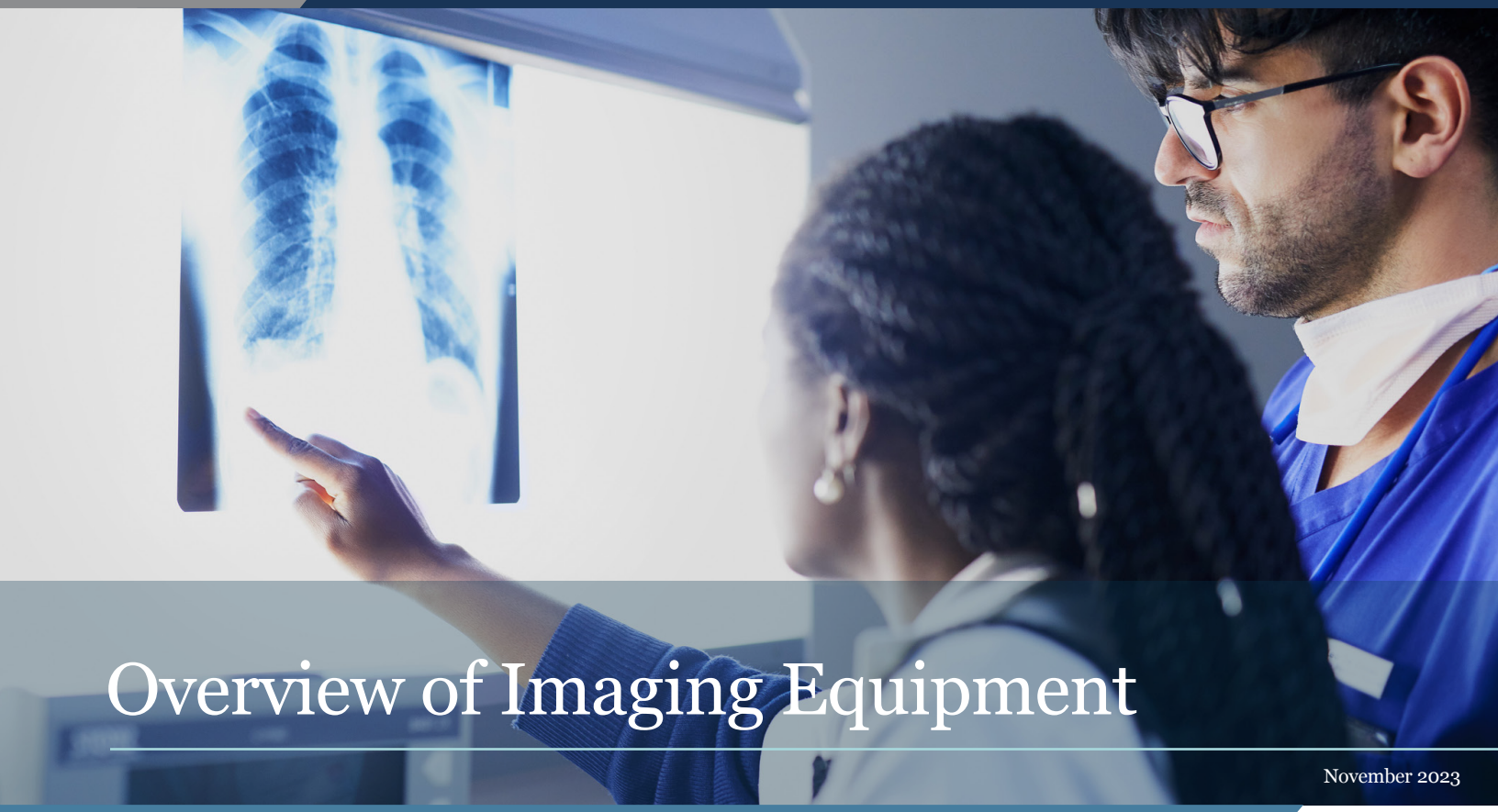

Overview of Imaging Equipment

November 2023

The Partnership for Supply Chain Management

Background

In the latest version of the consolidated guidelines for the systematic screening of general populations for tuberculosis, WHO listed chest X-ray (CRX) as one of the tools for systematic screening for TB disease among individuals aged 15 years and older in populations in which TB screening is recommended. CXRs are also routinely used to triage of patients presenting to care who are displaying signs, symptoms, or risk factors for tuberculosis (TB) to determine the most appropriate clinical pathway for proper evaluation.

However, in many settings, the use of CXR for TB screening and triage for TB disease is limited by the lack of trained health personnel to interpret radiography images. Substantial intra- and inter-reader variability also presents efficacy challenges for the accurate detection of abnormalities associated with TB.

Computer-aided detection (CAD) software packages have been developed and introduced in recent years to automate the interpretation of digital CXR images and produce a numerical score indicating the likelihood of TB. Based on independent evaluations, the diagnostic accuracy and the overall performance of CAD software were equivalent to the interpretation of digital CXR by a human reader in both the screening and the triage contexts.

While CAD is recommended as an alternative to human interpretation of digital CXR for screening and triage for TB, its use should be limited to interpreting plain CXRs for pulmonary TB in individuals aged 15 years or older.

The use of chest imaging in the acute care of adult patients with suspected, probable, or confirmed COVID-19 was recommended by WHO in a rapid advice guide published in June 2020. The imaging modalities considered are ultrasound, radiography, and computed tomography (CT) for use within the care pathway.

As a result of COVID-19, there has been a shift to consider strengthening imaging services through additional capital equipment investments. However, implementing major medical imaging equipment (CT scanner, fixed X-ray system, etc.) in low-resource settings is challenging and should be adapted to the local situation. These systems require an adequate infrastructure that includes but is not limited to well-maintained equipment, suitably trained personnel, and quality assurance programs.[1]

1 PFSCM roadmap for capital equipment procurement projects procurement & deployment 2022

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Different types of imaging equipment

Ultrasonography

Diagnostic ultrasound scanners are medical imaging devices that use high-frequency sound waves to collect information on normal and pathologic appearances of patients' internal and external organs and tissues.

Portable ultrasound scanners are designed for point-of-care (POC) applications with the appropriate capabilities and features for this use case. These take the shape of a laptop, notebook, or tablet computer and often have most of the functionality of a conventional full-size scanner but in a smaller package. They can be battery-powered and are relatively easy to use. Cart-based portable ultrasound scanners are included in this category. Diagnostic applications include examinations that can be performed externally (transcutaneously) or endoscopically (endocavitary or endoluminal) to visualize abdominal and pelvic organs, the lungs, cardiovascular and musculoskeletal systems, small parts, and obstetric imaging.

Diagnostic ultrasound is a highly operator-dependent imaging modality. Consequently, proper training is required to use the equipment optimally, produce quality images, and interpret them correctly to make reliable diagnostic judgments.

X-ray imaging

Computed Tomography

Computed tomography (CT) is an imaging technique which combines a series of X-ray images to produce cross-sectional images of the human body. The result of a CT exam is a set of axial slices that can be processed through different software/ hardware platforms to render sagittal/coronal image slices and/or 3-D image reconstructions. A CT scanning system mainly consists of an X-ray system, a patient table, a gantry, and a PC interface.

This technique allows the assessment of COVID-19-related lung damage and known comorbidities of COVID-19, such as pulmonary embolism/thromboembolism or extra-thoracic disease manifestations. CT systems are used primarily in imaging departments of district general and specialized hospitals. These units will serve multiple other general and specific purposes after the pandemic, for example, manifestations of other infections like tuberculosis, chronic lung diseases, trauma, the most common types of cancer, and other pathologies.

Portable X-ray

The portable radiographic digital system is used as a standalone solution for the acquisition, review, display, storage, and transfer of radiographic images in a resource-limited setting to support out-of-hospital infrastructure screening, diagnostic and monitoring interventions, applications, and campaigns (e.g. TB screening or skeletal radiography for road traffic accidents and other trauma). It comprises an X-ray generator, a flat panel detector, and accessories. The system's subcomponents are battery-powered and are provided with a battery and a charging system.

In this category, we can distinguish the following types:

Type of equipment	Ultra-Portable (Ultralight-weight)	Ultra-portable	Portable
Total weight of the system (W)	<8kg	<30kg	30kg<W<100kg
Number of exposures/ per full battery charge	~100	200+	>200

When electrically operated, the main AC line voltage is used to charge the batteries and, in some models, to power the equipment during standard operations.

Mobile X-ray

The mobile radiographic digital equipment is mainly used for radiographic imaging of patients who cannot be moved to the radiology department and are in hospital departments, such as intensive care units (ICUs) or operating and emergency rooms, where standard, fixed radiographic equipment is missing, or when patient transport is contraindicated. These devices are commonly used for general 2-dimensional (2D) radiographic studies (predominantly chest X-rays) and orthopedic imaging.

The mobile radiographic digital equipment requires direct digital radiography (DDR) technology with a flat-panel detector. The equipment consists of a wheeled cart that transports an X-ray generator, an X-ray tube, a tube telescopic arm support, collimators, an onboard computer, and a flat-panel digital detector. The equipment is a battery-powered unit with a battery and charging system and a motor drive powered by the battery. The main AC line voltage is used to charge the batteries and, in some models, to power the equipment during standard operations.

Fixed X-ray

A stationary X-ray system is an integrated facility-based chest imaging dedicated to a high workload scenario (>300 X-rays per day). It comprises a powerful X-ray generator (mostly AC-powered or sizeable rechargeable battery for temporary backup) and detectors with a chest stand. It usually weighs more than 200 kg and has an output power of 40 kW or higher. This type of equipment requires special infrastructure conditions.

This equipment can also be installed in a truck or a container for mobile community TB screening. There are, however, serious limitations, operational challenges, and costs associated with mobile applications, as this equipment is designed for facility-based imaging.

The decision of which fixed, mobile, or portable equipment should be purchased should take into account the local epidemiological situation and health needs, the geographic context, the local health infrastructure, the trained and available healthcare workforce, as well as the characteristics of the health system (e.g., decentralization of health services).

Additional Technologies and support for optimal use

CAD/AI

Computer-aided diagnostics to support tuberculosis detection (software or software and hardware options) can be implemented in various X-ray procedures with their chest X-ray screening tool to detect signs of pulmonary, hilar, and pleural tuberculosis and other lung malignancies in high-risk populations and certain cardiac disorders. The platform digitizes the TB screening process and delivers rapid results with patient registration and reporting features. Online and offline options are available to process and analyze the images of adults and children from age 4.

All equipment categories require a trained healthcare workforce and special infrastructure in the case of CT and fixed x-ray. All the equipment detailed requires specialized care and maintenance; accessories can be purchased to enhance functionality further.

Installation and training

Additional support for installation and training is available for the imaging devices summarized in this bulletin. Guided installation and training are provided online. Under the manufacturer's guidance, onsite services can be provided for complex equipment. Travel restrictions for the service engineers are an important factor to consider when arranging onsite services in the current environment. Installation and training support are available separately at a specific cost.

Maintenance and Services

Preventive maintenance of imaging equipment and its components is important to ensure the optimal performance of equipment. Maintenance procedures recommended by each manufacturer should be followed, which includes using the recommended disinfectants and cleaners for the equipment. Service support for the units is available from the equipment manufacturers. Maintenance and service support can be arranged on request and are available separately at specific costs. Online or onsite services may be provided based on the manufacturer's guidance.

References

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4. Digital Chest Radiography and Computer-Aided Detection (CAD) Solutions for Tuberculosis Diagnostics, Technology Landscape Analysis, FIND, 2021