



Center for
Tuberculosis

Artificial Intelligence and TB X-Ray Interpretation

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Artificial Intelligence



Tuna



ENT:

Pt. is asymptomatic by path

tolerating Bupropion well

except for nausea & perspiration

C. 1.4

Pt. is active headsets & sexual

blowing & perianth

Ph: 2002, 2002, 2002

1st test: 1st & 2nd & 3rd

Nm: ① serum

② blood

HP/NP: ①

② slight frontal sin

lx - clear, TUC noted

well tolerated scan, reading

achyromin

TE P. 1st

2nd: still

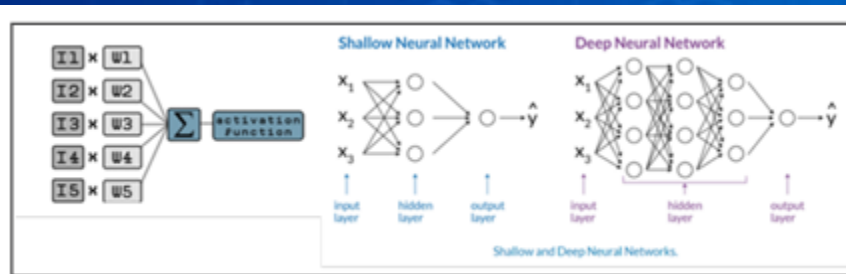
Plan: - continue Bupropion

- plan an

“The patient has a normal physical exam, and normal labs”

AI x-ray interpretation

COMPUTER AIDED
DETECTION (CAD) FOR
TUBERCULOSIS



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How are we going to “instruct” our algorithm to recognize TB?



= TB



Not = TB

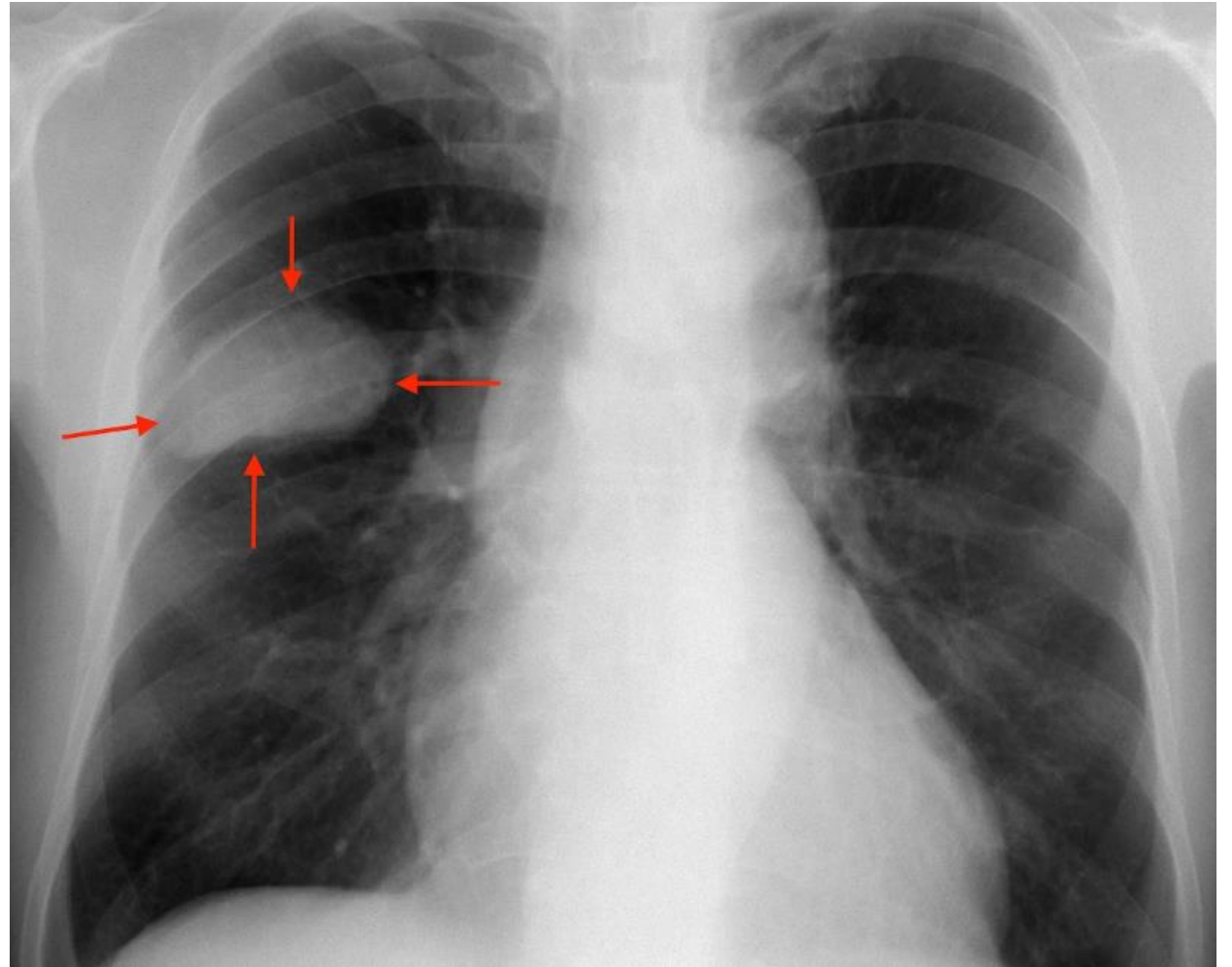
What do we
consider to be
TB for our
training set?

- Microbiologic confirmation
- Clinical case
- Radiologist confirmed

What population characteristics?

- Age
- HIV-status
- Region/population
- Disease severity
- BMI
- Sex
- Pregnancy
- Co-morbidities (e.g. diabetes)
- Prior TB
- Smoking
- Symptoms

What do we
want the tool to
do about non-TB
abnormalities?



WHO consolidated guidelines on tuberculosis

Module 2: Screening
Systematic screening for
tuberculosis disease



Type of case and type of reader	Accuracy estimate range	
	Sensitivity	Specificity
WHO target product profile	> 0.90	> 0.70
Screening use case		
CAD software	0.90–0.92	0.23–0.66
CXR with human reader	0.82–0.93	0.14–0.63
Triage use case		
CAD software	0.90–0.91	0.25–0.79
CXR with human reader	0.89–0.96	0.36–0.63

10. Among individuals aged 15 years and older in populations in which TB screening is recommended, computer-aided detection software programmes may be used in place of human readers for interpreting digital chest X-rays for screening and triage for TB disease (*new recommendation: conditional recommendation, low certainty of evidence*).

Current product landscape

Computer-aided detection of tuberculosis from chest radiographs in a tuberculosis prevalence survey in South Africa: external validation and modelled impacts of commercially available artificial intelligence software

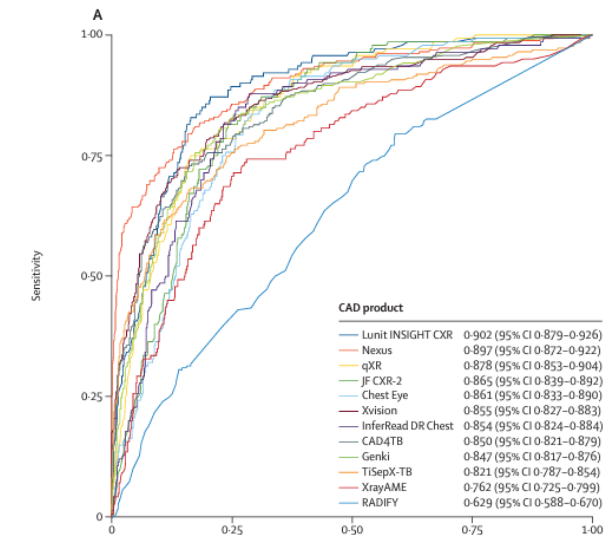
Zhi Zhen Qin*, Martie Van der Walt*, Sizulu Moyo, Farzana Ismail, Phaleng Maribe, Claudia M Denkinge, Sarah Zaidi, Rachael Barrett, Lindiwe Mvusi, Nkateko Mkhondo, Khangelani Zuma, Samuel Manda, Lisa Koepfel, Thuli Mthiyane†, Jacob Creswell†

**Lancet Digit Health 2024;
6: e605-13**

	Threshold	Sensitivity	Specificity
Threshold to match 90% sensitivity			
Lunit	0.07	89.9% (85.6–93.3)	67.7% (63.5–71.7)
Nexus	0.48	89.9% (85.6–93.3)	67.1% (62.9–71.2)
JF CXR-2	0.23	89.5% (85.1–93.0)	62.7% (58.3–66.9)
qXR	0.18	90.3% (86.0–93.6)	62.3% (57.9–66.5)
ChestEye	0.08	89.1% (84.7–92.7)	61.3% (57.0–65.5)
Xvision	0.11	89.9% (85.6–93.3)	58.6% (54.2–62.9)
CAD4TB	3	89.9% (85.6–93.3)	55.7% (51.3–60.0)
InferRead	0.26	90.3% (86.0–93.6)	54.9% (50.5–59.3)
Genki	0.02	89.5% (85.1–93.0)	54.5% (50.1–58.9)
TiSepX-TB	0.18	89.9% (85.6–93.3)	48.0% (43.6–52.4)
XrayAME	0.02	88.4% (83.8–92.0)*	36.9% (32.8–41.3)
RADIFY	0.02	82.6% (77.4–87.0)*	32.5% (28.5–36.7)
Threshold to match 70% specificity			
Lunit	0.09	89.5% (85.1–93.0)	70.2% (66.1–74.1)
Nexus	0.54	88.8% (84.3–92.3)	69.8% (65.7–73.8)
qXR	0.32	86.8% (82.1–90.7)	70.2% (66.1–74.1)
JF CXR-2	0.4	86.4% (81.6–90.4)	70.0% (65.9–73.9)
ChestEye	0.11	86.0% (81.2–90.0)	69.6% (65.5–73.6)
InferRead	0.37	85.7% (80.8–89.7)	70.4% (66.3–74.3)
Xvision	0.14	85.7% (80.8–89.7)	69.6% (65.5–73.6)
Genki	0.09	84.5% (79.5–88.7)	70.6% (66.5–74.5)
CAD4TB	12	81.0% (75.7–85.6)	70.6% (66.5–74.5)
TiSepX-TB	0.29	77.5% (71.9–82.5)	70.8% (66.7–74.7)
XrayAME	0.13	68.6% (62.6–74.2)	70.6% (66.5–74.5)
RADIFY	0.57	43.4% (37.3–49.7)	71.0% (66.9–74.9)†

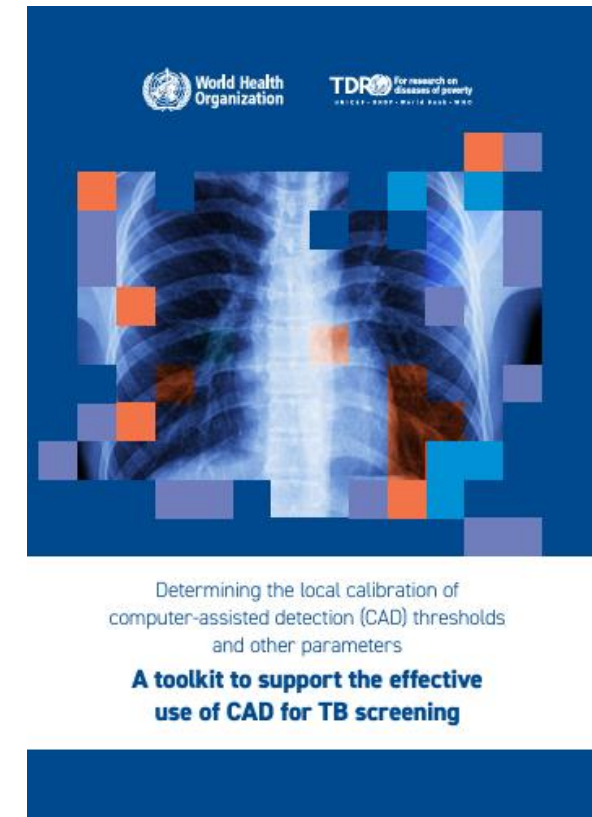
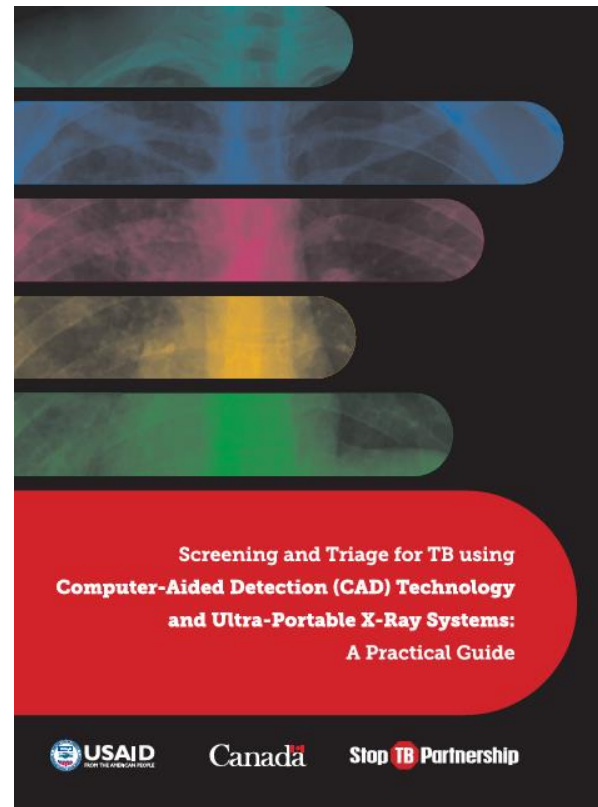
*The closest sensitivity to 90%. †The closest specificity to 70%.

Table 2: Computer-aided detection performance compared with 90% sensitivity and 70% specificity target values



Implementation Considerations

- Objectives
- Local validation
- Product
- Threshold
- Resources
- Integration with current work-flow



Stop TB Partnership hosted by UNOPS WHO WE ARE WHAT WE DO PARTNER WITH US RESOURCES NEWS DONATE



What use case?

What objective?

SCREENING

Population



X-Ray



Evaluation

TRIAGE

Clinical suspicion



X-Ray



Evaluation

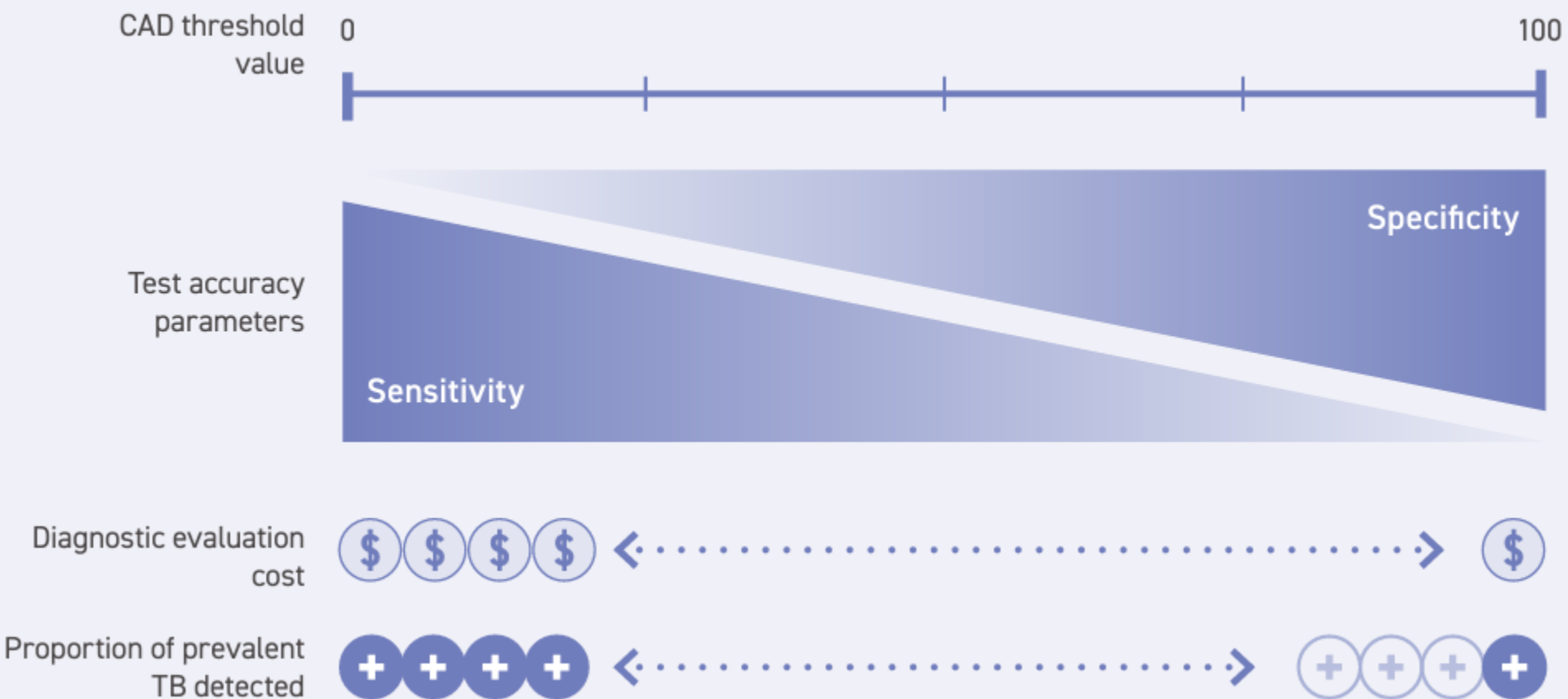
Implementation Considerations

■ Product

 T-Xnex Certification: Pending Development Stage: Validation Intended Age Group: 18+ years	 DxTB Certification: Pending (expected Q2 2021) Development Stage: On the market Intended Age Group: 14+ years	 CAD4TB Certification: CE-marked Development Stage: On the market Intended Age Group: 4+ years	 DrCADx Certification: Pending (expected in 2021) Development Stage: Validation Intended Age Group: 16+ years
 XrayAME Certification: Pending (expected Q1 2021) Development Stage: On the market Intended Age Group: 18+ years	 InferRead DR Chest Certification: CE-marked Development Stage: On the market Intended Age Group: 15+ years (approved), 12 - 18 years	 JF CXR-1 Certification: Pending (China NMPA-tier 3 expected in mid-2020) Development Stage: On the market Intended Age Group: 15+ years	 JLD-02K (JIEVER-X) Certification: CE-marked, Korea FDA, Australia FDA Development Stage: On the market Intended Age Group: 10+ years
 INSIGHT CXR Certification: CE-marked Development Stage: On the market Intended Age Group: 14+ years	 qXR Certification: CE-marked Development Stage: On the market Intended Age Group: 6+ years (approved), 2+ years	 AXIR Certification: CE-marked Development Stage: On the market Intended Age Group: 16+ years	The landscape of CAD products for TB is rapidly growing, and innovative new products are expected to either reach the market or receive certification later in 2021. The www.ai4hlth.org website will continue to be the most up-to-date resource.

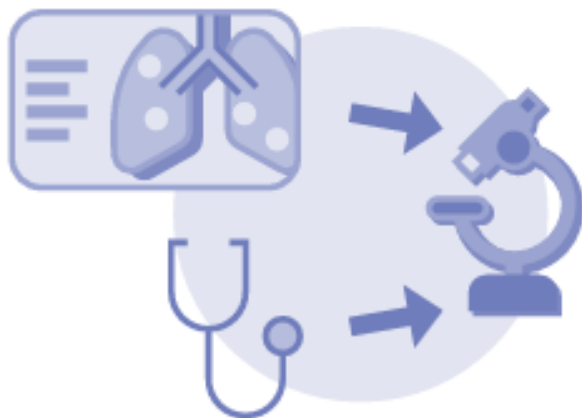
ai4hlth.org is a regularly updated online marketplace of CAD products for TB.

Figure 1: Sensitivity vs. specificity across CAD threshold spectrum





All x-rays read by CAD.
Abnormal x-rays (and
subset of normal) read by
radiologist prior to work-up



All x-rays read by CAD and
radiologist. Any abnormal
x-ray from either gets work-
up

Integration and operationalization



Thank you