# CAD Technology for Detection of Occupational Lung Diseases

Barry Kistnasamy

StopTB partnership, UBC, Wits, UP, UEM, NIOH, Minerals Council SA / selected mining companies

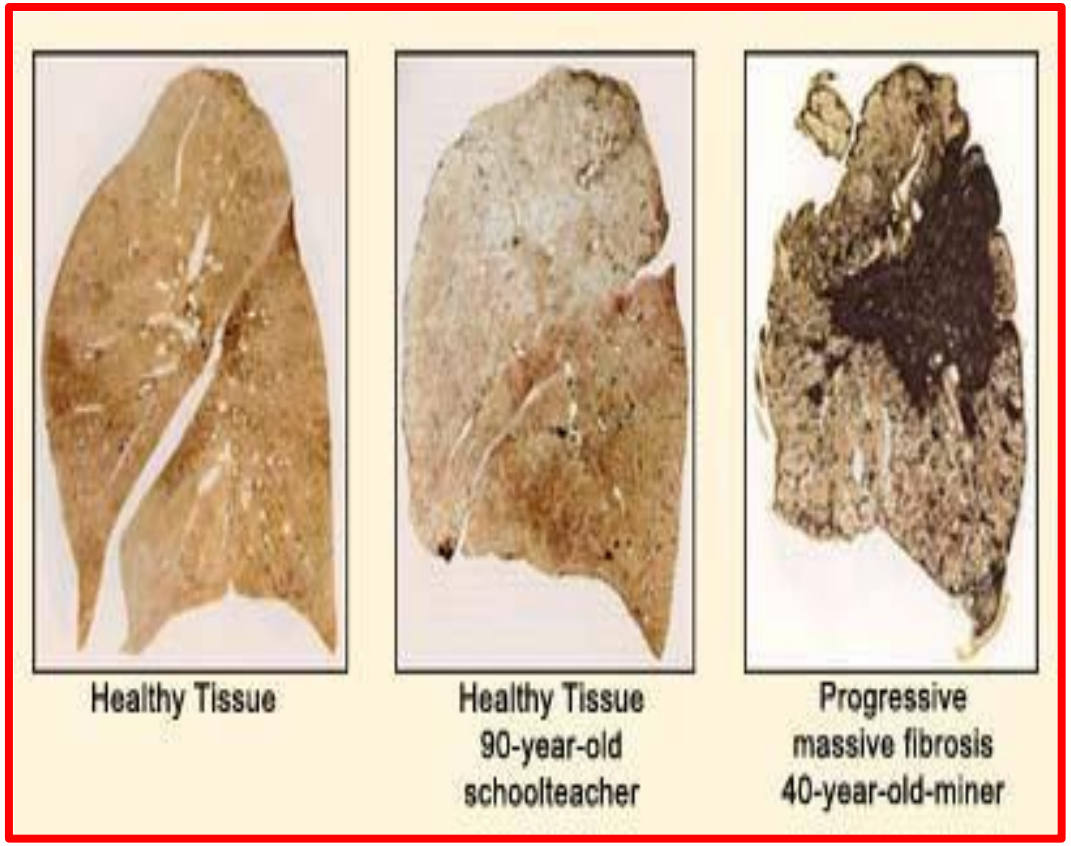
March 2026

# #Disease Burden in Current & Ex-Mineworkers (~1980 – 2024)

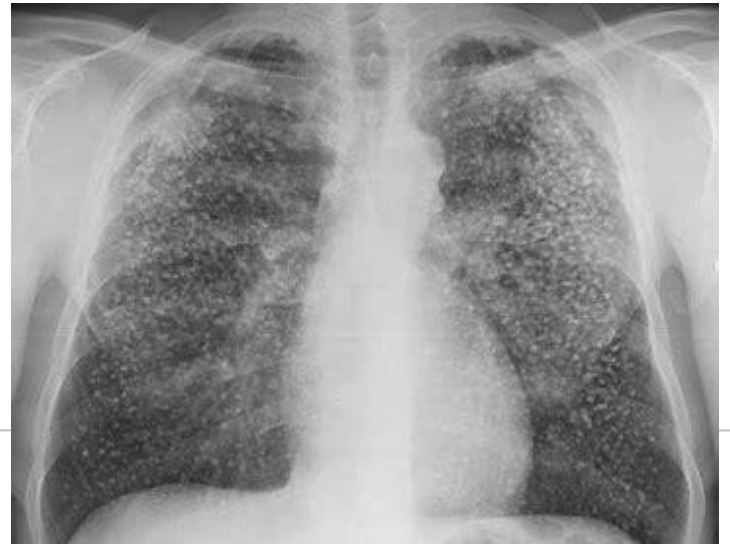
| Compensable Disease Claims | Total | Amount Paid |
|---|---|---|
| Tuberculosis Temporary | 77 351 | 226 254 722 |
| Silicosis | 38 954 | 1 712 217 205 |
| Tuberculosis Permanent | 12 955 | 719 997 847 |
| Asbestos Related Diseases | 6 678 | 182 719 921 |
| Pneumoconiosis | 6 320 | 79 277 114 |
| Obstructive Airways Disease | 3 541 | 138 929 373 |
| Other Diseases | 3 806 | 79 551 987 |
| Total | 149 605 | 3 138 948 169 |

# Compensation Fund. IPCapital. Fourie. 2024

# Mine Dust Exposure ~ Lung Disease Burden




Normal Lung

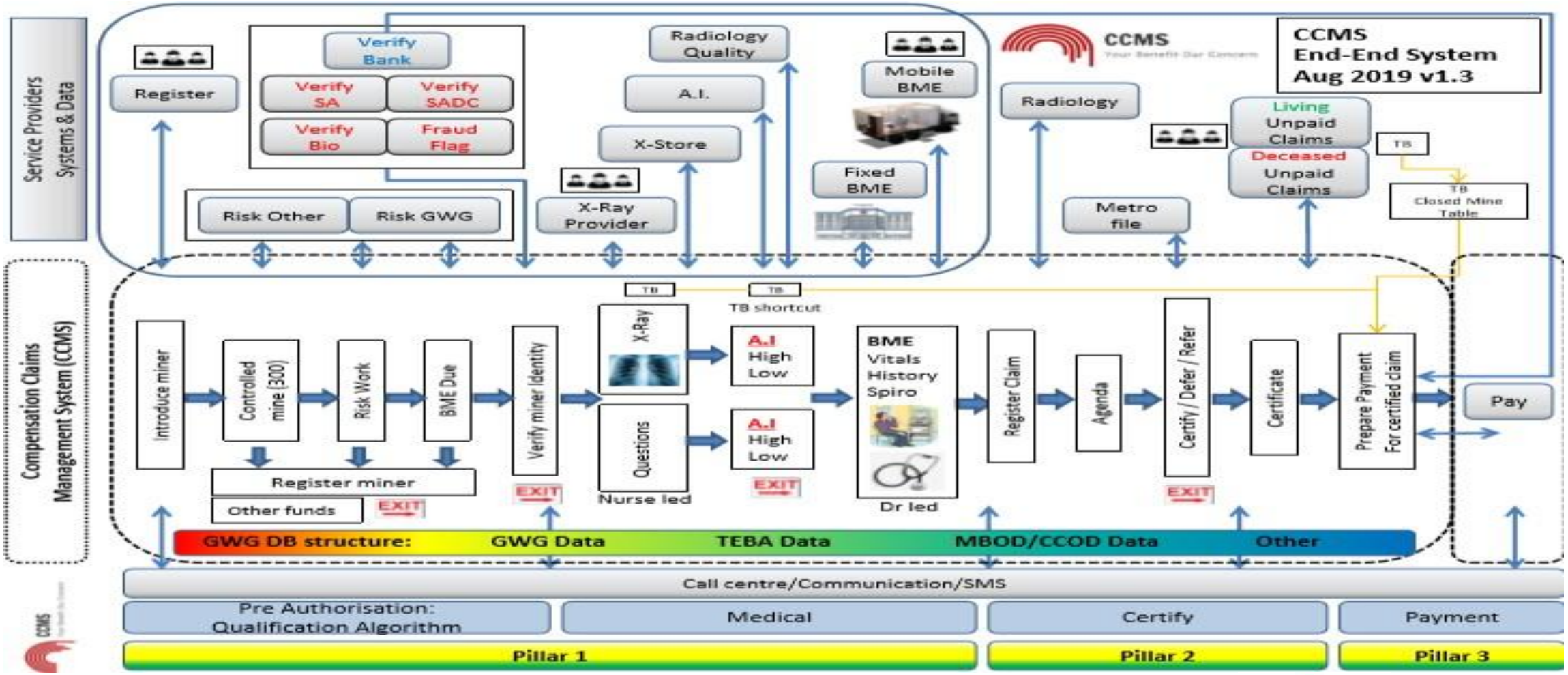


Lung with Silicosis

# MBOD / CCOD Legacy of Neglect / System Collapse

- Backlog in audited financial statements and annual reports with 7 years of disclaimers (2011/12)
- 30% of source documents not found
- Outdated technical resources
- Inadequate human resources and infrastructure

# A New Dawn –
# Compensation Claims Management System



# Use of Artificial Intelligence – Chest X-rays

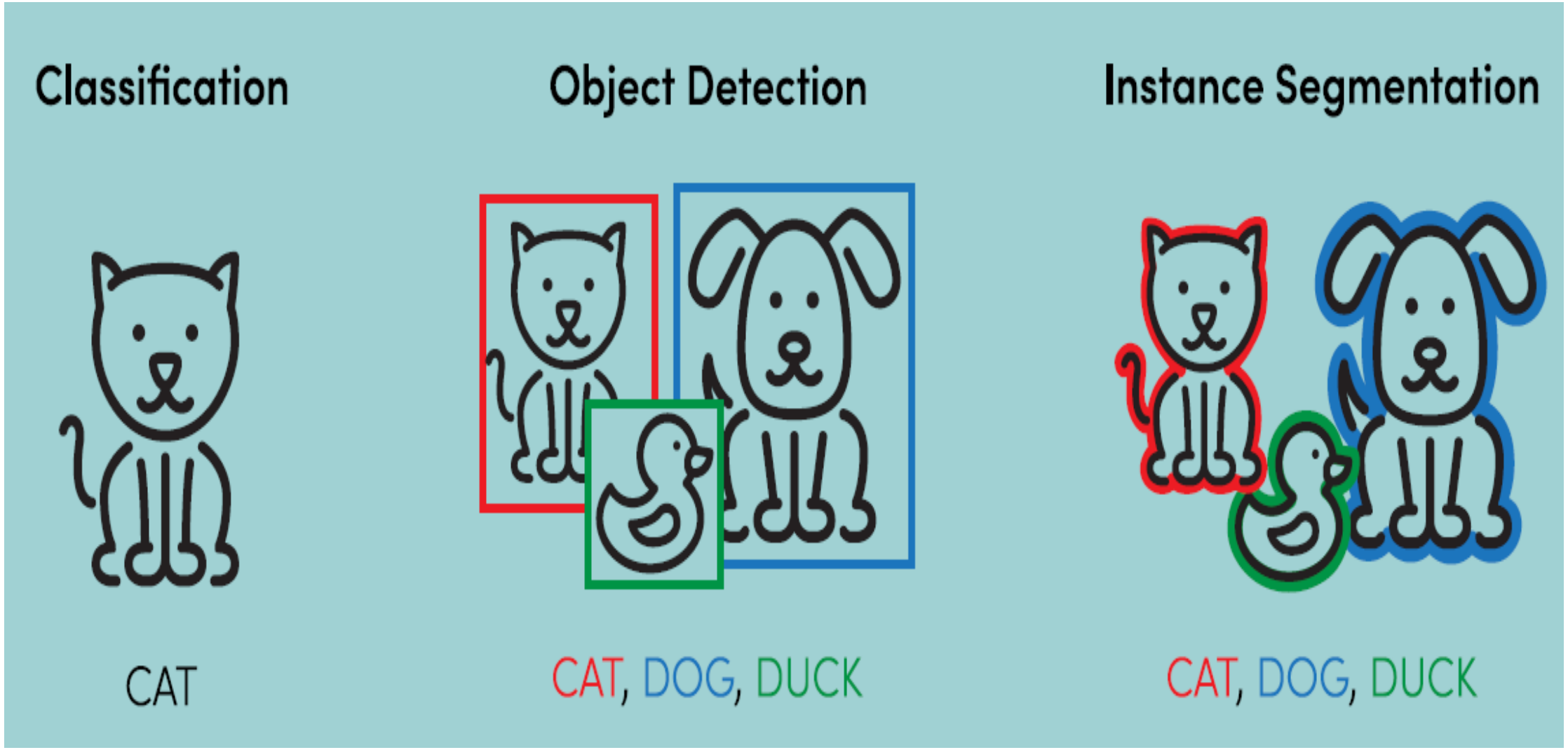


Photo credit: Delft Imaging Systems

# AI/CAD Product Landscape

## PRODUCT CHARACTERISTICS

**Commercial AI-powered computer-aided detection (CAD) systems are increasingly available that can automatically interpret chest X-ray images for signs of TB.**

**Intended age group:** Mostly suitable for people over 15 years old

**Input:** Read postero-anterior DICOM images. Antero-posterior images and other image forms (JPEG, PNG) are also widely accepted.

**Output:** Summarize results in a radiologist-style report. Output varies between products, but always includes classification and a numeric abnormality score, in addition to heatmaps or similar diagram.

**Deployment:** Can be deployed online (cloud) and offline.

**Integration:** Can be integrated with PACS and other clinical information systems. Ability to be deployed with most digital X-ray systems.

# Ai Product Landscape

**2020:** 12 CAD products for TB.

**2025:** 20 CAD products for TB.

| Genki | CAD4TB | RADIFY | InferRead DrChest |
|---|---|---|---|
| **Certification:** MoH - Kenya, Thai FDA, US FDA, CDSCO | **Certification:** CE Class IIb. CE 0344 marked | **Certification:** SAHPRA CLASS A, CE (Pending), FDA (Pending) | **Certification:** CE - Marked Class IIb |
| **Development:** On the Market | **Development:** On the Market | **Development:** On the Market | **Development:** On the Market |
| **Intended Age Group** 14+ Years | **Intended Age Group** 4+Years | **Intended Age Group** 2+ Years | **Intended Age Group** 12+ Years |

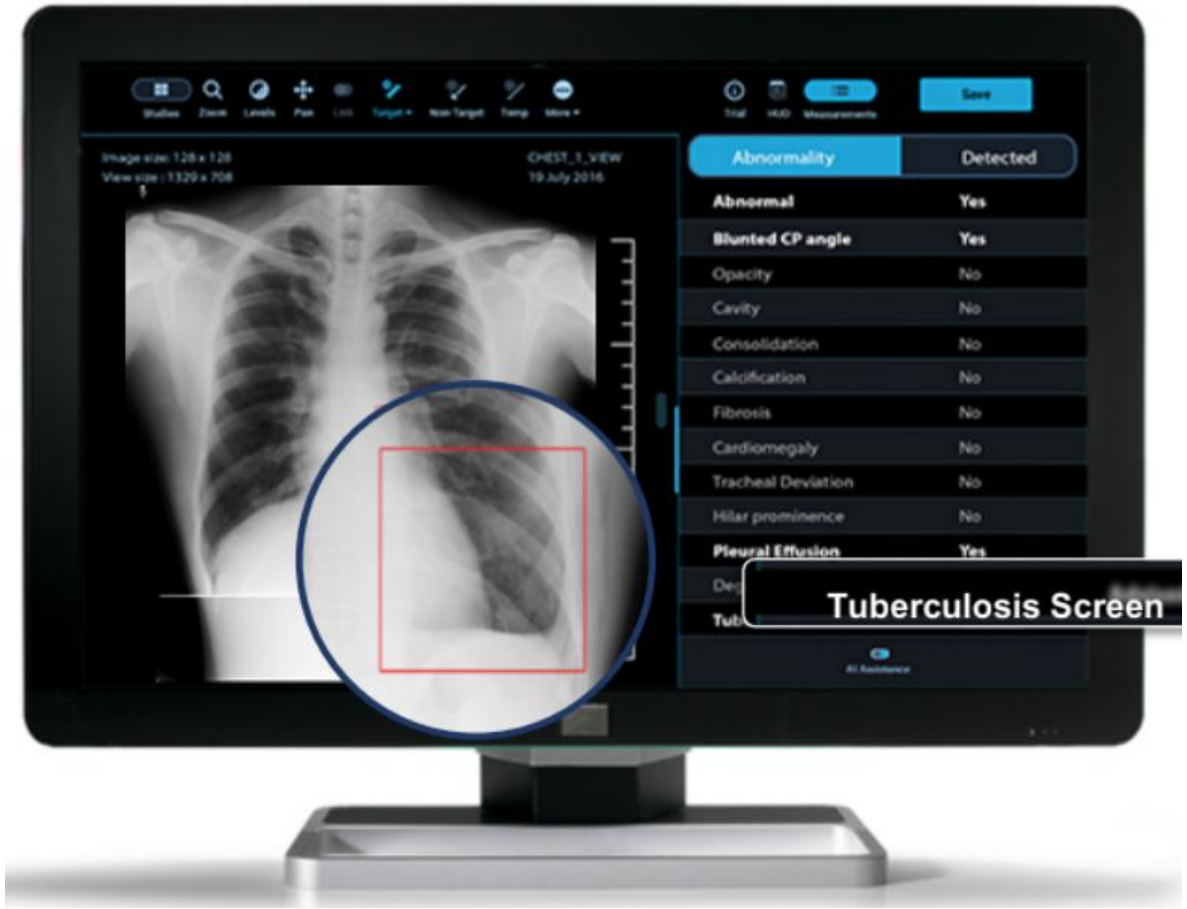
| JVIEWER-X(JLD-02K) | Lunit INSIGHT CXR | Rayscape CXR | ChestEye, ChestLink |
|---|---|---|---|
| **Certification:** CE-marked ClassI, Japan PMDA, Others | **Certification:** CE MDR Class IIa, Korea MFDS, Brazil ANVISA | **Certification:** CE Class I | **Certification:** ChestEye: CE Class IIb, ChestLink: CE Class IIb |
| **Development:** On the Market | **Development:** On the Market | **Development:** On the Market | **Development:** On the Market |
| **Intended Age Group** 10+ Years | **Intended Age Group** 14+ Years | **Intended Age Group** 16+ Years | **Intended Age Group** 18+ Years |

# CAD Output

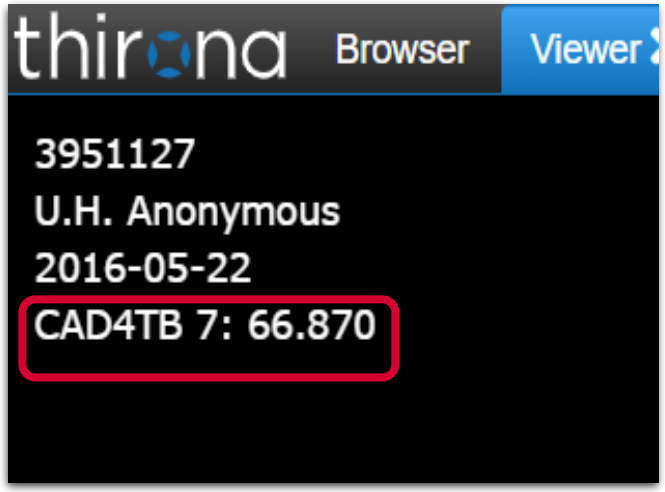
In general, for **each** X-ray received, CAD provides:

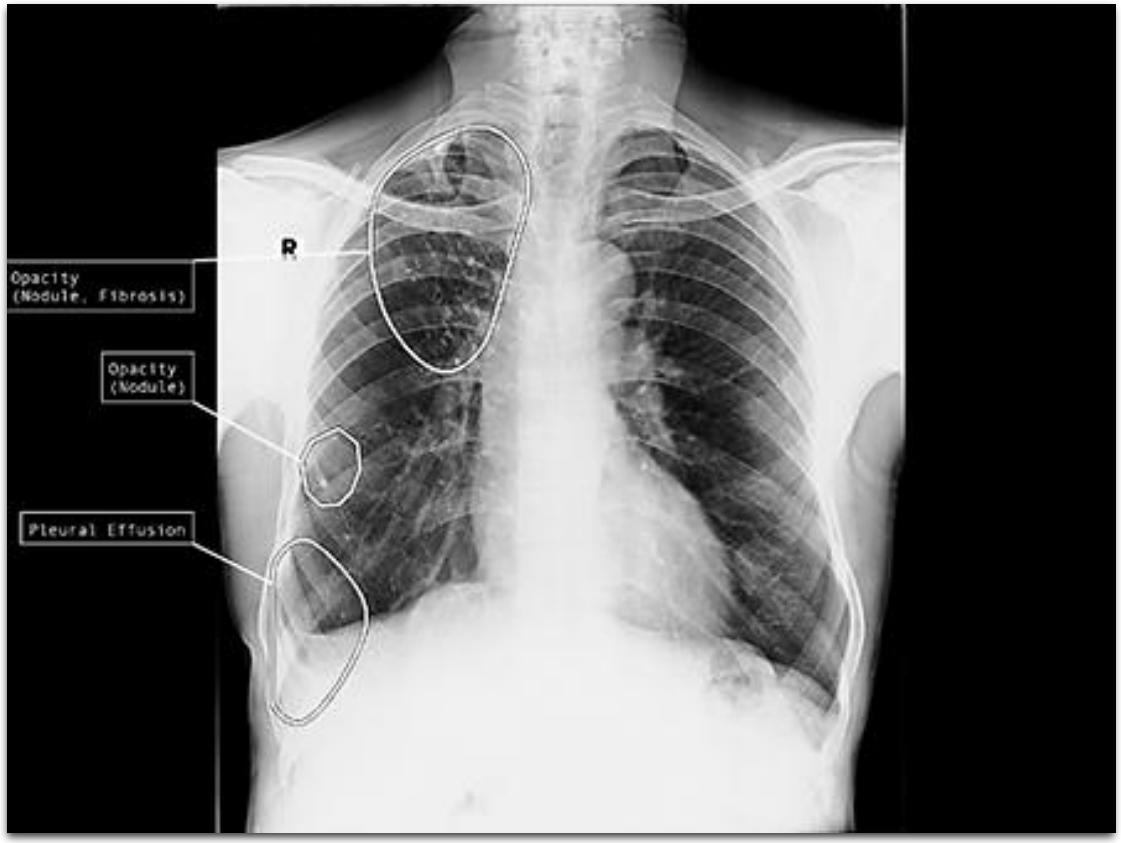
- A **heatmap** showing where abnormalities are detected by CAD.
- An **abnormality score** (between 0–1, or 0–100). High abnormality score = higher likelihood of TB.
- Some CAD products provide a **binary classification** (“TB-related abnormalities present” or “TB-related abnormalities absent”).

These can be summarized in a **customizable report** format. CAD products increasingly also offer a number of **add-on features** such as **data dashboards**.



# Example CAD/AI Output




# How Does CAD Compare Against Radiologists For TB Detection?

www.nature.com/scientificreports

scientific reports

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## Comparing the accuracy of computer-aided detection (CAD) software and radiologists from multiple countries for tuberculosis detection in chest X-Rays

Zhi Zhen Qin[1,2,8], Martie Van der Walt[3], Sizulu Moyo[4], Farzana Ismail[5], Phaleng Maribe[4], Claudia M. Denkinger[2], Sarah Zaidi[1], Rachael Barrett[1,8], Lindiwe Mvusi[6], Yolisa Tsibolane[6], Nkateko Mkhondo[7], Khangelani Zuma[4], Samuel Manda[3], Lisa Koeppel[2], Thuli Mthiyane[3] & Jacob Creswell[1]

**REFERENCE STANDARD:** Composite Microbiological (Xpert + Culture)

**DATASET:** Prevalence survey, South Africa (n=775)

### KEY FINDING

- CAD with CE Mark almost all demonstrate performance equal to- if not better than- radiologists from the UK, US, India and Nigeria for TB detection.

***Table 2: CAD that perform statistically better and worse than radiologists' reading***

| CE-marked | CAD system | Performance when matching sensitivity | | | | Performance when matching specificity | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Nigeria | US | UK | India | Nigeria | US | UK | India |
| Inclusive reading | | | | | | | | | |
| Class IIb | CAD4TB | | | | | | | | |
| | ChestEye | | | | | | | | |
| | InferRead | | | | | | | | |
| | qXR | | | | | | | | |
| Class IIa | Lunit | | | | | | | | |
| Class I | Xvision | | | | | | | | |
| Not CE-marked | Nexus | | | | | | | | |
| | Genki | | | | | | | | |
| | JF CXR-2 | | | | | | | | |
| | RADIFY | | | | | | | | |
| | TiSepX-TB | | | | | | | | |
| | XrayAME | | | | | | | | |

Cells in grey have no significant difference between CAD and human readers at $p<0.05$

# WHO Recommendation

**In March 2021, the World Health Organization (WHO) recommended the use of AI for the first time.**

Among individuals aged 15 years and older, in populations in which TB screening is recommended, computer-aided detection software may be used in place of human readers for interpreting digital chest X-rays for screening and triage for TB disease.

**CAD** improves the detection of TB using AI by circumventing inefficiencies in the interpretation of chest X-ray (CXR) images, automating & standardizing X-ray interpretation, & supplementing existing health workers by also:

- Optimizing workflow
- Alerting human readers to abnormal images
- Providing reporting assistance
- Providing quality control
- Performing pre-reading assistance

There is **insufficient** evidence to support the use of CAD with CXR alone for TB **diagnosis**

# CAD/AI for Abnormalities besides TB

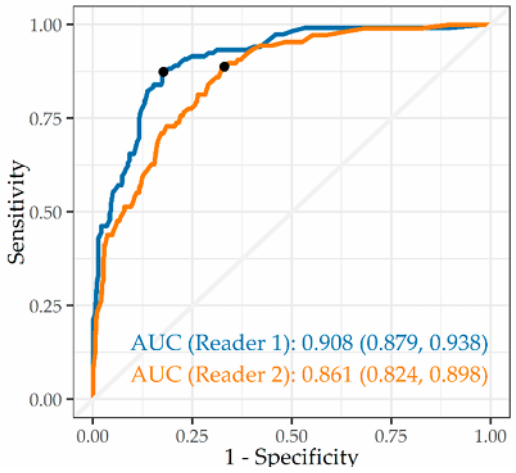
| CAD Software | Calcification | Cardiomegaly | Cavity | Consolidation | Fibrosis | Lymphadenopathy | Mass | Nodule | Opacity | Pleural Effusion | Pneumothorax | Silicosis |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAD4TB | | *CTR only | | | | | | | | | | *CAD4silicosis |
| DrAid | X | X | X | X | X | | X | X | X | X | X | |
| Genki | X | X | X | X | X | X | X | X | X | X | X | X |
| InferRead DR Chest | X | *CTR only | X | X | X | X | X | X | X | X | X | |
| Lunit INSIGHT CXR | X | X | | X | X | | X | X | X | X | X | |
| qXR | X | X | X | X | X | X | X | X | X | X | X | X |

Highlighted TB & Non-TB diseases and abnormalities that current CAD software products report on, independent of score for TB

# AI / CAD for Silicosis Detection

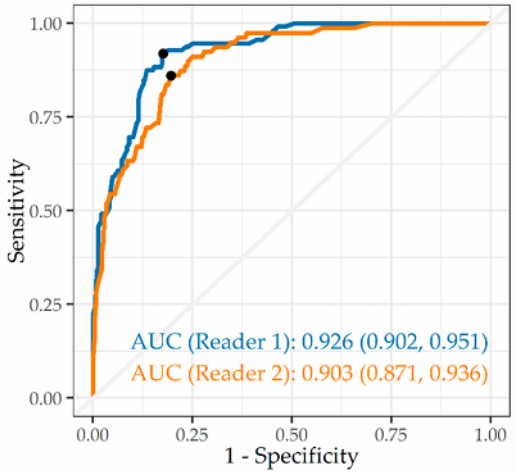
**CAD software also demonstrates significant potential for silicosis detection in retrospective evaluations in South Africa.**

***ROC of CAD software for silicosis (≥1/0) detection against Reader 1 + 2***




| Reader | Sensitivity | Specificity |
|---|---|---|
| At Youden-index maximum | | |
| 1 | 87.4% | 82.3% |
| 2 | 88.8% | 66.9% |
| At fixed minimum 90% sensitivity | | |
| 1 | 90.8% | 77.0% |
| 2 | 90.7% | 63.6% |

***ROC of CAD software for silicosis (≥1/1) detection against Reader 1+2***




| Reader | Sensitivity | Specificity |
|---|---|---|
| At Youden-index maximum | | |
| 1 | 92.0% | 82.3% |
| 2 | 86.1% | 80.4% |
| At fixed minimum 90% sensitivity | | |
| 1 | 91.1% | 82.6% |
| 2 | 91.1% | 74.9% |

International Journal of *Environmental Research and Public Health*

MDPI

*Article*

## Accuracy of Computer-Aided Detection of Occupational Lung Disease: Silicosis and Pulmonary Tuberculosis in Ex-Miners from the South African Gold Mines

Rodney Ehrlich [1], Stephen Barker [2], Jim te Water Naude [1,3], David Rees [4], Barry Kistnasamy [5], Julian Naidoo [6] and Annalee Yassi [2,*]

1 Division of Occupational Medicine, School of Public Health and Family Medicine, University of Cape Town, Cape Town 7925, South Africa
2 School of Population and Public Health, University of British Columbia, Vancouver, BC V6T 1Z3, Canada
3 Diagnostic Medicine, Cape Town 7708, South Africa
4 School of Public Health, University of the Witwatersrand, Johannesburg 2193, South Africa
5 Office of the Compensation Commissioner for Occupational Diseases, Johannesburg 2001, South Africa
6 Faculty of Health Sciences, University of the Witwatersrand, Johannesburg 2193, South Africa
* Correspondence: annalee.yassi@ubc.ca

***Conclusion:*** CAD systems demonstrate performance close to expert readers for silicosis identification in ex-miners from South African gold mines.

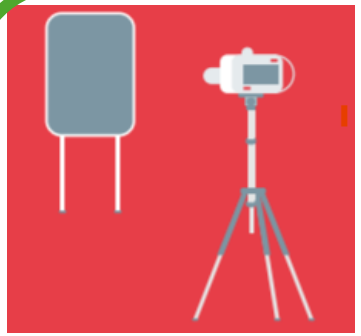
# Types of X-ray Systems

**Stationary:**
High workload, stable electricity, general radiology, delivers high image quality

| Stationary DXR | Manufacturer |
|---|---|
| EASY DR | Delft Imaging, the Netherlands |
| 1600PLUS X-SERIES | Imaging Dynamics Company Ltd, Canada |
| UNIVERSAL CHIROPRACTIC STRAIGHT ARM | UMG/DEL MEDICAL, USA |
| ECOVIEW9 PLUS- CHEST EXAM | ECORAY, South Korea |
| PERFORM-X DR CHEST SYSTEM | Control-X Medical, Hungary |
| DDR AURA U SWISSRAY | Swissray, Switzerland |
| AMADEO S SYSTEMS | Oehm and Rehbein GmbH, Germany |
| DIGIX U | Allengers, India |

**Mobile:**
Moderate workload, intermittent power supply, can be moved/rolled around, high image quality

| Mobile DXR | Manufacturer |
|---|---|
| Fujifilm FDR nano | Fujifilm, Japan |
| Amadeo M-DR mini | Oehm and Rehbein GmbH, Germany |
| MinXray CMDR HF100H+ Wireless | MinXray, USA |
| ATX QUANTpower400 AiO | KE Meditec Consulting GmbH, Germany |
| Rayence GO DPX | Rayence, USA |
| Epsilon EP Corsa 2.4P | Epsilon, India |
| Medical ECONECT meX+100 | medical ECONET GmbH, Germany |
| Dragon LW | Sedecal, Spain |
| ECO RAY ULTRA200/200A | ECORAY, South Korea |



**Ultra-portable:**
Low to moderate workload, battery powered, acceptable image quality, low radiation, low output power, field friendly

| Ultra-portable DXR | Manufacturer |
|---|---|
| Delft Light | Delft Imaging, the Netherlands |
| Delft Ultra | Delft Imaging, the Netherlands |
| MinXray Impact TR90BH | MinXray, USA |
| Fujifilm FDR Xair | Fujifilm, Japan |
| MINE 2 | HDT, South Korea |
| MINE ALNU | HDT, South Korea |
| Aspen AiR Touch Europa | Aspen imaging, USA |
| Medical ECONET meX+20 | medical ECONET GmbH, Germany |
| RadmediX Acuity PDR | RadmediX, USA |
| Amadeo P-100/35HB, Leonardo DR nano | Oehm and Rehbein GmbH, Germany |
| ATXtreme, ATOMED X-Ray GmbH | KE Meditec Consulting GmbH, Germany |

*Table recreated from **FIND Digital Chest Radiography and CAD solutions** for TB diagnostics technology landscape analysis*
https://www.finddx.org/wp-content/uploads/2021/04/FIND-CXR-CAD-solutions-for-TB-diagnosis-7Apr2021-2pg-spread.pdf

# Evolution of the X-ray

**General X ray room**

**Containerised X-ray**

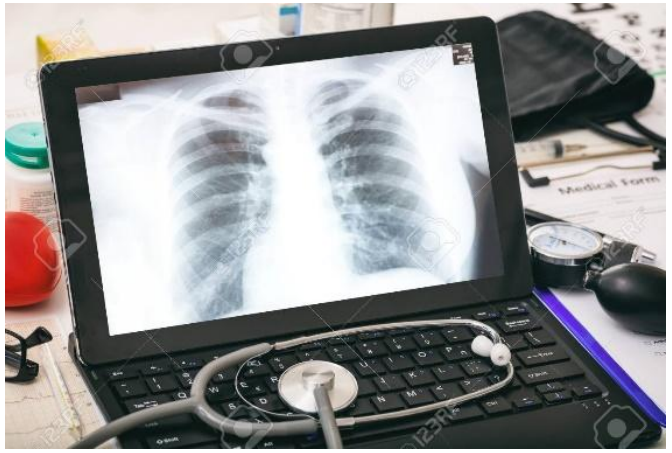
**Mobile X-ray**


**Mobile trailer X-ray**

# Ultra Portable X-ray components


DELFT IMAGING

# Ultra Portable X-ray Components



# Using CAD with Ultra-portable X-ray


Photo credit: Delft Imaging Systems

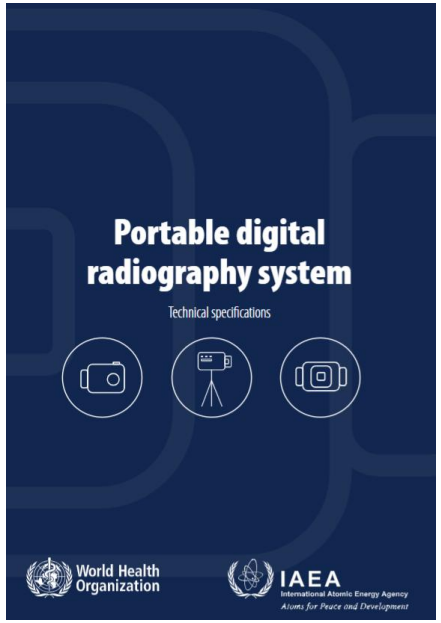



Photo credit: IDDS/ Stop TB Partnership

**Ultra-portable X-ray machines can expand the reach of CAD software.** They differ from other X-ray system types because they are:

- Able to be carried in a suitcase or backpack (including generator, detector, stands, console PC)
- Lightweight
- Emit less radiation than stationary systems
- Battery powered for use in off-grid settings
- Able to use alternative power sources (such as solar panels) to extend field operations off-grid

Ultra-portable X-ray systems are therefore **recommended by WHO/IAEA for use in settings where stationary X-ray systems are not feasible**, including primary health care centers, emergency health care, outreach and field interventions.

# Take Home Messages – CAD / UXP

- AI is recommended for the detection of active TB by the WHO due to robust evidence demonstrating strong performance.
- Work is ongoing to validate AI for other abnormalities, including occupational lung diseases such as silicosis.
- Evaluations suggest high potential of AI to aid silicosis detection in South Africa.
- Ultra-portable X-ray systems are ‘field friendly’ and recommended by WHO/IAEA for use in settings where  access to stationary radiography is otherwise limited.
- When combined with ultra-portable X-ray systems, CAD has significant potential to enhance access to lung health care in low resource settings.

NATIONAL INSTITUTE FOR OCCUPATIONAL HEALTH

Division of the National Herlath Laboratory Service

# Implementation of State-of-the-Art Technology for Detection of Tuberculosis and Silicosis: A Mixed Methods Occupational Health Service Study in Mining Companies in South Africa

Prof Muzimkhulu Zungu

WSU Walter Sisulu University In pursuit of excellence



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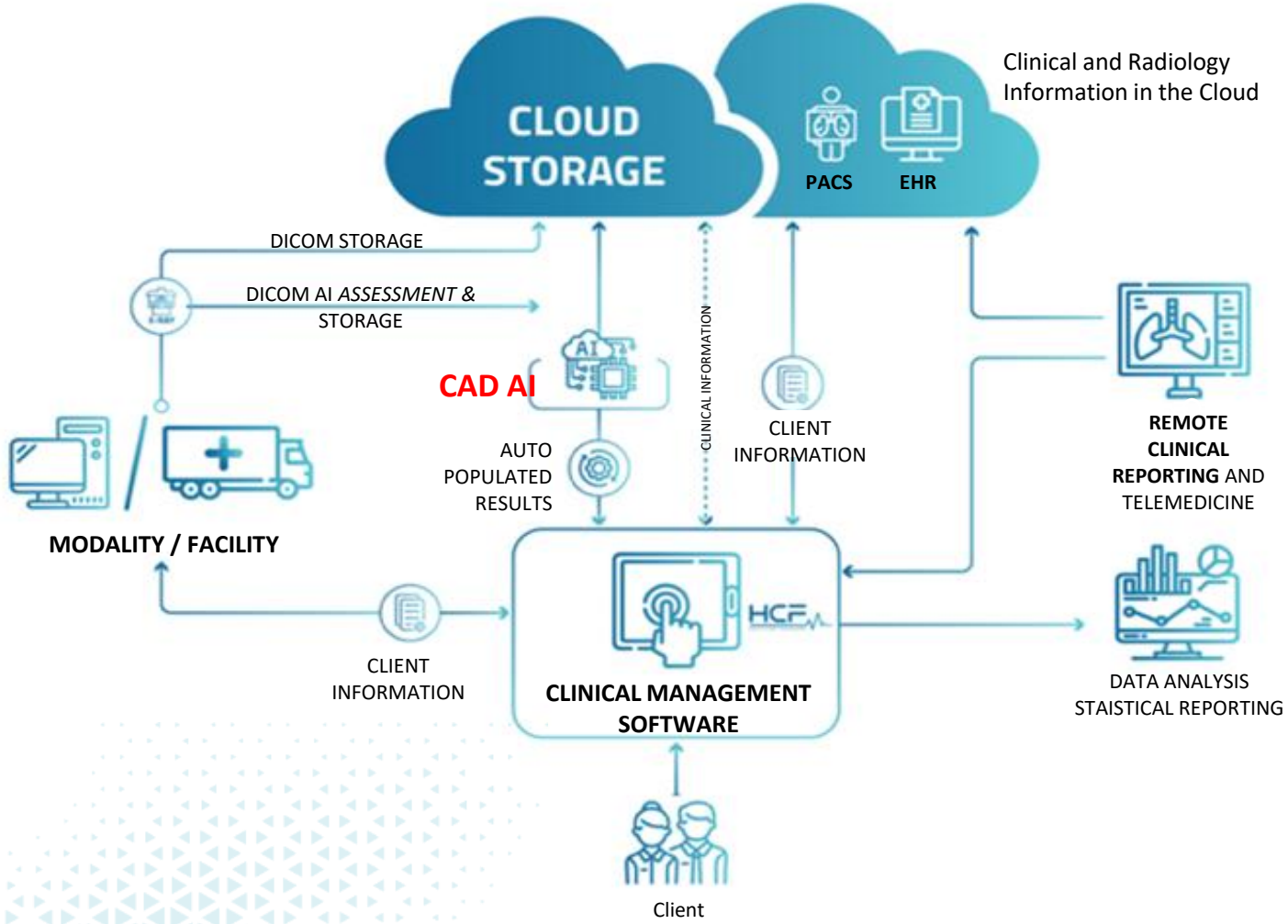
# Research Questions

1. What are the challenges and advantages in using **CAD-UP-XR systems in TB and or silicosis screening** in mining & peri-mining clinics?
2. What is the impact on **accuracy, efficiency & clinical decision-making** of integrating CAD & or UP-XR into a process of triage in TB & or silicosis screening and compensation claims submission?

# Ecosystem

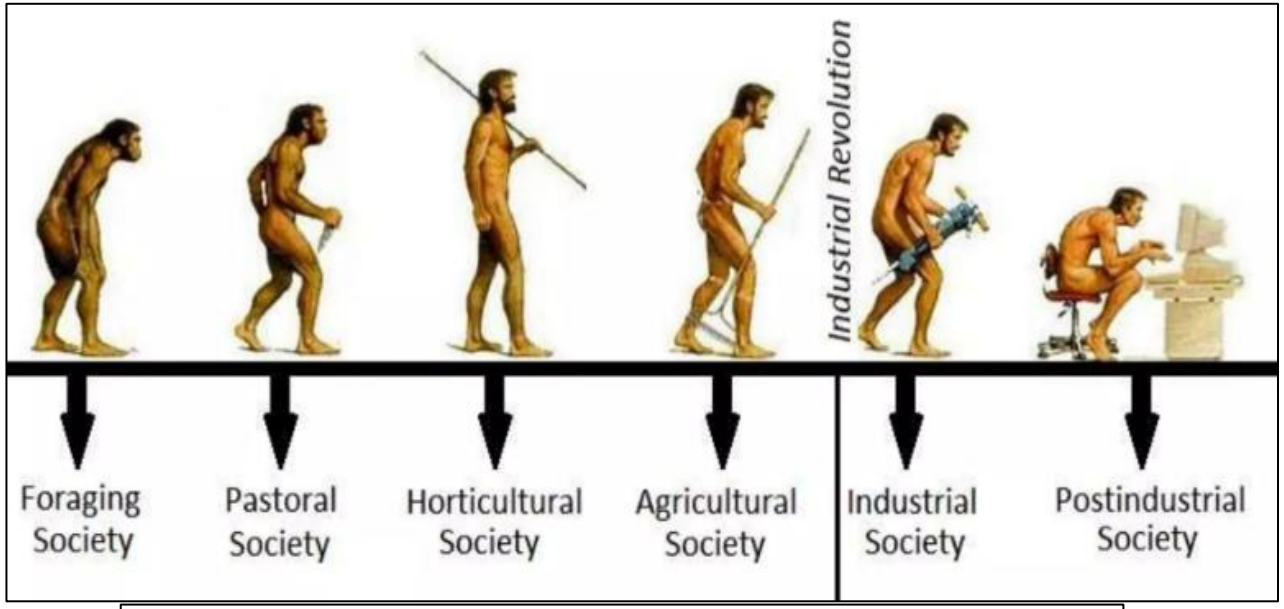



Slide 23

- Full integration between Clinical Management Software, EHR (HCF), CAD Ai, PACS and Hardware systems enabling automated accurate data transfer.
- Automated CAD Ai result population within EHR (HCF).
- Built-in remote radiology reporting and telemedicine modules.
- Dynamic real-time extracts, dashboards and BI reports.

# Acknowledgement


- Ms Rachael Barrett (StopTB Partnership)
- Mr Kgaugelo Moropane (Technical Advisor – Radiography)
- Prof Muzimkhulu Zungu (NIOH)
- Mr Andries Vorster (Biomedical Engineer)


https://www.slideshare.net/slideshow/types-of-societiespptx/255915907

Omeife - Africa's First Humanoid @omeife Technologies

# Thank You

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# GET TO KNOW THE PRESENTER

## Dr Barry Kistnasamy

Barry Kistnasamy is a public health specialist with additional training in occupational and environmental health, health economics and planning and health leadership. He currently heads Occupational Health in the National Department of Health of South Africa and is the Compensation Commissioner for occupational lung diseases in mineworkers.

“Contributing to innovations in health care and global south partnerships”