Comparative analysis of all chest X-ray imaging technologies

	Complete DR-based CXR imaging (new X-ray generator and detector package)	**Retrofit DR-based CXR imaging (existing analogue X-ray generator and new detector)**	**CR-based CXR imaging (existing analogue X-ray generator + CR reader)**	**Analogue CXR imaging (existing analogue X-ray generator and manual image processing)**
Technology	Combination package of a calibrated X-ray generator and DR panel (no additional processing technology required)	Analogue X-ray generator and retrofit DR panel (no additional processing technology required); existing X-ray generator can be used	Analogue X-ray generator and reusable phosphor plates (with CR reader or digitizer for image processing) is required; existing X-ray generator can be used	Analogue X-ray generator and accessories (X-ray films and cassettes with screens) along with darkroom-based wet processing mechanism or automatic chemical processing
Equipment models	Available for facility-based or offsite portable application (portable models are highly compact and have significantly fewer logistical limitations compared with analogue retrofit DR- and CR-based equipment)	Can be used for facility-based or offsite portable application (some logistical limitations may apply in terms of portable applications)	Can be used as facility-based or portable application (there are significant logistical limitations for the portable application compared with DR-based systems owing to the need for additional processing equipment and multiple phosphor plates, depending on the workload)	Mostly used at facility-based imaging; difficult to implement for offsite or portable application owing to manual image processing requirements
Output image, PACS and CAD implementation	Digital image (usually DICOM®), PACS compatible and can run CAD	Digital image (usually DICOM), PACS compatible and can run CAD	Digital image (usually DICOM), PACS compatible and can run CAD	Analogue image, X-ray film; not compatible with PACS and CAD unless the original output image is digitized using a digital camera or

				smartphone (JPEG or PNG file formats only) Narrow choice of CAD solutions because digital image is in non-DICOM format, and digital image is of low diagnostic quality
Image characteristics	Image parameters (contrast and resolution) are comparable to or sometimes slightly superior to CR-based imaging or retrofit DR-based imaging; also, has the fewest manual steps in terms of achieving the highest possible image parameters; the image is less susceptible to artefacts than CR and analogue imaging	Image parameters (contrast and resolution) are comparable to complete DR equipment and CR-based imaging; however, has more manual steps than using complete DR equipment to achieve the highest possible image quality; the image is less susceptible to artefacts than CR and analogue imaging	Image parameters (contrast and resolution) are usually comparable to complete DR and analogue retrofit DR equipment; however, has more manual steps than complete DR or analogue retrofit DR equipment to achieve the highest possible image quality; the image is more susceptible to artefacts than DR-based imaging, and the phosphor plates need to be cleaned periodically	Image parameters (contrast and resolution) are significantly worse than digital images produced by DR- and CR-based equipment; careful selection of exposure parameters is needed and there is heavy dependency on processing conditions to maintain diagnostic image quality; the image is more susceptible to artefacts than DR- and CR-based imaging
Throughput	Excellent throughput, modern equipment requires <5 seconds of image generation time	Excellent throughput, slightly longer image processing time than complete DR equipment	Moderate throughput, usually 2–3 minutes of image processing cycle by CR scanner	Low throughput, huge variation in terms of image processing time depending on choice of either darkroom-based processing or automatic processing
Radiation-dose efficiency	Highly dose efficient; modern equipment uses sensitive detectors and X-ray generators	Better dose efficiency than CR-based equipment or analogue equipment, but slightly less dose	Less dose efficient than DR-based equipment, but dose efficiency can be improved by careful selection	Less dose efficient than CR and DR X-ray equipment

	calibrated to a specific detector	efficient than complete DR equipment	of exposure parameters because of the greater sensitivity range of CR image receptors	
Service and maintenance	Detectors are highly susceptible to mechanical damage; usually, replacement is needed in the case of damage	Detectors are highly susceptible to mechanical damage; usually, replacement is needed in the case of damage	More robust than detectors, but more susceptible to mechanical issues and needs periodic maintenance	Manual processing technology usually has more technical or operational issues (e.g. X-ray cassettes and screens need to be maintained and replaced periodically)
Cost considerations	Initial investment (additional insurance cost might be needed for detectors)	More expensive than CR but less than complete DR because there is cost saving in the X-ray generator component (additional insurance cost might be needed for detectors)	A less expensive option for digital imaging than DR but might be expensive in the long run depending on the use case (throughput, service and maintenance costs)	Significant indirect costs (e.g. consumables such as X-ray films, cassettes with screens, chemicals, processing tank and automatic processors, as well as HR costs) can add up in the long run

CAD: computer-aided detection; CR: computed radiography; CXR: chest X-ray; DICOM: digital imaging and communications in medicine; DR: digital radiography; HR: human resources; PACS: picture archiving and communication system.

Comparative analysis of stationary, portable and ultra-portable digital radiography X-ray equipment against various consideration parameters applicable for tuberculosis programmes

Consideration parameters	Stationary equipment	Portable equipment	Ultra-portable equipment
Throughput	High workload (>300 X-rays per day)	Medium workload (100–300 X-rays per day)	Low workload (<100 X-rays per day); however, it was possible to take >100 images in half a day (i.e. in 3.5 hours, in Nepal) owing to the recent development of new battery system and a charger during the operations
Setting	Applicable for health care facilities with stable electricity and ICT infrastructure	Applicable for health care facilities with intermittent power supply, mobile van installation and temporary clinics	Applicable for temporary X-ray clinic, hard-to-reach areas lacking power supply, or event-based screening
Vehicle installation	Logistically challenging and presents significant costs (e.g. large truck and dedicated driver)	Relatively easy to equip a vehicle for mobile application; recommend checking with local equipment supplier, if possible, for an offer to bundle the elements of a complete vehicle installation	Vehicle installation is not needed but mobile application inside a van can easily be implemented
CAD integration	May need to check with equipment manufacturer for offers to bundle or validate CAD with images from equipment	May need to check with equipment manufacturer for offers to bundle or validate CAD with images from equipment	May need to check with equipment manufacturer for offers to bundle or validate CAD with images from equipment
Installation and maintenance	Will require service personnel to visit the installation site; consider having long-term service agreements as part of the procurement package	May require service personnel to visit the installation site or provide remote guidance; consider having at least a mid- to long-term service agreement as part of the procurement package	Usually do not require an installation visit by service personnel; consider having at least a mid- to long-term service agreement as part of the procurement package
Life of equipment	This class of equipment has the longest lifespan	Given the lower power of the X-ray generator, it is important to check (via the manufacturer) the average lifespan of the X-ray tube and equipment	Given the lowest power of X-ray generator it is important to check (via the manufacturer) the average lifespan of the X-ray tube and equipment

Potential other uses	Can be used for general radiography (at a facility)	Can be used for general radiography (at a facility and in communities)	Limited use for general radiography purposes in the medium to long run; also, not ideal for imaging thick body parts because of the limited power of the X-ray generator
Human resources	Equipment must be operated by a licensed radiographer; also, additional staff are needed to manage the workload if large numbers of people are to be screened on a daily basis	Equipment must be operated by a licensed radiographer; also, additional staff may be needed to manage people presenting and registering at the X-ray clinic (if >100 cases need to be X-rayed, may need a dedicated driver if van or truck installation is required)	Equipment must be operated by a licensed radiographer; however, there may not be a need for additional staff (for taking X-rays) if the number of people X-rayed per day is <100, or a dedicated driver in the case of mobile application
Importations	Usually approved for use in all countries if meets radiation safety standards; however, registration and licensing of the equipment may be needed at the country level	May need to check with country-specific regulatory authorities for radiation safety standards, registration and licensing-specific requirements if the equipment is to be used for mobile applications or any other form of non-facility-based imaging (outside the X-ray department)	New generation of equipment; may need to check with country-specific regulatory authorities for radiation safety standards, registration and licensing-specific requirements if the equipment is to be used for mobile or outdoor radiography The GDF catalogue can also be checked

CAD: computer-aided detection; GDF: Global Drug Facility; ICT: information and communication technology.