Digital Radiology

<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>
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</table>
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Radiology for prevalence studies

Sputum–direct digital radiology-culture

- Immediate: 100% accuracy, 60% speed
- 1 or more days: Immediate
- 6 to 8 weeks: 100% accuracy, 60% speed

StopTB Partnership
Radiology for prevalence studies

Creating new solutions for prevalence studies

New solutions for large scale prevalence or screening

Remote diagnosis capability

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

Computer Aided Diagnosis for CXR images

Mobile, sturdy, low dose
Radiology for prevalence studies
Self supporting unit

- 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
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
Radiology for prevalence studies
Access pricing 2009 digital radiology

<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>
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</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.
CheckTB! bridging needs & solutions

We welcome comments and questions!

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