

An Improved computer assisted detection (CADx) plugin for TB diagnosis from digital Radiographs

Prakash Kodali, Development Team

Adevnio India (Chandigarh & STEP, IIT Kharagpur)

(on behalf of Mausumi Acharyya, Advenio CEO)

leadership



Dr. Mousumi Acharyya

CEO Advenio

Lead Engineer GE Global Research, Bangalore

Senior Developer , Siemens India, Bangalore

DRDO

Post Doc, Upenn; PhD, Indian Statistical Insititute, Kolkata

> 10 patents medical image analysis; > 50 publications



Dr. Kunal Bose

COO Advenio

APAC, MiddleEast & Africa Agilent Technologies Nanosciences

APAC Sr. Applications Specialist, Bruker Nano

Post Doc, Columbia Univ., Radboud Univ., Leeds Univ.

PhD, Southampton University

B. Tech Indian Institute of technology

Advisory Board



Prof. K. Suzuki
Radiology, U of Chicago



Dr. B. R. Das
President, Res & Inno SRL (Religare)



Prof. M. Garg
Radiology, PGI Chandigarh



Prof. P. Klatser
Instituut Voor Tropen/KIT



Dr. B. John
The Global Fund, AIDS, TB &
Malaria



Dr. A. Yadav
Clinton Foundation

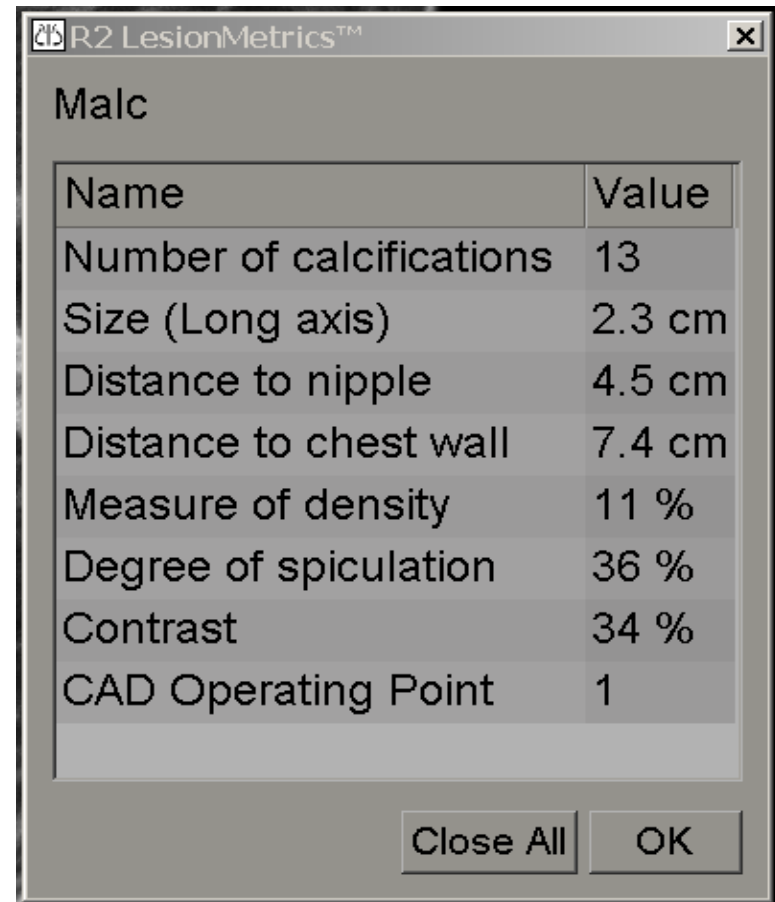
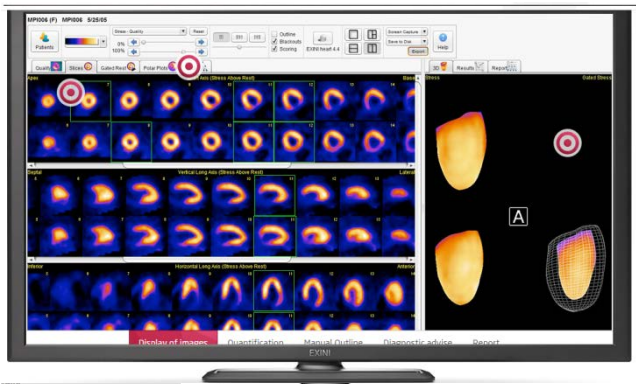
Computer Assisted radiography (CADx)-

Machine learning & Artificial Intelligence

- Widely used predominantly in cancer, cardiac, dementia, Alzheimer's & other 'diseases of affluence' radiography – USES DIGITAL IMAGES
- Neglected in 'poverty diseases'
< 20 scientific publications

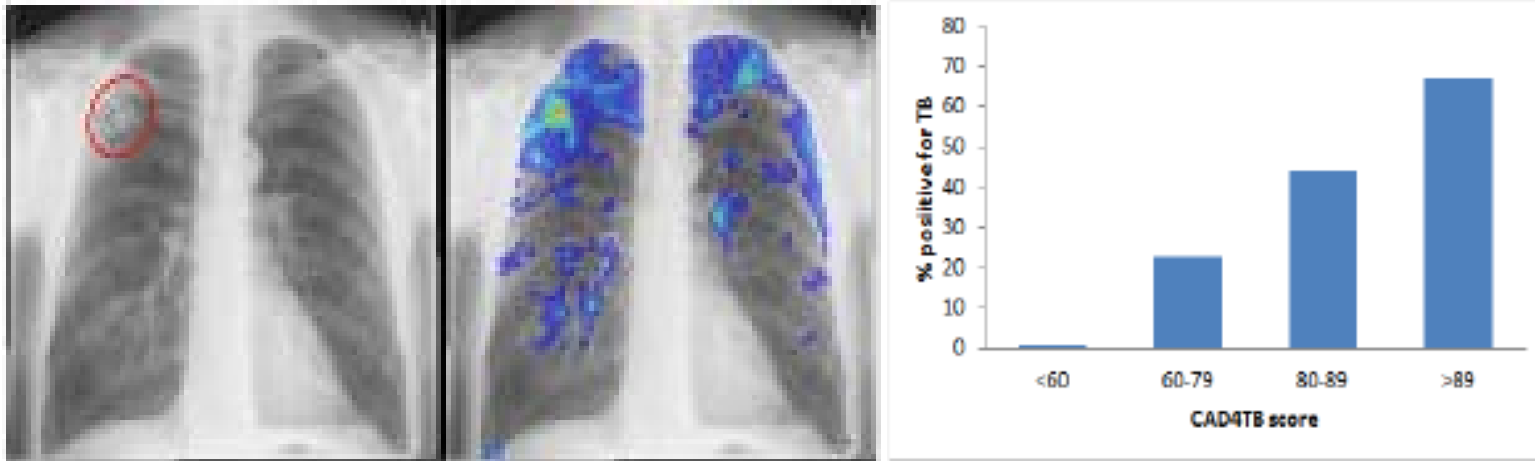
**IMPROVES EVEN EXPERT RADIOLOGIST
PERFORMANCE BY UPTO 25% AND CUTS
INTERPRETATION TIME MANIFOLD**

**Prostrate cancer/dementia/cardiac
function**



Name	Value
Number of calcifications	13
Size (Long axis)	2.3 cm
Distance to nipple	4.5 cm
Distance to chest wall	7.4 cm
Measure of density	11 %
Degree of spiculation	36 %
Contrast	34 %
CAD Operating Point	1

CADx in PTB



- **Restricted to predominantly academic studies in screening/triage and prevalence studies in presumptive populations**
- **Using mobile hardware in field settings attempting autoscoring in the absence of radiological opinion – not in radiological settings in the healthcare system**
- **Validation limited predominantly to specific ethnicity – sub-saharan Africa**
- **NOT VALIDATED IN INDIA AT.**

CADx in PTB

Delft Imaging systems, Netherlands –
Hardware specific CAD4TB



SOUTH ASIA (2013-14)



**SUB-SAHARAN
AFRICA**



CXR in PTB diagnosis algorithm

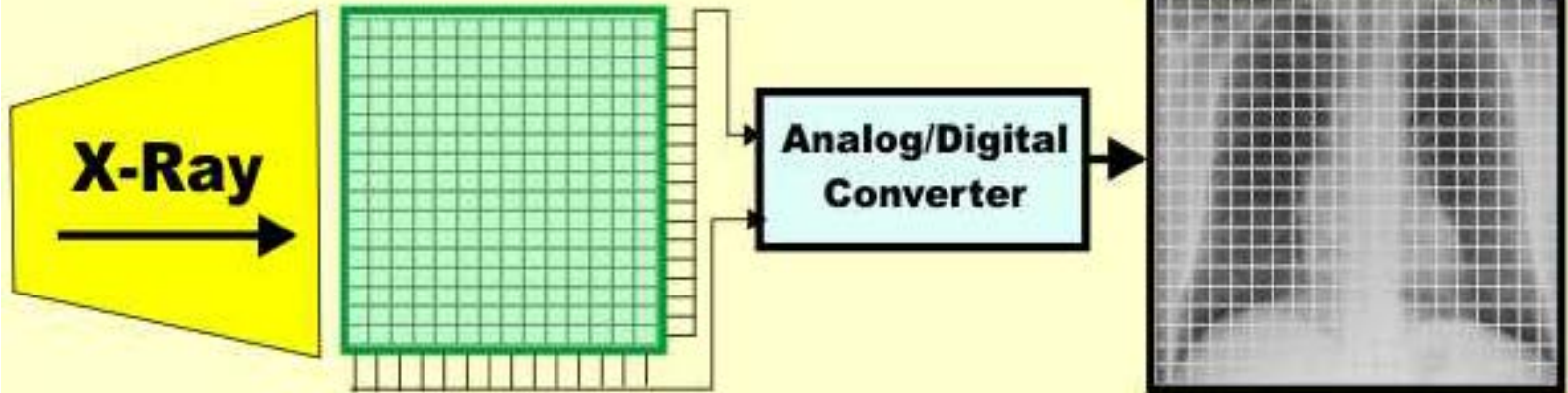
- Widely adopted in healthcare systems in diagnosis and management of TB & respiratory infection symptoms – screening of sputum negative suspect cases
- Primary imaging modality in symptomatic patients – DOTS strategy recommends CXR to follow ‘sputum negative’ cases
- CXR is evaluation & monitoring recommended by the WHO for the clinical case management/treatment evaluation of both resistant and non drug resistant TB
- *(non RNTCP) 78% of the cases of pulmonary TB were diagnosed on the basis of chest radiography alone - before they submitted a sputum sample to District TB Center , CXR normally high sensitivity, lower specificity*
- *In a survey of general practitioners in New Delhi, only 12% of private practitioners opted for sputum examination for diagnosis of pulmonary TB, with 88% relying on chest radiology (Pai, 2011)*
- Studies highlight the usefulness of CXR before Xpert testing in smear-negative suspect cases – (Oct. 2014, Nat. Tuber. Ins. Bangalore & S. Vivekananda Rural Health Centre)
- *Of 378 individuals with both Xpert and CXR results available, 14 were positive for Mycobacterium tuberculosis. Of these, 13 (92.9%) had an abnormal CXR and one was normal – primary human radiologist interpretation considered ground truth*

CXR in PTB diagnosis algorithm

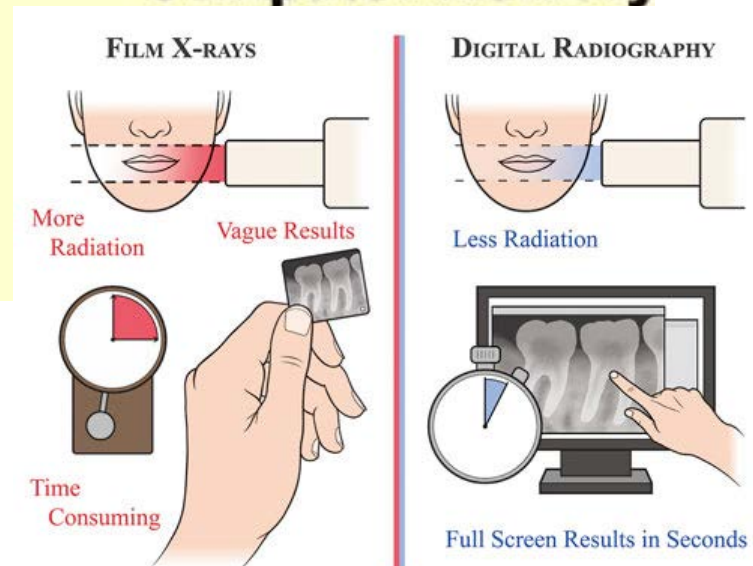
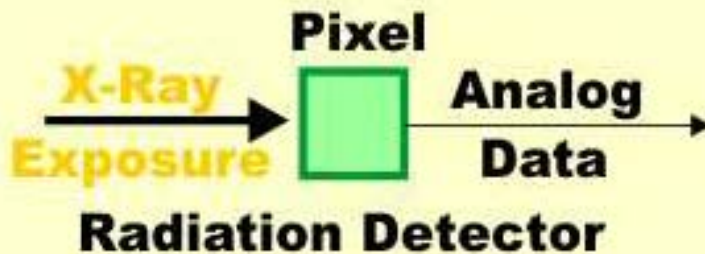
- Sputum smear followed by CXR effective and most cost efficient strategy, CXR score "No pathology" with a certainty of over 90% rules out active TB (Klatser, 2005)
 - Need for the "Introduction of a clearly defined scoring system for CXR for the interpretation of CXR may well improve the diagnostic performance" – the study employed a 'expert' validation to readings following ground truth interpretations
 - High Sensitivity, relatively low specificity (> 90 & < 70 respectively) – consistent with other reports
- *The WHO does not provide a clearly defined scoring system for CXR in TB – hence CXR performance difficult to evaluate systematically - Human factor/skill level*
- *Computer assisted diagnosis for TB from CXR – Applies the same algorithm for diagnosis everytime!! – (well defined scoring system)*

Digital Radiography

Auto contrast High resolution digital image



Computer Memory



Digital Radiography



Direct Digital
\$40,000
(INR 25-30 L)

Digital image acquired by direct or in-direct digital X-ray flat panel detector.

DR
Digital Radiography

Retrofit Analog
< \$20,000 (INR 10-12 lakhs)



Lower operating cost

CR
Computed Radiography

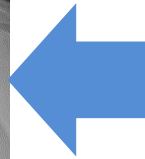
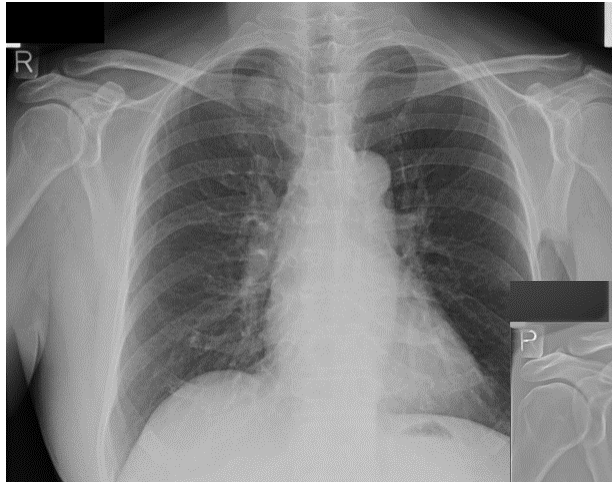
Instead of X-ray film, imaging plate is used. It is digitalized by optical scanner.

ANALOG

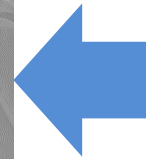
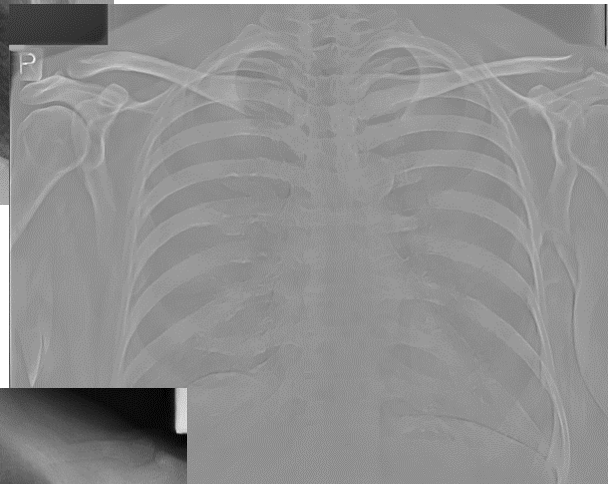
X-ray film is used for imaging, it needs to develop the film.



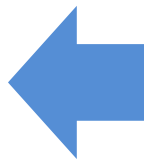
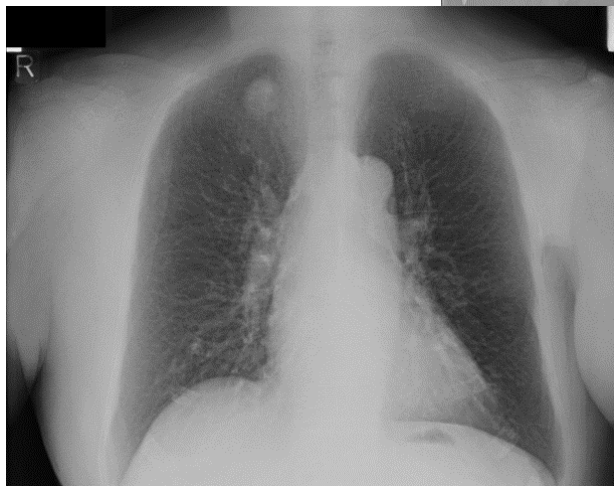
Digital Radiography



Consistent High resolution digital image
Cost & time savings– << than traditional x-ray film dev.
~ \$1 (INR 60)/IMAGE



Readily suppress bone image
& subtract artifacts – enhance
soft tissue



Soft tissue image provides enhanced
clarity & resolves features – for both
Humans & for CADx software analysis

Human performance increases by 20%
(www.riveraintech.com)

Landscape in India & low/middle income countries

- Rapid proliferation of digital radiography systems in public and private systems in India and several LMICs – including at district/ sub district levels
- > 50 tendered for district level facilities across the country in 2014

KERALA MEDICAL SERVICES CORPORATION LIMITED
(Dept. of Health & Family Welfare, Govt. of Kerala)
Thycaud P.O., Thiruvananthapuram, Kerala - 695 014

e- TENDER DOCUMENT
for
Running contract for the Supply & Installation of
Computerised Radiography Model B
(TENDER NO: KMSCL/EP/T95/ 411B1/2014)

Sl.No	Equipment Code	Description	Quantity
1.	411B1	Computerised Radiography Model B	12

ASSAM – 2013 NRHM led PPP operated upgrade of analog x-ray installations to CR in 11 district hospitals

- **Led by upgrade of existing analog by retrofitting digital imaging plates (CR) / Full DR installations also at new radiology infrastructure**

CADx in PTB : Current Status

- Only one commercially available solution, CAD4TB, from Delft Imaging systems
- Captive to custom hardware representing < 2% of the digital radiography market
- Expensive (eq. ~\$20,000, INR 12 L for software plugin)
- Early release (2012-13) – limited algorithm sophistication, low specificity (<70%), limited validity against humans, attempts auto scoring only and not designed to prompt radiologist with CADx guidance
- Performance below expert human levels
- Widescale adaptation of CADx for TB platform warrants further algorithm training, sophistication and validation of a cross- platform CAD software, available on vendor neutral hardware that represent the majority of installations in the market

“This distinction between software tied to hardware and this which is a standalone – that could be key to its dissemination” - EXPERT

ADVENIO CADx for PTB

Advenio's proprietary cross-platform CXR feature detection CAD algorithm employs:

- Advanced bone suppression methods & multiple feature detection (eg: pleural effusion)
- Region-wise probabilistic estimation of lesion occurrence for reduction of false positives (and increase specificity)
- VALIDATED ON INDIAN / SOUTH ASIAN CXR DIGITAL IMAGES.
- **The objective is to improve CAD assisted detection of TB from CXR by radiologists and physicians, especially with limited experience and in high burden settings, to ~95% sensitivity and ~85% specificity with a 95% confidence interval (auto scoring also possible & link up with teleradiology)**
- **Significantly improve workflow efficiency in radiological interpretation of TB, including teleradiological consultations**
- **Low cost per analysis/interpretation ~ \$1-1.5 (INR 60-100) < \$ 3-5 Teleradiology**
- **Preferential plugin annual license rates to public institutions ~ INR 50000 (<\$1000)**

ADVENIO CADx for PTB:

Current status – Validation on training dataset



- *Validation (algorithm training) on confirmed (microbiology+GeneXpert) digital CXR in partnership with SRL Diagnostics & Fortis*
- *1000 digital CXRs / 'Adaptive learning' against expert human*
- Seek public sector validation partner
- Release : 3rd Quarter 2015
- Funding: *BIRAC SBIRI, The Gates Foundation (proposed for 2015 funding)*

**VALIDATION
PARTNERS**



THANKS

Prakash kodali

Prakash@microxlabs.com