Implementation Considerations

MODULE 3

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INTRODUCTION

This module offers a menu of key considerations to consider when using ultra-portable X-ray systems with CAD software to screen and triage for TB.

Outline

→ General screening workflow

→ Key implementation considerations

→ Challenges and lessons learned from early users of CAD and UP-XR

Summary

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Learning Objectives

By the end of this module, participants should be able to:

- Understand the general screening workflow involving CAD and UP-XR programs.

- Be aware of key implementation considerations for CAD and UP-XR.

- Be aware of some challenges and lessons learned from pilot projects.

General Screening Workflow – FOR NTP TO CUSTOMIZE

1. Outreach and promoting X-ray and CAD screening projects and identify presumptive patients who require X-ray examination as per national TB screening and diagnostic algorithm

2. Presumptive patient screening and registration

3. Presumptive patient preparation and X-ray exposure

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# General Screening Workflow – FOR NTP TO CUSTOMIZE

4. After the exposure, the detector receives the images and immediately transfers the X-ray image to the console PC using Bluetooth (or wired connection). The console laptop automatically processes and generates the X-ray image.

X-ray images may also be viewed on the tablet accompanying the CAD4TB box.
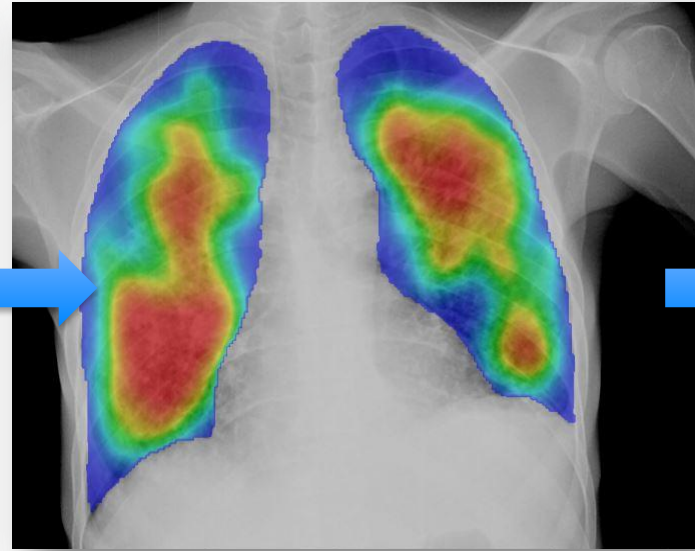
5. The X-ray is then automatically read by CAD4TB and generates results.

CAD4TB results can be displayed on the console PC (online) or accompanying tablet (offline).
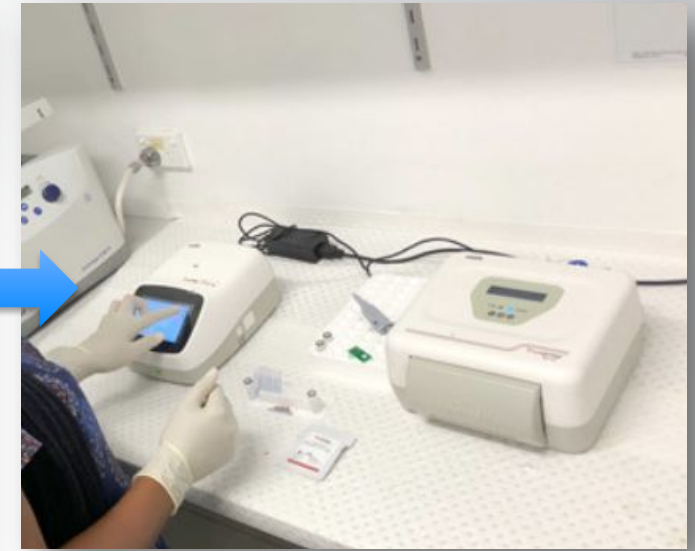
6. Post-screening referral and diagnostic and care provided, along with monitoring and evaluation (Module 5).

IMPLEMENTATION CONSIDERATIONS

Electricity and Power

> Because of the limited battery capacity and charging options, ultra-portable X-ray may not be suitable for high throughput settings without power in the field.

The entire Delft Light system has **built-in batteries** so it can be operated in screening settings without access to electrical mains.

The charging requirements of the system are:

Generator battery	Capable of approximately 200 exposures. Recharging takes approximately 4 hours. **Note:** The battery must be **removed from the tube for charging** and inserted into the generator charger. This means that the X-ray generator **cannot be charged and operated** at the same time.
Detector battery	Capable of approximately 100 exposures per set of 2 batteries. A second set of batteries means up to 200 exposures are possible. Recharging takes approximately 2.5 hours.
CAD4TB box	The CAD4TB box requires an AC connection to operate. It is **not** capable of storing its own power.

Electricity and Power

> If implementers plan to deploy the systems for high throughput in an off-grid setting, external power sources are critical to ensure continued operation.

MobiSun solar panel and power bank

All system components (generator, detector, workstation, and CAD4TB box) can be recharged from a portable, water-resistant MobiSun solar panel with built-in power bank in settings without access to electrical mains.

- The solar panel power bank takes **16 hours to fully charge in direct sunlight.**
- There were some difficulties experienced by early users using the solar panel due to the difficulties and deficiencies of charging by sunlight.
- Alternatively, the solar panel's power bank can be charged from the electrical grid in **approximately 2.5 hours.**
- Solar charging cannot occur while the system is in operation.

Note: 12 second gap is required between exposures.

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Portability

The full kit contains several components in addition to the X-ray generator and detector. The overall weight of a complete set can still be **too much for a single person** to carry.

The Delft Light comes with two bags for carrying the system:

- **Backpack** for the generator, detector, detector stand, console, CAD box, and accessories

- **Carrying case** for the generator stand


Photo credit: KNCV Nigeria

Delft Light component	Weight (kg)
X-ray generator	7.0
X-ray generator stand	8.0
X-ray detector (incl. batteries)	3.8
X-ray detector stand	0.4
Console laptop/workstation	1.5
Lead apron	3.0
Battery chargers	1.0
Solar panel/power bank	6.0
Carrying case (empty)	2.5
Delft Light total	**33.2**
CAD4TB Box	1
System total	**34.2**

Portability and Setup

For portability, a Versarix holder is provided instead of a detector stand, and this must be hung onto improvised mounts at the field location, such as doors or trees.

Daily set-up can take approximately **30–35 minutes** after identifying a suitable field site, with one person setting up the detector and stand and the radiographer preparing the generator.

A further 35–40 minutes may be required to tidy up and clean the equipment after a screening session.
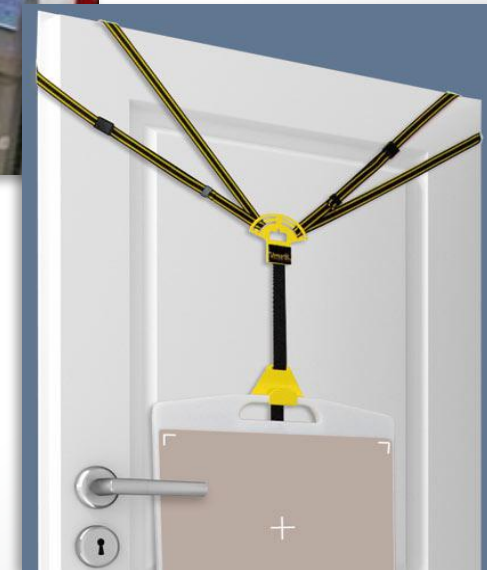
Radiation Safety

Radiography involves exposure to ionizing radiation. Although the risk remains low when the levels of radiation are controlled, precautions are needed to ensure the safety of health care workers and patients.

Local and international radiation safety regulations should be followed, especially when deployed in non-specialized facilities in the field.

Best practices for safe operation include, but are not limited to:

★ Choosing a screening site far from residential areas, barricading places with an exposure risk, and ensuring that no one can enter the radiographic assessment zone

★ Ensuring safe operation of the machine using the handswitch, and wearing appropriate safety equipment/with shielding

★ Directing patient flow at screening sites to minimize exposure to radiation, with consideration to entry/exit route to screening room/ area and beam direction

★ Setting up the generator and detector so the minimum safe distance is adhered to

★ Ensuring that no more radiation than necessary is used to obtain images of adequate quality

Digital Data—Data Privacy and Security

Patient medical data are collected, stored, and transferred during CAD projects. It is important that these data are kept **private** and **secure.**

Data privacy
is the right to restrict the use, access, disclosure, and dissemination of information.

Data security
comprises technological and non-technological mechanisms that limit the use, access, disclosure, and dissemination of information.

Restricting the use of digital data to a limited set of purposes necessary when using CAD technologies is essential for data privacy and security.

➔ For CAD companies in the GDF catalogue, the principal agreement stipulates that CAD companies can **only** use data to read the CXR images and provide outputs.

➔ Image data can also be **de-identified** before upload to the cloud using a **unique patient ID**. This anonymizes the data and removes all personally-identifying information.

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Further Considerations

Internet requirement: When using CAD products online or in hybrid mode, a **strong and stable Internet connection** is required for online mode because X-ray files are large (approx. 10–30 MB). If the intended use is in areas without reliable Internet access, it is important to purchase a CAD product that can analyze CXR images and generate results offline.

Privacy: Prospective sites should be assessed for suitability for mounting the detector in an area where **privacy** is available for anyone being screened who needs to remove any clothing with metallic components, or accessories, before taking a CXR.

What to Expect from Suppliers

- Onboarding training and installation, including system installation, theoretical and practical training on safety, use, transportation, and maintenance

- Monthly virtual support call

- Extended onsite/remote training with eLearning

- Threshold point calibration and troubleshooting

- Onboarding toolkit, including the IT, infrastructure, and human resource requirements for running CAD

- User manual capturing installation process, software update process, troubleshooting, and maintenance

- To be discussed in manufacturer's training

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CHALLENGES AND LESSONS LEARNED FROM EARLY USERS OF CAD AND UP-XR

Challenges and Lessons learned from early users

> **Interviews with six early implementers of CAD with UP X-ray identified through Stop TB's partner network revealed the following insights:**

Assembly and ease of use
Overall, the system was described as **easy to assemble and use,** but it can take about 30–35 min. It also needs proper cleaning and handling.

- *"It's easy to set up, it's easy to consult, and there are less repeats."* —Radiographer

Image quality
Generally, image quality was described as **comparable to stationary machines** when taking images of most people.

- *"Before we started using the UP XR, we had another stationary one. I think the one that we're using has better quality images than the one we had before."* —Clinician

Portability is a clear advantage, especially compared to previously used solutions which still need specialized vans/ trucks. Sometimes the UP-XR system was described as **not as portable as marketed** due to the number of components and their combined weight.

Challenges and Lessons Learned

> **Equipment fault and CAD reading error*:*

- Detector to the console connection: Bluetooth resulted in delayed or failed image transfer. A wire connection would make this more efficient, but the length of the wire can be limiting.

- The connection between the console and CAD laptops can also be a weak point. Some projects experienced loss in connection prior and fixed it by restarting the laptops.

- X-ray generator battery failed → new product, having a good service and maintenance contract is important.

- The detector battery is durable, but the battery life of the console laptop may not last with use. → new product, more actively engage Delft's client service

- Solar panel charges slowly without direct sunlight or in winter → charge it with electricity grid or replace with another power bank.

Manufacturer service: All projects reported positive experiences with the supplier's IT support system, but access to this service may be limited for implementers who work in settings without Internet connection.

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Experiences from early users in [country name]

> For customization by NTP/MoH

- Encourage any local implementers with experience of CAD and/or ultra-portable X-ray to present their use case and experience as an example.

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Summary

Summary

- When implementing CAD and UP-XR key considerations include:

  - Electricity and power

  - Portability and set-up

  - Radiation safety

  - Data management and privacy

  - Internet access

  - Availability of private spaces

- CAD suppliers provide installation, training, and technical help to support the smooth operation of CAD programs.

- Preparations for implementation include identifying key stakeholders, performing a situational assessment, and analyzing field site readiness and suitability.

- CAD and UP-XR projects require a blend of clinical, IT, scientific, and legal expertise.

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