TRAINING COURSE FOR CONSULTANTS
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Chest Radiography
in TB Prevalence Survey

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TB is an airborne disease caused by mycobacterium tuberculosis

When patients with TB in airway cough, sneeze... TB germs spread in the air, when you breath deep into your lung, infection may occur
• Only 10% of the infected may develop disease
• Half of disease occur within 1-2 years after the infection, however, another half will happen anytime through the life of infected people
• Positive in Tuberculin test may indicate that you are infected but not disease
• Once develop disease, without chemotherapy, 50-60% may die within 2 years
• 1/3 will be cured without treatment. However, they may develop disease again. No complete immunity exists
Radiography, CXR, X-ray
Primary Role: Screening, not diagnosis
• At field level - Normal (non-eligible for sputum examination) or Abnormal (eligible for sputum examination).

• By employing intentional over-reading it is expected that there will be some CXR which are labelled ‘abnormal’ at the field level but ‘normal’ at the central level. As long as this percentage is small, it is acceptable.

  – intentional over-reading: when it is not sure if "shadow" suggests a presence of disease or not, take as "abnormal"
• **Normal CXR** – A normal chest X-ray means clear lung fields and no abnormality detected. Participants with normal CXR have no radiological basis for undergoing bacteriological examination.

• **Abnormal CXR** - An abnormal chest X-ray means any lung (including pleura) abnormality detected on interpretation by the medical officer (e.g. opacities, cavitation, fibrosis, pleural effusion, calcification(s), any unexplained or suspicious shadow, etc.). Congenital abnormalities, normal variants, and bony abnormalities like fractures are excluded by definition as are findings like increased heart size and other heart-related abnormalities.
• A more detailed interpretation (audited reading) can be performed at the central level
• The central team should classify x-rays based on a classification decided upon earlier (as mentioned in the x-ray reference manual)
• The result of the central reading will be used as a supportive evidence to define the disease
• May help identify quality issues with lab
CXR Selection

- ? Technology
- ? Number of units
- ? Value additions (e.g. CAD, Teleradiology)
X-ray technologies

CONVENTIONAL
• Conventional radiography
• Conventional with autoprocessor

DIGITAL
• Computed radiography (CR)
• Direct radiography (DR, DDR)
Conventional radiography
Autoprocessor

+ Clean Water
Computed Radiography (CR)

1. X-ray Exposure
   Patient

2. Image Reader

3. Image Scaling

4. Image Record

5. Computed Radiograph

X-ray system
Phosphor plate

unexposed
exposed
Image Acquisition

CR Reader

CR QC Workstation

Display / Archive

DICOM / PACS

Latent image produced

Patient information

Latent image extracted

Laser film printer
Direct Radiography
DDR

- Flat panel
- CCD
- CMOS
- Slot-scan
Post processing – Digital only
Value additions

- Teleradiology
- CRRS(Chest/Comuputed Radiology Reading and Recording System/Services)
- Computer-Aided-Detection (CAD)
- Computed-Aided-Diagnosis (CADx)
- Temporal subtraction imaging
<table>
<thead>
<tr>
<th>No.</th>
<th>Feature</th>
<th>Conventional</th>
<th>CR</th>
<th>Digital</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Electronic data collection, reporting and storage, data management &amp; privacy, back-up data</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>2</td>
<td>High Image readability and quality</td>
<td>NO</td>
<td>YES/NO</td>
<td>YES</td>
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<td>3</td>
<td>Value additions (CAD, Teleradiology)</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>4</td>
<td>Use of films and chemicals (potential environmental issues)</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>5</td>
<td>Radiation safety</td>
<td>NO*</td>
<td>NO*</td>
<td>YES*</td>
</tr>
<tr>
<td>6</td>
<td><strong>Cost</strong></td>
<td><strong>Cheap initially</strong></td>
<td><strong>Intermediate</strong></td>
<td><strong>Cheap in long run</strong></td>
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<tr>
<td>7</td>
<td>Faster throughput</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>8</td>
<td>Immediate image reproducibility</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>
Costs

- Conventional: 10-25,000 USD
- Autoprocessor: 7-12,000 USD
- CR: 50-70,000 USD
- DR with imaging panel: 100-120,000 USD
- DDR: 150,000 USD and above
Long term costs
Hidden costs
Fine print
Logistics, maintenance, breakdown
CXR Requirements

- Planning
- Procurement
- Teamwork
- Allied equipment
- Radiation safety
- Legal and regulatory requirements
- Logistic requirements
- Technical assistance
Planning & Procurement

• Local technical expertise with TA
• Frequent bottleneck and time-consuming step
• Initiate early
• Attention to minute details
  – Accessories
  – Software/hardware
• Legal/regulatory issues
Radiation exposure

• MBUR Referral guidelines, Royal College of Radiologists London: ‘typical effective dose = 0.02 mSv = 3 days app. Equivalent period of natural background radiation

• HPA – RCR: CXR associated risk of childhood cancer is very low and acceptable when compared with natural risk. Radiation doses resulting from Dx procedures present a negligible risk of induced hereditary disease in descendants of the unborn child

• ACR: Some procedures (incl. CXR in 1\textsuperscript{st} & 2\textsuperscript{nd} trimester) render so low exposures that pregnancy status need not be considered for a “medically indicated” exam, as long as good radiation practice is ensured

• At 1 meter, occupational exposure (if no apron is worn) is 0.1% of that which enters the patient.
Regulatory

- No ‘safe’ radiation, use regulated
- Radiation regulatory authority/body clearance
- Ethics committee clearance
- Consent, voluntary participation
- Exclude children, pregnant participants
- Good comprehensive protocol
- Timely engagement
Logistics
Fieldwork
Technical Assistance

- WHO
- TBTEAM
- CDC
- KNCV
- RIT/JATA
- JICA
IDENTIFY X-RAY TECHNOLOGY
- Involve country experts, technical partner, WHO/TBTEAM etc.
- Base decision on available infrastructure (like roads, electricity etc.), regulations on radiation safety, manpower availability, cost

PROCURE
- Start early as it may take considerable time
- Possible facilitators - WHO, UNICEF, UNOPS, GDF etc.

X-RAY TEAM
- Teaching hospital radiology staff / expert radiologist / chest physician / radiographer
- Achieve consensus on methodologies (interpretation, QA etc.)

X-RAY MANUAL
- X-ray team to develop. Assistance can be provided by technical partner, WHO etc.
- Include SOPs, QA, interpretation methodology, radiation safety etc.

TRAIN
- Central X-ray team to impart training
- Include hands-on training and field simulation

PILOT
- Co-ordination of X-ray team, survey team, technical partner, experts
- Identify practical issues and how to tackle them

PRE-VISIT
- Inspect site for housing x-ray equipment
- Sketch map for participant flow in x-ray area

FIELD WORK
- Carried out by field X-ray team under supervision of team leader
- Innovate and adapt to local factors and needs

MONITOR
- To be done by central X-ray team
- Monitor for QA, Interpretation consistency, imputing

POST SURVEY
- To be done by central X-ray team
- Decide on radiological - bacteriological result mismatch
Thank you!