



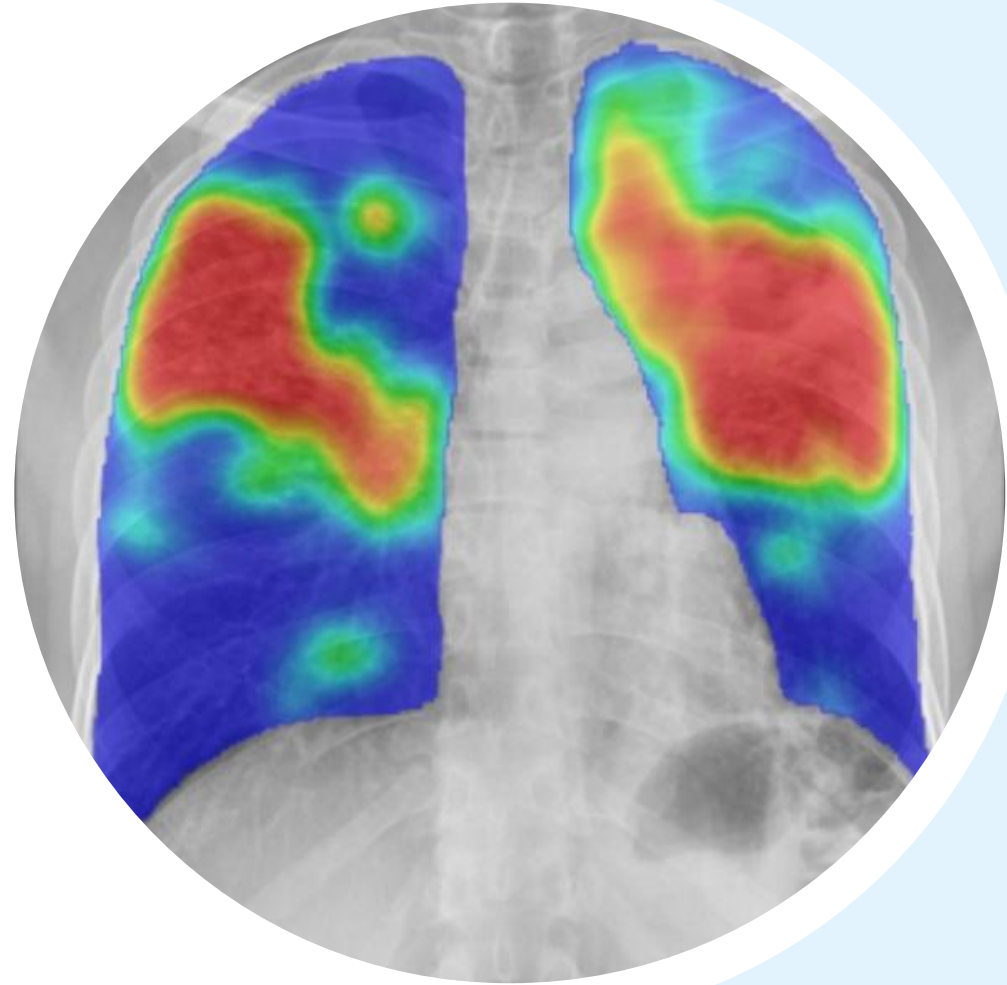
**РЕГИОНАЛЬНЫЙ СЕМИНАР ПО ВОПРОСУ УСКОРЕННОГО ВНЕДРЕНИЯ
РУКОВОДСТВА ВОЗ ПО ПРОФИЛАКТИКЕ И ДИАГНОСТИКЕ ТУБЕРКУЛЕЗА И ЛЕЧЕНИЮ
ТУБЕРКУЛЕЗА С ЛЕКАРСТВЕННОЙ УСТОЙЧИВОСТЬЮ (ЛУ-ТБ)**

**REGIONAL WORKSHOP ON ACCELERATED IMPLEMENTATION OF WHO GUIDELINES
ON TB PREVENTION, DIAGNOSIS, AND DRUG-RESISTANT TB (DR-TB) TREATMENT**

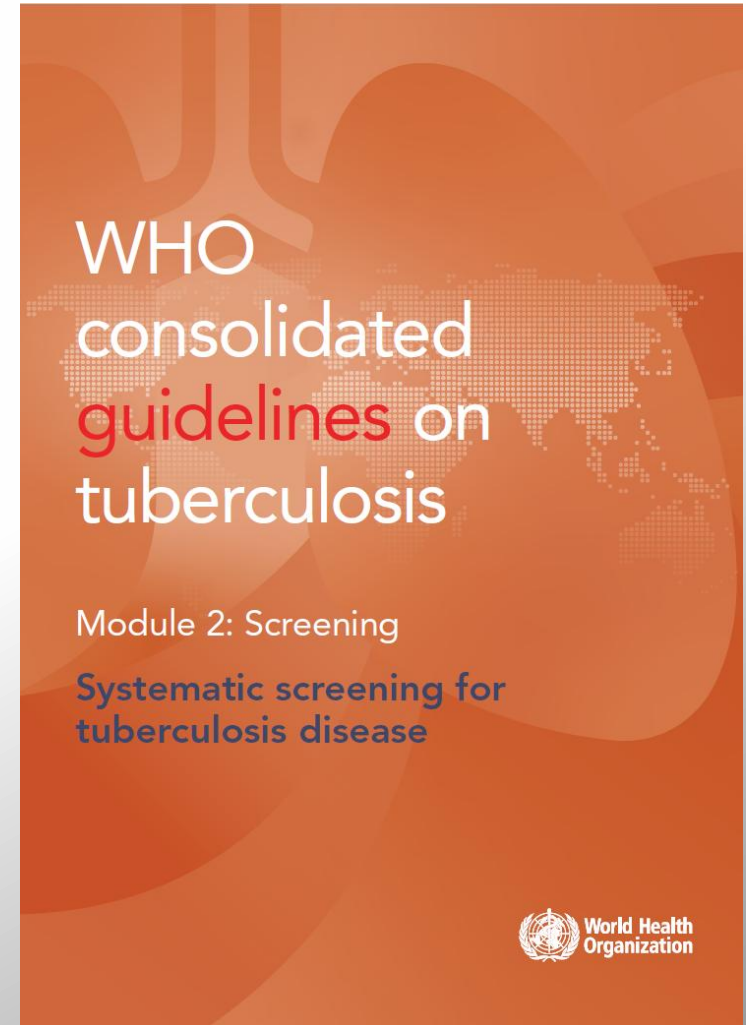
COUNTRY EXPERIENCE IN USE OF CAD FOR TB SCREENING

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Médecins Sans Frontières

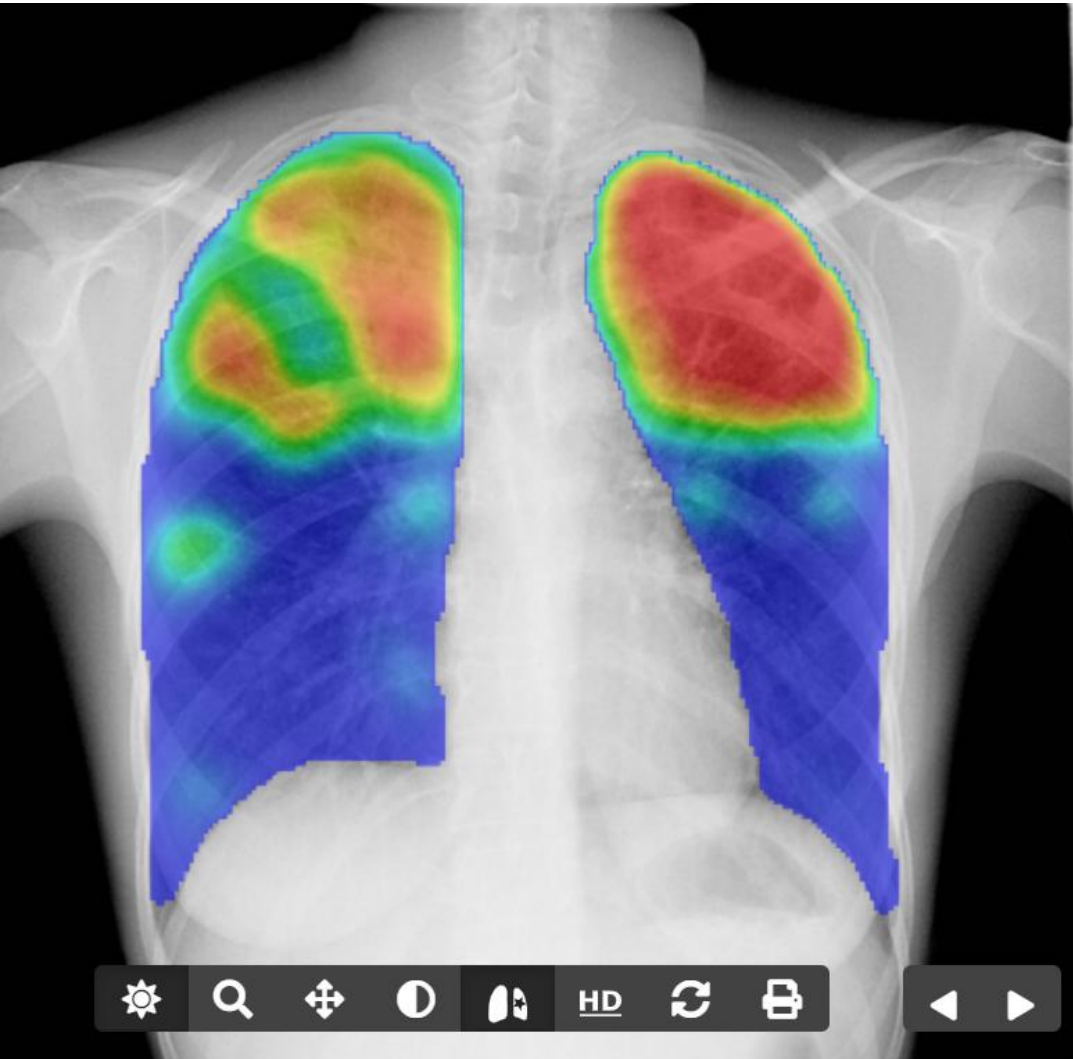
28-30 April 2025
Almaty, Kazakhstan



“Computer-aided detection (CAD) may be used as an alternative to human reader interpretation of digital chest X-rays for screening and triage for pulmonary TB in individuals aged 15 years and older”



AI-based computer-aided detection (CAD)

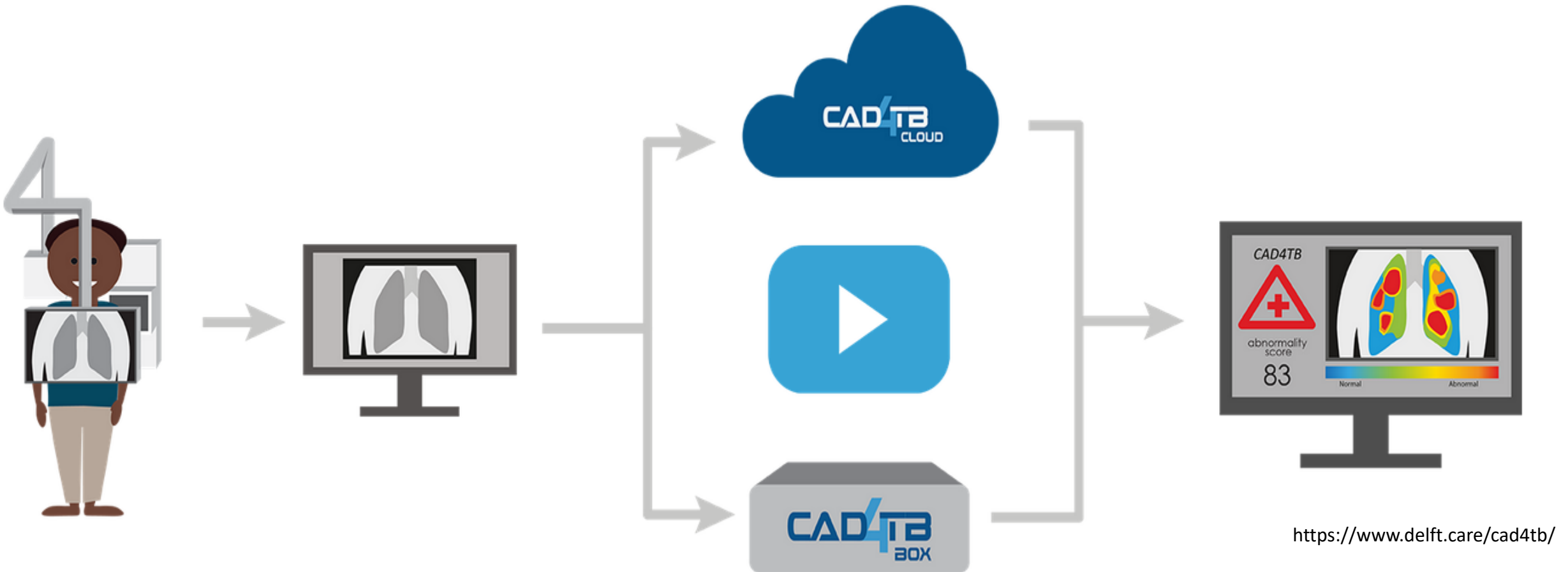


- **Widespread adoption of CAD**
 - Community and facility-based screening for TB
 - Used in 75+ countries
 - >20 CAD products currently available
- **WHO evaluation of CAD solutions in 2025**
 - CAD solutions were evaluated for diagnostic accuracy
 - WHO will release a policy statement on CAD solutions that passed an expert assessment of performance

**1. Digital X-ray
obtained**

**2. Off-line or
Cloud-based CAD**

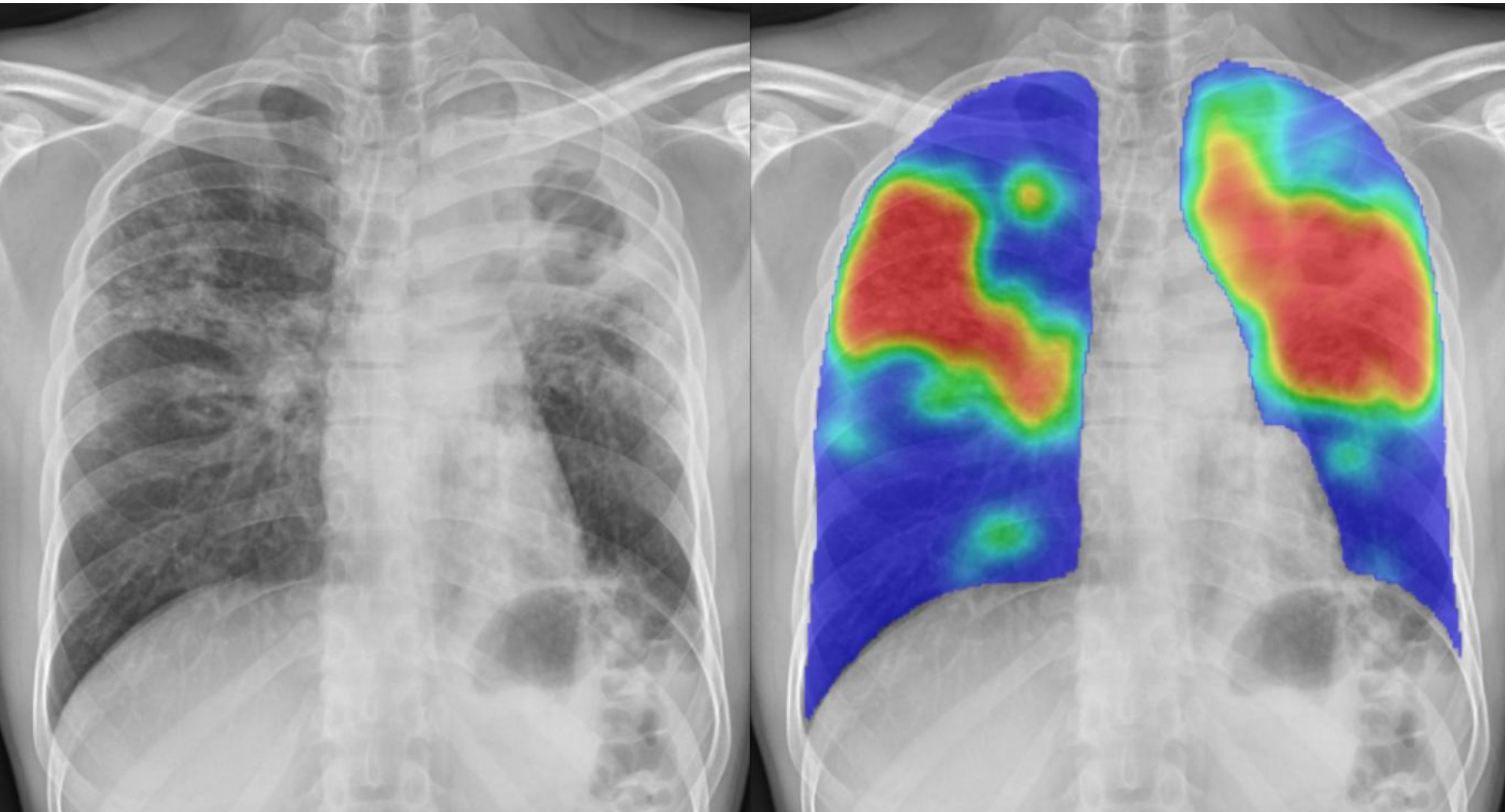
**3. CAD output
(< 1 minute)**



CAD4TB output

GeneXpert: TB detected

CAD score 94



1. Heat map of TB findings
2. TB abnormality score (0-100)

Abnormal



Pneumothorax

qXR Interpretation

Abnormal _____ YES

Lungs

Opacity _____ NO

Consolidation _____ NO

Fibrosis _____ NO

Nodule _____ NO

Emphysema _____ NO

Cavity _____ NO

Pleura

Blunted Costophrenic Angle _____ NO

Pleural Effusion _____ NO

Pneumothorax _____ YES

Mediastinum

Tracheal Deviation _____ NO

Hilar Enlargement _____ NO

Heart

Cardiomegaly _____ NO

Diaphragm

Elevated Hemidiaphragm _____ NO

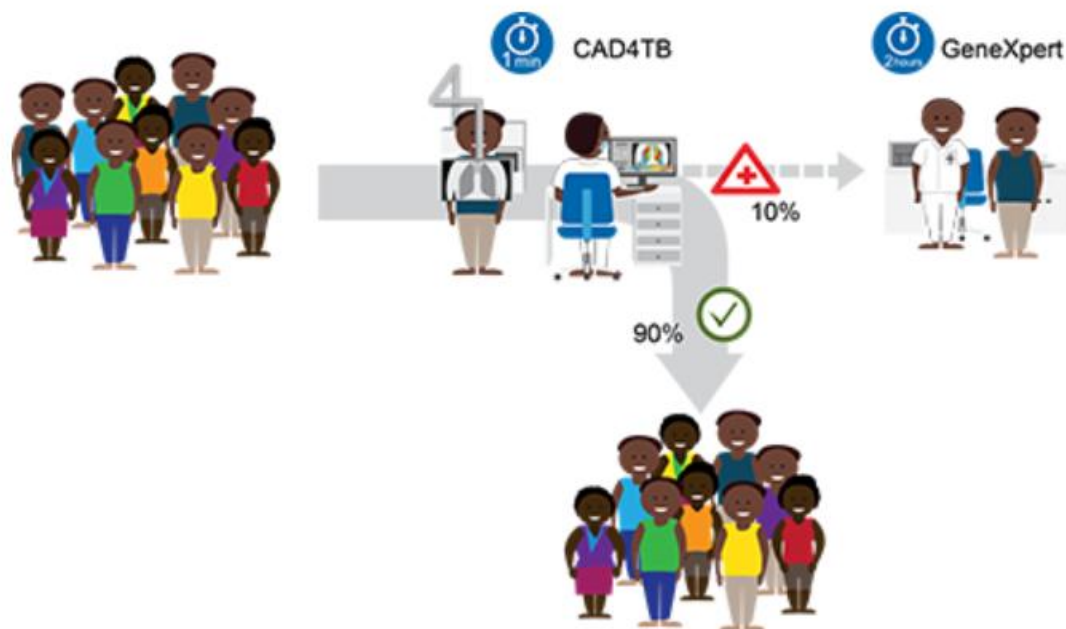
Pneumoperitoneum _____ NO

Bones

Scoliosis _____ NO

Rib Fracture _____ NO

CAD for TB screening



- CAD is not used for TB diagnosis
- CAD can help identify individuals who need to go for confirmatory testing (e.g. GeneXpert)
- Threshold score (e.g. 40) is selected:
 - CAD score > 40 → **GeneXpert**
 - CAD score < 40 → **No GeneXpert**

CAD threshold selection

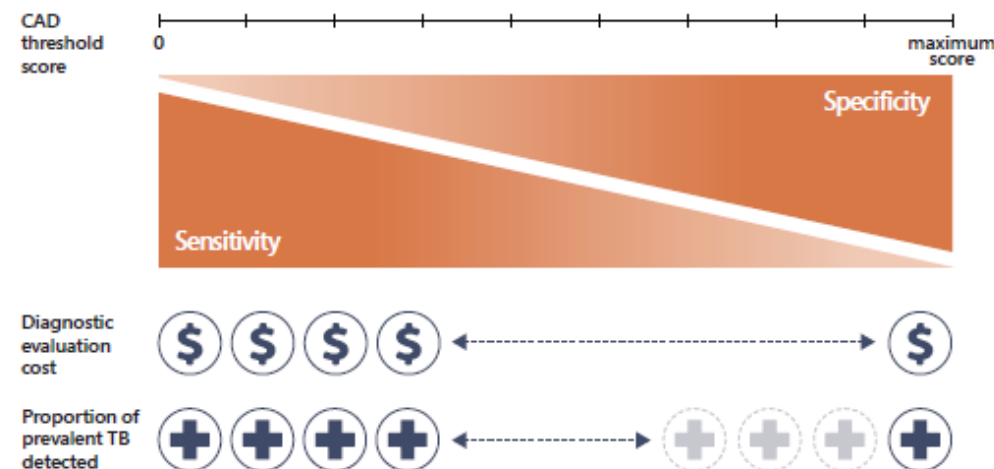
- **Threshold selection**

- CAD performance depends on which threshold is selected
- Trade-off between sensitivity and specificity (e.g. higher sensitivity = lower specificity)

- **Threshold needs to be calibrated to local conditions**

- CAD scores **vary in different contexts**, depending on population characteristics (e.g. age, co-morbidities, TB prevalence, etc), CAD product, X-ray equipment
- Also need to consider **confirmatory testing capacity**

Fig. 4.1 Sensitivity vs specificity over the CAD threshold spectrum



2021 WHO Operational Handbook on TB

CAD in MSF

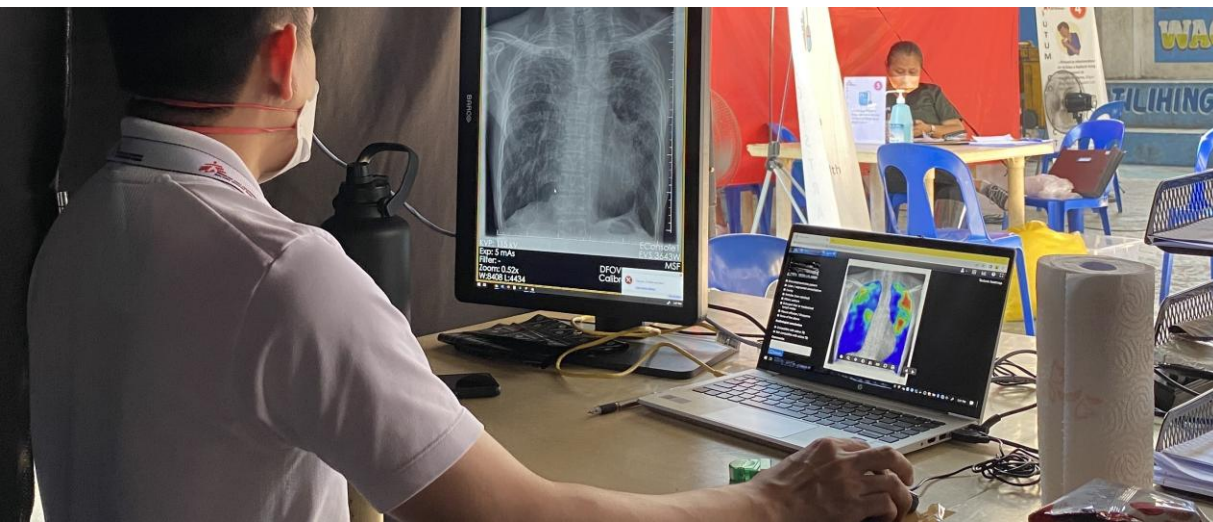
Philippines



Tajikistan

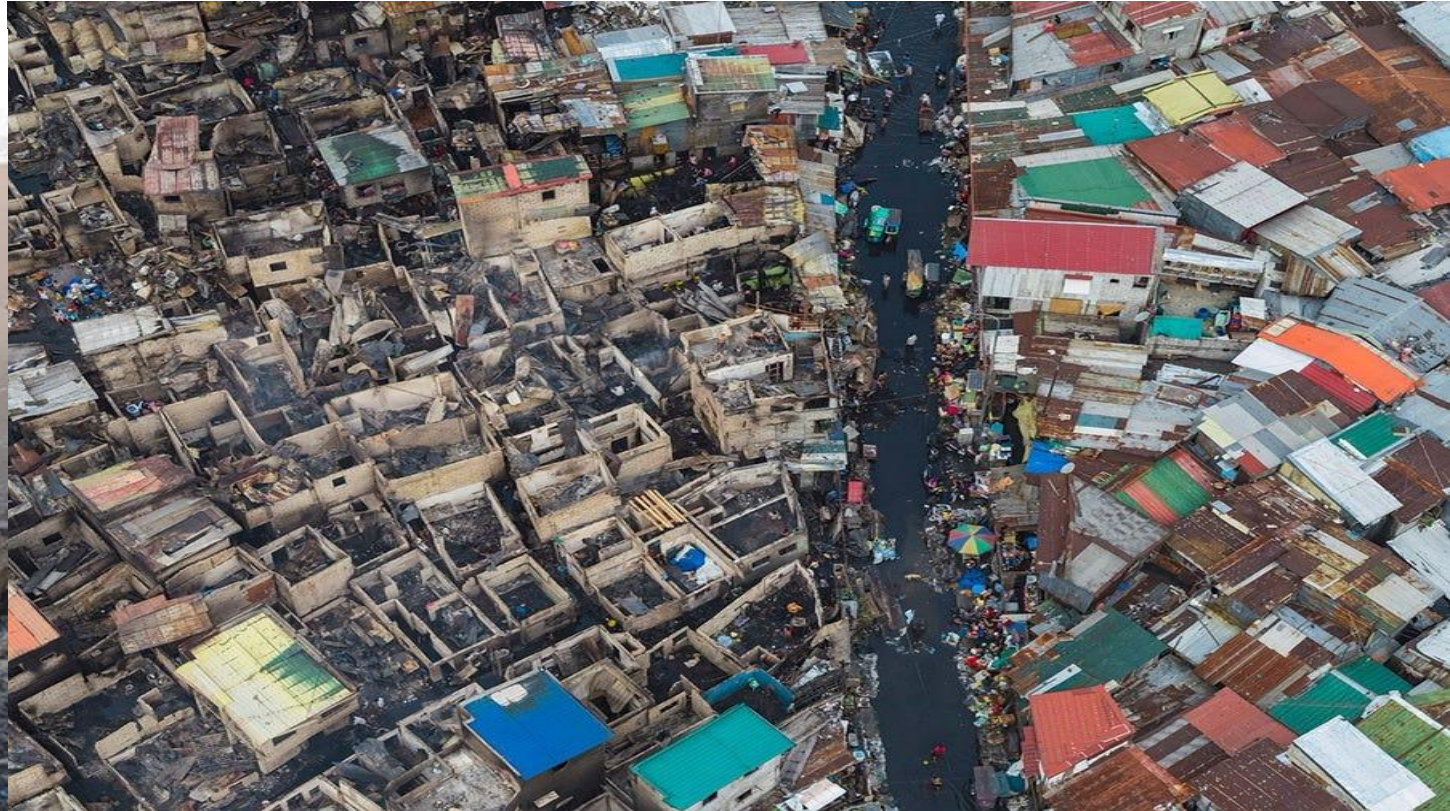


Central African Republic



CAD in Philippines

- Objective: TB active case finding (ACF) and contact tracing in densely populated urban district of Manila (Tondo district)



CAD in Philippines

- ACF with **mobile X-ray truck**, allowing movement between ACF sites

ACF circuit:

1. Patient registration
2. Symptom screening
3. Chest X-ray / CAD
4. Sputum collection
5. Physician evaluation
6. Exit registration



CAD in Philippines

- Offline CAD4TB version 7 (Delft Imaging) installed in X-ray truck
- All ACF participants received CXR with CAD
- Those with **CAD scores > 32** or with **symptoms** referred for sputum Xpert testing



**GENEXPERT
POSITIVITY RATES
BY CAD SCORE
(2022-2024)**

CAD score	Sputum Xpert positive (n)	Total sputum (N)	% Xpert positive (n/N)
≥ 90	151	206	73.3%
80-89	124	217	57.1%
70-79	206	618	33.3%
60-69	145	700	20.7%
50-59	99	602	16.4%
40-49	85	1,220	7.0%
30-39	63	1,841	3.4%
20-29	13	496	2.6%
10-19	3	251	1.2%
< 10	8	636	1.3%

CAD in Philippines: Impact

- ❖ CAD has helped screen **>38,000 people** in Tondo district for TB since November 2022
- ❖ **Nearly 5% of all screened individuals** found to have bacteriologically confirmed TB
- ❖ **Almost 2/3 of individuals** with bacteriologically confirmed TB were asymptomatic
- ❖ CAD has helped **decrease turnaround time of ACF circuit by 50%**

CAD in Tajikistan

- Objective: Screen population of a remote district (Kulob) for TB through ACF activities
- Mobile radiology unit that can move to different locations to increase access to X-ray



CAD in Tajikistan

- Ultraportable X-ray (Delft Light) used with CAD4TB v7
- X-ray and CAD can be assembled / disassembled every day before and after ACF (20 min for set-up)
- Ultraportable X-ray with CAD allows flexible and versatile set-up



CAD in Tajikistan



ACF circuit:

1. Patient registration / Symptom screening
2. Chest X-ray / CAD
3. Physician evaluation
4. Referral for GeneXpert testing



CAD in Tajikistan: Impact

- ❖ CAD has helped screen **>16,000 people** in Kulob district for TB from May 2023 – March 2025
- ❖ Portability of equipment allows mobility and flexibility of ACF
→ more **decentralized model of TB care** and **increased access to X-ray**
- ❖ CAD has facilitated **transition to digital system** for ACF
- ❖ CAD has been an important **support tool for physicians**, enabling them to work **more efficiently** and with **greater confidence**

CAD in Central African Republic

- CAD implemented in hospital in remote region of Central African Republic



- CXR with CAD used for TB screening of hospitalized patients with symptoms

CAD in Central African Republic

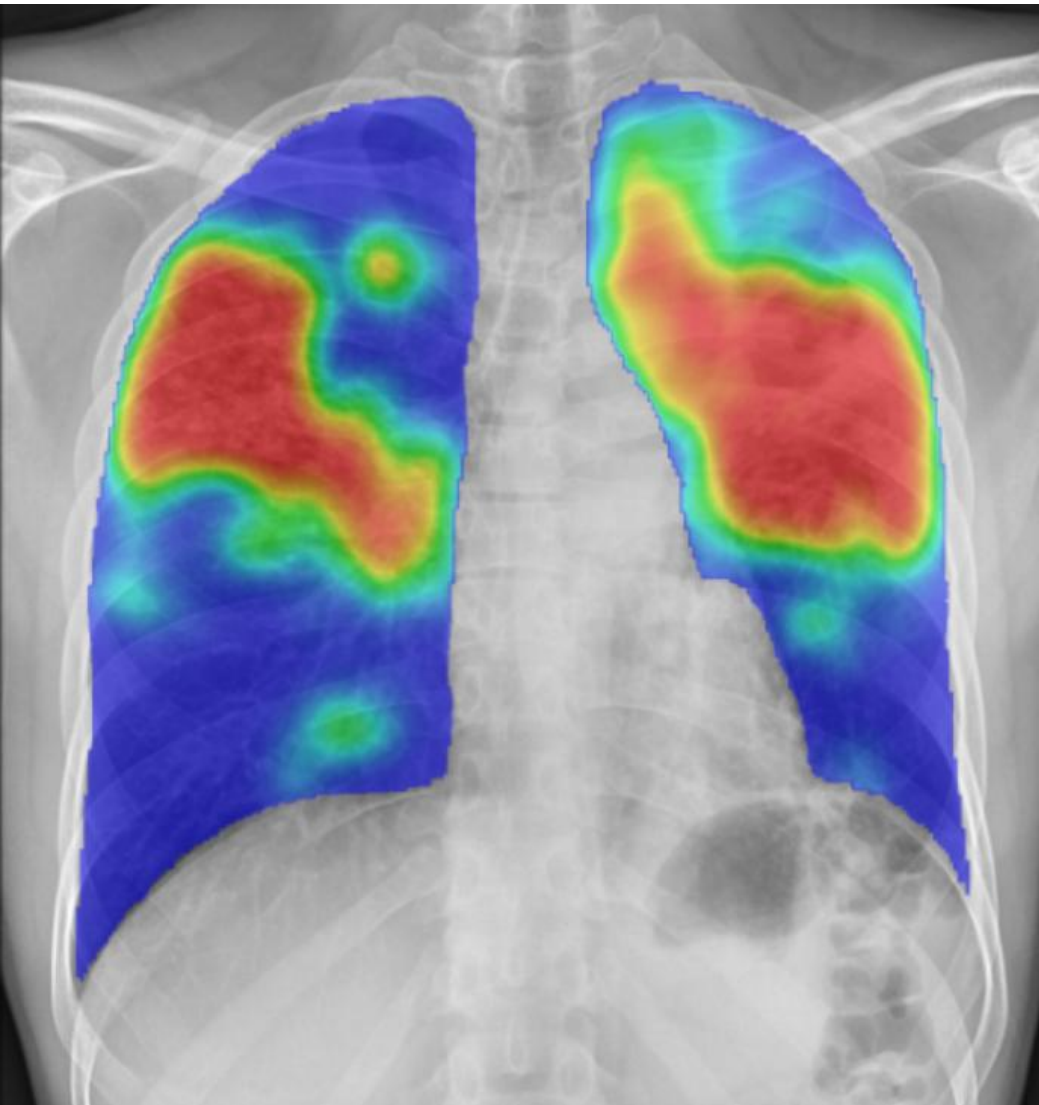
- Offline CAD4TB v7 set up in radiology department and connected to existing X-ray machine



CAD in Central African Republic

CAD score	CXR findings	Result	Comments
0 – 20	No significant findings	No Xpert	
20 – 40	Minor findings	No Xpert Clinical follow-up	
> 40	Possible TB	Xpert	
> 70	Possible or Probable TB	Xpert	If Xpert negative: <ul style="list-style-type: none">• <u>No previous TB</u>: Consider clinical diagnosis of TB• <u>Previous TB</u>: Use clinical judgement (CAD is less reliable)

Impact of CAD



1. **CAD is accurate for TB detection (with good quality CXR)**
2. **CAD can increase efficiency**
 - Decreased turnaround time
 - Increased number of individuals screened (e.g. 150 people/day)
3. **CAD can help non-expert readers with CXR interpretation**
4. **CAD can decrease costs**
 - More efficient use of confirmatory tests
 - Decreased need for human resources

Challenges

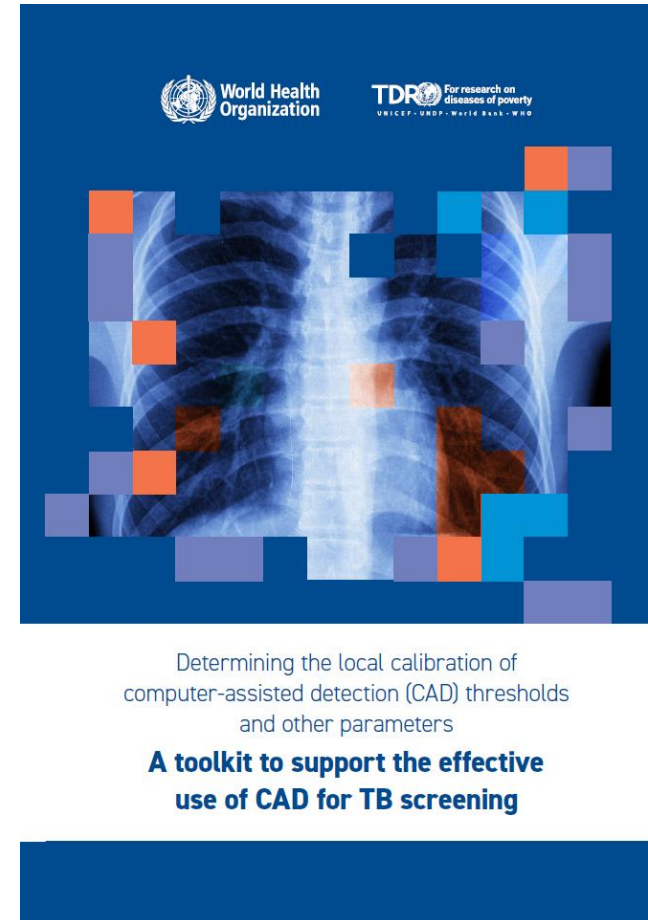
1. Need guidance on CAD implementation and proper use

2. Increased awareness of CAD limitations

- Only recommended for ages 15+
- Only recommended for TB detection (limited evidence for non-TB findings)
- Decreased accuracy in individuals with previous TB disease and PLHIV
- Not used to diagnose TB

3. CAD threshold selection

- WHO/TDR toolkit for threshold calibration



Screening and Triage for TB using Computer-Aided Detection (CAD) Technology and Ultra-portable X-Ray Systems: A Practical Guide

WHO
consolidated
guidelines on
tuberculosis

Module 2: Screening

Systematic screening for
tuberculosis disease


Pragmatic approach to CAD threshold selection

General points

- Agile and flexible method to select and adjust CAD threshold
- Does not require confirmatory test results prior to CAD implementation
- Practical step-by-step guide developed by MSF in collaboration with WHO will be available soon

Two main steps

1. **Initial threshold selection:** 3 options (e.g. match CAD to expert human reader)
2. **Threshold adjustment:** Evaluation of indicators to decide if threshold needs adjustment

	CAD threshold calibration: Pragmatic Approach	
	Diagnostic Imaging SOP	
	Doc ID: TBC	Year 2024
	Document status: DRAFT	Language: EN
	Validation by: MSF DIWG	Page 1 of 20

Background

Chest X-ray (CXR) has an important role in screening and triage for tuberculosis (TB) because of its high sensitivity for TB, low operational costs and rapid turn-around of results. However, countries with the highest prevalence of TB often have the lowest availability of local expertise in CXR interpretation.

Computer-aided detection (CAD) is a form of artificial intelligence that uses machine-learning technology to analyse medical images and detect radiographic abnormalities. It can be particularly useful to non-expert readers to aid CXR interpretation and may help improve detection of TB in high burden settings.

CXR with CAD has been validated in multiple studies for TB screening and triage. CAD indicates the likelihood of TB based on identification of relevant CXR findings and studies have shown that CAD performs as well as expert human readers in detection of TB.

In an independent evaluation, WHO found that the diagnostic accuracy and overall performance of CAD for TB detection (CAD-TB) are similar to interpretation by a human reader, in both the screening and triage contexts. In 2021, WHO endorsed the use of CAD as an alternative to human reader interpretation of CXR for pulmonary TB in individuals aged 15 years or above (1).

The output for CAD-TB products is a numeric score (e.g. 0-1, 0-100), which represents the likelihood of TB; i.e. the higher the score, the more likely the radiographic findings represent pulmonary TB.

It is important to note that CAD-TB output is not used to diagnose TB. Instead, CAD can help identify individuals who should be referred for confirmatory testing by a molecular WHO-recommended rapid diagnostic test (mWRD). In order to identify the most appropriate individuals for testing, a threshold score must be selected. Those with a CAD score above threshold are referred for confirmatory testing, while those with a CAD score below threshold are not referred.

CAD threshold calibration

The performance of CAD-TB is highly dependent on the selection of threshold. In choosing between different thresholds, there is a trade-off between sensitivity and specificity. For example, selecting a lower threshold results in higher sensitivity but lower specificity, resulting in detection of more individuals with TB but at the cost of more diagnostic tests used. A higher threshold can reduce the costs of confirmatory testing but a larger number of TB cases will be undetected.

It is essential that the CAD threshold is calibrated to local conditions. CAD scores vary across contexts due to factors such as TB prevalence, co-morbidities in the population, CAD product and

Challenges



Other challenges

- Avoid overreliance on CAD (e.g. still need humans for non-TB diagnoses and clinical integration)
- Managing individuals with high CAD scores and negative confirmatory tests
- Implementing CAD for facility-based screening
- Poor CXR quality affects CAD results

CAD is not “Plug-and-Play”

- Requires proper guidance, training, technical support, integration into clinical workflow, monitoring and evaluation, etc

**“AI will not replace radiologists, but
radiologists using AI will replace
those not using AI”**

THANK YOU!
СПАСИБО!

