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Medical Imaging in Sub-Saharan Africa: Technological and Organizational Challenges and Low-Cost Innovative Solutions: A Narrative Review

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Abstract: Medical imaging serves as a foundational pillar of modern healthcare by enabling early disease detection and precise treatment planning. Sub-Saharan Africa faces a complex, dual burden of high infectious disease rates alongside rising cases of non-communicable conditions. This reality makes diagnostic services increasingly vital. However, severe barriers limit patient access to these critical tools. This narrative review assesses the current landscape of medical imaging in the region. It aims to identify the primary technological and organizational challenges hindering diagnostic access and to explore low-cost, innovative solutions. A literature search of peer-reviewed articles published largely between 2015 and 2026 was conducted using PubMed and PubMed Central. Findings indicate that hospitals struggle constantly with broken equipment, poor maintenance networks, unreliable power grids, and digital infrastructure limitations. Organizationally, severe shortages of radiologists and radiographers are compounded by migration, limited training, and high out-of-pocket costs for patients. Despite these hurdles, frugal innovations provide viable paths forward. Point-of-care ultrasound enables non-physician healthcare workers to perform basic scans in rural settings. Artificial intelligence assists in interpreting chest X-rays, reducing specialist workloads. Low-field magnetic resonance imaging, solar-powered systems, and teleradiology networks are successfully circumventing traditional infrastructure gaps. Sustaining these innovations requires governments to invest in local biomedical engineering, update regulatory frameworks, and improve health financing mechanisms.

Keywords: *Medical imaging, Sub-Saharan Africa, artificial intelligence, portable ultrasound, radiology workforce, health technology.*

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Introduction

Medical imaging is an essential component of modern healthcare, supporting the detection of diseases, assessment of injuries, treatment planning and monitoring of clinical outcomes. Modalities such as conventional radiography, ultrasound, computed tomography (CT) and magnetic resonance imaging (MRI) provide information that may not be available through clinical examination alone. However, access to these technologies remains uneven across Sub-Saharan Africa (SSA). The availability of imaging services depends not only on the number of machines in healthcare facilities but also on the infrastructure, trained personnel, technical support and financial resources required to operate them effectively.

One of the persistent challenges is the acquisition of suitable and sustainable medical equipment. In several resource-limited settings, hospitals rely partly on donated devices to strengthen their diagnostic capacity. Although equipment donations can help address immediate shortages, they do not always translate into long-term improvements in healthcare services. Howie et al. (2008) highlighted the difficulties associated with medical equipment donations through their examination of an African hospital, drawing attention to the importance of assessing the actual needs and capacity of the receiving institution. Paustian et al. (2025) further discussed the sustainability concerns surrounding equipment donations in the global South. These issues are particularly important for imaging equipment, which may require specialised installation, reliable electricity, regular servicing and access to replacement components.

The sustainability of imaging services is also closely linked to the availability of biomedical engineering support. Equipment that cannot be maintained or repaired may become unavailable even when it has been successfully installed. Wainaina et al. (2026) examined biomedical engineering workshop readiness and medical device maintenance in hospitals supported by the NEST360 programme across Sub-Saharan Africa, highlighting the importance of strengthening local technical capacity. Evidence

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from Burundi also demonstrates the potential contribution of organised maintenance systems. Beniacoub et al. (2021) evaluated a computerised maintenance management system, while Beniacoub et al. (2023) investigated a decentralised maintenance model designed to improve equipment functionality and availability. Together, these studies suggest that equipment procurement and maintenance need to be considered as connected parts of healthcare planning.

Workforce capacity represents another important factor influencing the delivery of imaging services. Radiologists and radiographers are needed for image interpretation, acquisition and reporting, while biomedical engineers provide technical support for equipment operation and maintenance. However, the availability and retention of these professionals remain concerns in the region. Udam et al. (2025) examined factors influencing the choice of radiology as a specialty among medical students in Nigeria. In Ghana, Ohene-Botwe et al. (2024) investigated the factors influencing radiographers' decisions to migrate to high-income countries. Broader evidence from Nigeria also indicates concerns about the intention of healthcare workers to seek employment abroad (Badru et al., 2024). These findings point to the importance of strengthening professional training, working conditions and career opportunities to support the long-term availability of skilled imaging personnel.

Limited specialist availability can also affect the interpretation of diagnostic images, particularly in facilities without regular access to radiologists. In such settings, non-radiologist clinicians may be required to interpret images to support clinical decisions. However, this approach requires appropriate training and supervision. Fawole et al. (2020), for example, investigated the interpretation of paediatric chest radiographs by non-radiologist clinicians in Botswana. Their work highlights the importance of developing image interpretation skills while recognising the need for specialist expertise in diagnostic practice.

In addition to availability and workforce challenges, the safe use of imaging technologies requires appropriate quality assurance and radiation protection measures. Diagnostic reference levels (DRLs) help healthcare facilities and regulatory authorities assess radiation doses and identify opportunities for optimisation. Studies conducted in Nigeria and Ghana have contributed to the development of dose benchmarks for CT examinations, including paediatric imaging (Ekpo et al., 2018; Ekpo et al., 2019; Issahaku et al., 2024). Research on radiation exposure during diagnostic and interventional cardiology procedures in Ghana further demonstrates the importance of monitoring patient doses across different imaging-related procedures (Anim-Sampong et al., 2023).

Alongside these challenges, several technologies and service-delivery approaches are being explored to improve access to diagnostic imaging. Point-of-care ultrasound (POCUS) can bring basic imaging closer to patients in settings where conventional facilities are limited. Baker et al. (2021) examined its contribution to diagnosis and treatment in rural Uganda. Artificial intelligence (AI)-based computer-aided detection systems are also being investigated, particularly for the interpretation of chest radiographs and the identification of tuberculosis (Fehr et al., 2021; Macpherson et al., 2025). Research in Uganda has further demonstrated the possibility of constructing a point-of-care low-field MRI system locally (Obungoloch et al., 2023), while work in Malawi has examined the feasibility of mobile ultra-low-field MRI for infant brain imaging (Vokhiwa et al., 2026). Digital communication approaches, including satellite-based networking, have also been explored to support imaging research and collaboration across geographically separated settings (Latourette et al., 2011).

Although these developments offer opportunities to extend diagnostic services, their usefulness depends on more than technological availability. Their implementation must account for local infrastructure, clinical requirements, staff training, maintenance capacity and long-term affordability. Furthermore, evidence from individual countries or specialised programmes cannot automatically be generalised to all healthcare settings across Sub-Saharan Africa, where resources and service needs differ considerably.

This narrative review examines the challenges affecting medical imaging services in Sub-Saharan Africa, focusing on equipment availability and sustainability, biomedical engineering and maintenance, workforce capacity, image interpretation, radiation safety and quality assurance. It also discusses emerging approaches, including POCUS, AI-assisted image interpretation, portable low-field MRI and digital communication technologies. By critically examining the available evidence, the review aims to identify the opportunities, limitations and priorities for developing accessible, safe and sustainable medical imaging services across the region.

Methods

This study adopted a narrative review approach to examine recent literature on medical imaging in Sub-Saharan Africa. The review was guided by the Scale for the Assessment of Narrative Review Articles (SANRA) criteria. Literature searches were conducted using PubMed and PubMed Central, focusing mainly on articles published between January 2015 and early 2026. A few older publications were also included to provide relevant historical background.

The search used combinations of keywords such as "medical imaging," "radiology," "Sub-Saharan Africa," "technological challenges," "radiology workforce," "point-of-care ultrasound," "artificial intelligence," and "diagnostic reference levels."

Articles were included if they were peer-reviewed, published in English, and addressed medical imaging services, challenges, or recent developments in Sub-Saharan Africa. Studies focusing exclusively on high-income countries or discussing imaging techniques without considering their relevance to healthcare systems were excluded. Priority was given to studies reporting original research, clinical findings, and regional surveys. The selected literature was then reviewed and discussed to identify major challenges, recent developments, and potential solutions for improving medical imaging services in the region.

Current Landscape of Medical Imaging in Sub-Saharan Africa

Access to medical imaging services across Sub-Saharan Africa remains uneven, particularly between urban and rural communities. Conventional X-rays and ultrasound are generally more accessible, while advanced imaging technologies, such as computed tomography (CT) and magnetic resonance imaging (MRI), remain limited in many settings. Imaging facilities and trained professionals are often concentrated in larger cities, making it difficult for people living in rural and underserved areas to

receive timely diagnostic services. A study from rural Zambia identified unequal equipment distribution, inadequate maintenance and shortages of resources as important barriers to providing imaging services outside urban centres (Ng'andwe & Bwanga, 2022).

Financial constraints add another layer to these challenges. Many households in the region rely on out-of-pocket payments to cover healthcare expenses, which can make accessing diagnostic services difficult. At the healthcare facility level, limited funding can also affect the regular operation, servicing and repair of imaging equipment. Ly et al. (2026), in their analysis of financial protection across eight West African countries, reported that a considerable proportion of the population remained exposed to financial hardship when accessing healthcare. Similarly, Memirie et al. (2025) found substantial out-of-pocket expenditure and a risk of catastrophic health expenditure among patients receiving treatment for chronic kidney disease in Ethiopia. Although the latter study focused on kidney disease care rather than imaging specifically, it illustrates the financial pressures that patients may face when seeking healthcare.

The wider financial burden of healthcare is also reflected in the systematic review and meta-analysis conducted by Eze et al. (2022). Their analysis included evidence from 31 Sub-Saharan African countries and found that a considerable proportion of households experienced catastrophic health expenditure. The findings highlight how direct healthcare payments can place pressure on household finances and make it harder for people to obtain the care they need. These concerns are relevant to medical imaging because patients may have to pay for diagnostic investigations themselves, particularly where financial protection is limited. Therefore, the availability of imaging equipment does not necessarily mean that patients can afford to use the services.

Together, these geographical and financial barriers contribute to unequal access to diagnostic imaging across the region. People living in urban areas may have better opportunities to access advanced investigations such as CT and MRI, whereas those in rural communities may face difficulties obtaining even basic examinations, including chest X-rays. This difference shows that access to medical imaging depends on more than the number of machines available. The location of healthcare facilities, distribution of equipment, availability of trained personnel, healthcare funding and patients' ability to meet the costs of investigations all influence whether imaging services can be accessed when needed.

Technological Challenges

Introducing medical imaging technologies in resource-limited settings involves challenges that go beyond the initial cost of purchasing the equipment. The infrastructure and technical support needed to operate and maintain these machines are often inadequate. In many healthcare facilities, unreliable electricity, limited internet connectivity, and insufficient maintenance services make it difficult to ensure the continuous and effective functioning of imaging equipment.

Equipment and Maintenance

The availability of medical imaging services also depends on whether hospitals can keep their equipment in good working condition. Frequent equipment breakdowns and delays in repairs remain major challenges in resource-limited healthcare settings. Many hospitals depend on equipment donations from international organisations, but donated devices are not always suitable for local conditions or supported by the necessary technical resources. Howie et al. (2008), in a study conducted at a referral hospital in The Gambia, reported that donated oxygen concentrators became unusable because of technical incompatibility and a lack of local expertise to assess and maintain them. Similarly, Paustian et al. (2025) highlighted that medical equipment donations in low-resource countries often face problems related to spare-part availability, equipment compatibility and long-term maintenance. These findings suggest that donating medical equipment without considering its maintenance requirements and the local healthcare infrastructure may create additional difficulties rather than improve access to healthcare.Maintaining and repairing medical equipment is further complicated by shortages of trained biomedical engineers and technicians, particularly in rural healthcare facilities. Wainaina et al. (2026), in an assessment of hospitals across Kenya, Malawi, Nigeria and Tanzania, identified persistent gaps in biomedical engineering workshop readiness, including shortages of skilled personnel, repair tools and spare parts. Although improvements in workshop readiness were observed, human resource shortages and limited availability of spare parts continued to affect maintenance capacity.

Similar challenges have been reported in Burundi, where Beniacoub et al. (2021) evaluated the introduction of a computerised maintenance management system (CMMS) across hospitals and health centres. Following its implementation, the number of recorded maintenance interventions increased from 4 to 350 per month, while the average delay in corrective maintenance decreased from 106 to 26 days. However, the study also highlighted the importance of trained personnel, properly equipped workshops, administrative support and reliable technical infrastructure for the successful implementation of such systems. Furthermore, Beniacoub et al. (2023) demonstrated that a decentralised maintenance model in Burundi improved the functionality of medical equipment by strengthening maintenance management and providing dedicated human, financial and material resources. These findings highlight the importance of establishing proper maintenance policies, allocating sufficient budgets and developing local technical expertise to ensure that medical equipment remains functional over time.

Power Supply and PACS/IT Infrastructure

Medical imaging modalities require a stable and continuous electricity supply. In many parts of the region, national power grids are unreliable and subject to frequent voltage fluctuations. Previous decades of deployment have shown that power interruptions can disrupt both the scanning process and the transfer of data (Pandian et al., 2007). Even modern facilities face these challenges; an MRI study in Malawi identified unreliable electricity as the primary cause of interruptions to equipment operations (Latourette et al., 2011). These power fluctuations can also damage sensitive electronic components.

Digital infrastructure poses an equal challenge. Modern radiology utilizes Picture Archiving and Communication Systems (PACS) to store and share digital images. PACS requires reliable internet connectivity and sufficient bandwidth. Early military telemedicine deployments in disaster zones demonstrated that limited satellite bandwidth can severely restrict the transmission of high-resolution diagnostic images (Meade & Lam, 2007). General facility operations, including digital archiving and cooling systems,

remain vulnerable to these compounding infrastructure deficits (Obeagu & Bolo, 2025).

Radiation Safety and Quality Assurance

Patient safety during medical imaging is another important concern. In high-income countries, radiation doses from X-rays and CT scans are monitored using national Diagnostic Reference Levels (DRLs). These benchmarks help ensure that patients receive the lowest radiation dose needed to produce a diagnostically useful image.

In much of Sub-Saharan Africa, however, national DRLs are still being developed or are not widely implemented. A nationwide survey of adult CT examinations in Nigeria found considerable differences in radiation doses between centres. Although some dose parameters were comparable with international standards, the effective doses for chest and abdominal CT examinations were considerably higher (Ekpo et al., 2018). A separate study of paediatric head CT examinations in Nigeria also reported doses higher than international levels, highlighting the need for better dose optimisation in children (Ekpo et al., 2019).

Ghana faces similar challenges. National DRLs for adult CT examinations have been established using data from teaching hospitals and other centres, providing a basis for monitoring and optimising patient doses (Issahaku et al., 2024). Studies of adult CT examinations in Ghanaian teaching hospitals further highlight the importance of applying these benchmarks in routine clinical practice. The problem also extends to mammography. Digital mammography systems in Ghana operate with average glandular doses that are higher than international counterparts (Dzidzornu et al., 2021). Even in specialised fields such as interventional cardiology, studies from Ghanaian tertiary hospitals indicate the need to optimise radiation exposure during procedures (Anim-Sampong et al., 2023).

The underlying issue is a lack of rigorous quality assurance. Very few hospitals run formal quality control checks on their equipment. This issue also affects advanced cancer treatments, where clinical trials requiring radiation therapy in the region face significant challenges in maintaining timely and adequate quality assurance (Lin et al., 2023). Radiotherapy staff themselves express anxiety over workplace safety and radiation protection due to limited resources (Kyei et al., 2025). International campaigns aimed at paediatric radiation protection stress that local advocacy is necessary to change clinical habits (Nkubli et al., 2021). Interventional radiology audits in South Africa further demonstrate that without continuous local monitoring, procedures like biliary drainage expose patients to unpredictable radiation levels (Slave & Mahomed, 2023).

Regulatory bodies often lack the manpower and legal frameworks needed to inspect hospital equipment regularly. Expanding nuclear regulatory frameworks is critical, as these agencies manage diverse public health responsibilities, ranging from medical device inspections to monitoring radioactive contamination in imported food supplies (Dickson-Agudey et al., 2026). Stronger governance is essential to minimise the potential long-term risks associated with radiation exposure. The launch of regional radiation safety campaigns, such as AFROSAFE, has slowly begun to raise awareness and bring professionals together to improve safety practices (Kawooya et al., 2022).

Organisational and Workforce Challenges

Advanced technology provides no benefit without trained professionals to operate it and interpret the results. The organisational structure of radiology departments in the region is currently experiencing considerable challenges as summarised in Table 1.

Shortage of Radiologists and Radiographers

There is a considerable shortage of imaging specialists across many healthcare settings. Although some medical students show an interest in pursuing radiology, attracting and preparing enough specialists remains an important challenge (Udam et al., 2025). The limited workforce also places considerable pressure on the radiographers working in public hospitals. A study of radiographers employed in tertiary hospitals in South Africa found that high stress levels, long working hours, poor working conditions and uncompetitive salaries were important factors influencing resignation (Pillay et al., 2023).

When radiologists are unavailable, hospitals may depend on referring clinicians to interpret medical images or send patients to other facilities for specialist review. Both options can create difficulties for patient care. A study conducted in Ethiopia found that when onsite image consultation was unavailable, patients were sometimes referred to distant facilities, contributing to delays in diagnosis and treatment (Nigatu et al., 2023). The accuracy of image interpretation by non-radiologists is also a concern. In Botswana, a study found that non-radiologist clinicians did not consistently identify important chest X-ray findings in children with pneumonia. Although targeted training improved interpretation, the findings highlight the need for specialist guidance and appropriate supervision (Fawole et al., 2020).

Training, Governance, and Retention

Training opportunities for imaging specialists remain limited in many parts of Africa. Earlier visits to African teaching hospitals highlighted a strong dependence on basic imaging techniques and a shortage of teaching staff, leaving residents with limited opportunities to gain experience in more advanced procedures (Rabinowitz et al., 2005). Initiatives such as musculoskeletal imaging outreach programmes in Kenya demonstrate how international partnerships can help strengthen local expertise and improve access to specialist training (Stevens et al., 2016). Developing related fields is equally important. For example, expanding medical physics education in Ghana can help build the technical expertise needed to operate, maintain, and support the advanced equipment used in medical imaging (Pokoo-Aikins et al., 2026).

Radiographers are also interested in taking part in clinical research, but limited time, inadequate mentorship, and a lack of funding often make it difficult for them to contribute to research and evidence-based practice. Radiography education also needs to address environmental sustainability, an area that has received relatively little attention in traditional training programmes (Emery et al., 2025).

The Brain Drain Phenomenon

The shortage of healthcare professionals is further worsened by the ongoing migration of skilled workers to high-income countries. A survey of healthcare workers in Nigeria found that 80.1% intended to seek employment abroad, with burnout

identified as one of the factors associated with this intention (Badru et al., 2024). A similar trend has been reported among Ghanaian radiographers. One study found that 92.2% of respondents were considering working abroad, mainly because of low salaries and poor working conditions (Ohene-Botwe et al., 2024). Unless African health ministries take meaningful steps to improve working conditions, remuneration, and career opportunities, retaining skilled imaging professionals will remain a major challenge, as shown in Figure 1.

Table 1: Main Technological and Organizational Challenges

Challenge Category	Specific Issue	Country / Regional Example	Citation
Technology: Maintenance	Used equipment fails due to missing parts and lack of engineers.	The Gambia, General SSA	(Howie et al., 2008)
Technology: Power & IT	Unreliable grids damage machines; poor internet blocks teleradiology.	Malawi, West Africa	(Latourette et al., 2011)
Technology: Safety	Lack of DRLs leads to dangerously high radiation exposure.	Ghana, Nigeria	(Ekpo et al., 2018; Dzidzornu et al., 2021)
Organization: Workforce	Severe brain drain of radiographers to high-income nations.	Nigeria, Ghana	(Badru et al., 2024; Ohene et al., 2024)
Organization: Funding	High out-of-pocket costs cause catastrophic health expenditures.	Ethiopia, WAEMU	(Ly et al., 2026; Memirie et al., 2025)

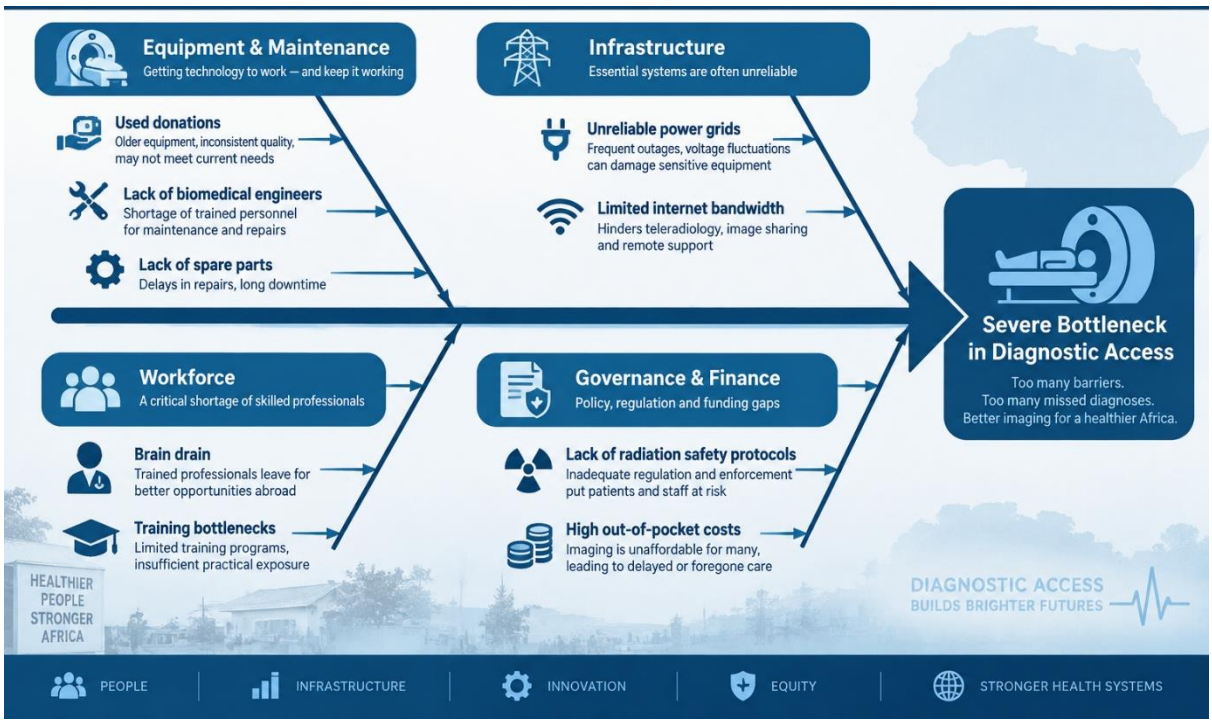


Figure 1. Intersecting technological, organisational, and financial barriers limiting access to medical imaging services in Sub-Saharan Africa

Low-Cost and Innovative Solutions

To address these long-standing challenges, the medical community is increasingly turning to frugal innovation. This approach focuses on developing simpler, more affordable ways of delivering healthcare that suit the local infrastructure, resources, and financial conditions.

Portable and Handheld Ultrasound

Ultrasound is one of the most practical imaging options for rural areas in Africa because it does not use ionising radiation and is relatively affordable. The introduction of handheld point-of-care ultrasound (POCUS) devices, which can be connected directly to smartphones or tablets, has made it easier to provide imaging services in remote and resource-limited settings.

To address the shortage of radiologists, some health ministries are adopting task-shifting approaches by training non-physician healthcare workers to perform basic, focused ultrasound examinations. In Sierra Leone, community health officers used POCUS to change the initial clinical diagnosis in nearly one-fifth of patients, with findings showing good agreement with specialist assessments (Sabatino et al., 2020). Similarly, midwives and nurses in rural Uganda reported positive experiences after receiving training in point-of-care obstetric ultrasound (Mubuuke et al., 2023). In remote Ugandan clinics, general practitioners have also

used handheld POCUS devices, supported by telemedicine, to help diagnose conditions such as trauma and shock (Epstein et al., 2018).

The use of POCUS is also expanding into other areas of care. During short-term surgical missions in West Africa, it has been used to screen patients before surgery, helping clinicians identify cases where surgery could be safely postponed and make better use of limited operating room time (Sule et al., 2025). However, expanding these programmes requires proper training and clear guidelines. Context-specific curricula, such as those developed for family medicine residents in Kenya, can help ensure that training reflects the health needs and common disease patterns of local communities (Bishop et al., 2024). Defining the ultrasound skills expected of healthcare workers in district hospitals is also important for maintaining consistent standards of practice (Mans et al., 2023).

AI-Assisted Interpretation

Artificial intelligence (AI) is increasingly being explored as a way to ease the shortage of radiologists. AI software can analyse digital images, identify suspicious findings and help clinicians decide which cases need further review. Healthcare professionals generally view these tools positively, particularly because they may improve workflow in settings with limited resources. However, successful implementation depends on whether the technology is affordable and suitable for local healthcare systems (Mukandayisenga et al., 2026).

Across Sub-Saharan Africa, one of the main applications of AI in medical imaging is the interpretation of chest X-rays for tuberculosis (TB) screening. Deep-learning software can assess chest images and flag abnormalities that may indicate TB (Fehr et al., 2021). During large-scale screening programmes, this technology can help prioritise patients who need further investigation. For example, a South African prevalence survey found that computer-aided detection (CAD) software could identify TB-related abnormalities with performance comparable to human readers, while also helping reduce the number of people requiring confirmatory testing (Qin et al., 2024). Research involving household contacts of patients with drug-resistant TB in South Africa has also evaluated CAD software for detecting TB. The systems showed good ability to identify existing TB, although their performance in predicting future cases was more limited (Macpherson et al., 2025).

AI may also make population-level screening more practical by reducing the time and resources needed for the initial assessment of chest X-rays (Melendez et al., 2016). In South Africa, researchers evaluated qXR software for distinguishing between pulmonary TB and lung cancer. The software showed promising results for identifying both conditions, suggesting that AI could support the assessment of chest radiographs in settings where these diseases are common (Nxumalo et al., 2024). Researchers have also investigated the use of AI-based chest X-ray analysis alongside simple blood tests, such as C-reactive protein (CRP), in Lesotho and South Africa. CAD-based image analysis performed better than CRP alone as a TB triage test, although the usefulness of combining the two approaches requires further investigation (Bosman et al., 2024).

Despite these advances, AI-based diagnosis still has limitations. Its performance may be affected by factors such as older age, previous TB-related lung damage and HIV co-infection (Mendelsohn et al., 2025). AI systems also need to be evaluated in the settings where they will actually be used, as differences in patient populations, healthcare practices and available resources can affect how well the technology performs (Onno et al., 2023). Without regular testing and validation, these limitations may lead to incorrect results (Mahomed et al., 2020). Another concern is that chest X-rays themselves may not always provide enough information for a reliable TB diagnosis. For example, a study in a high-TB and HIV-burden setting in South Africa reported very low specificity when chest radiographs were used to assess patients with suspected TB and negative sputum smears (Cudahy et al., 2017). AI cannot completely overcome the limitations of the images it analyses. Similarly, research using random forest models to predict treatment failure and death in children with TB found that drug concentrations, laboratory results and other clinical factors were important predictors of outcomes. This highlights the value of combining imaging findings with broader clinical information rather than relying on images alone (Swaminathan et al., 2016). Radiography professionals have also expressed concerns about job security as AI becomes more widely used, making transparent policies and appropriate professional involvement important for its implementation (Chaoui et al., 2026).

Teleradiology

Teleradiology allows medical images to be sent electronically to specialists in other locations for interpretation. An early overview of telemedicine in the region highlighted the importance of choosing technologies that are compatible with local communication infrastructure to ensure reliable image transfer (Meso et al., 2009). Earlier teleradiology projects in South Africa also faced challenges, including low usage and concerns about cost-effectiveness, partly due to technical difficulties (Gulube & Wynchank, 2001).

More recent initiatives have shown encouraging results (Figure 2). The World Federation of Pediatric Imaging established a teleradiology partnership through which volunteer radiologists from different countries interpreted children's X-rays for a district hospital in South Africa (Griggs et al., 2014). Despite this progress, wider adoption remains challenging. Reviews of teleradiology systems across Africa have identified poor internet connectivity and limited integration of picture archiving and communication systems (PACS) as major barriers to expanding these services (Ewing & Holmes, 2022).

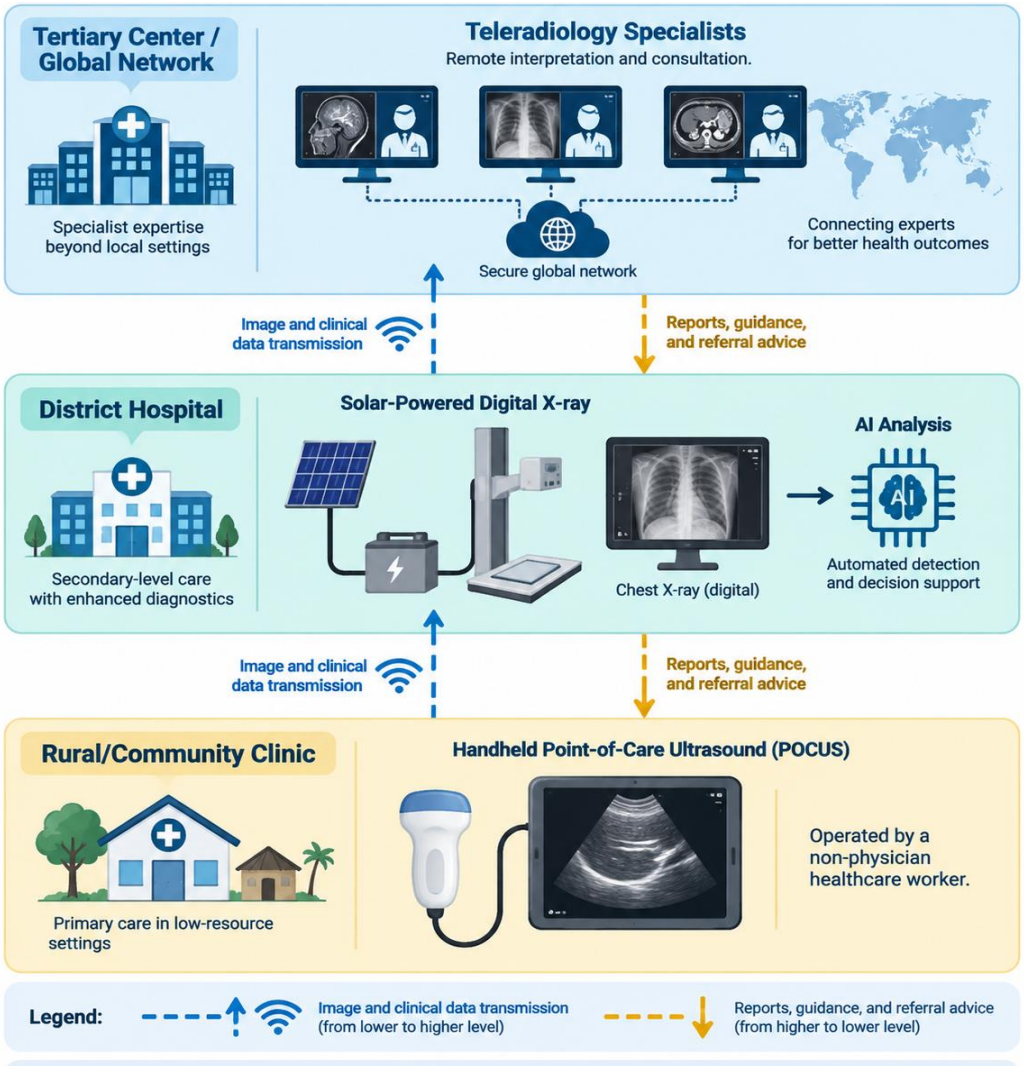


Figure 2. Proposed ecosystem of frugal diagnostic innovations, demonstrating the integration of point-of-care ultrasound (POCUS), artificial intelligence (AI) triage, and teleradiology across decentralized health system tiers

Solar-Powered Systems and Low-Field MRI

MRI has traditionally been difficult to introduce in rural African settings because conventional scanners require substantial electricity, specialised infrastructure and, in many cases, complex cooling systems. However, portable ultra-low-field MRI offers a different approach. These scanners operate at much lower magnetic field strengths and can be used in settings where conventional MRI facilities are unavailable. In Uganda, researchers successfully assembled and tested a 50 mT point-of-care MRI prototype using a Halbach magnet, demonstrating the potential to develop and test low-field MRI technology locally (Obungoloch et al., 2023).

Further progress has been reported in Malawi, where researchers evaluated a commercially developed 64 mT portable MRI system for brain imaging in infants without sedation. The study reported encouraging scan completion rates and demonstrated the feasibility of infant neuroimaging in a setting with limited access to conventional MRI (Vokhiwa et al., 2026). Portable low-field MRI is also being investigated for stroke assessment, including the detection of acute ischaemic stroke and intracerebral haemorrhage (Zabinska et al., 2025). For example, a study using the Hyperfine Swoop 64 mT portable MRI system demonstrated its potential for detecting intracerebral haemorrhage at the bedside (Mazurek et al., 2021).

Although portable MRI produces lower-resolution images than conventional high-field systems, it can still provide useful information for specific clinical decisions. Practical challenges, including transporting equipment through hospitals with limited space and difficult access, also need to be considered (Chetcuti et al., 2022). Therefore, portable ultra-low-field MRI should be assessed not only by image resolution but also by its ability to improve access to diagnosis. In resource-limited settings, affordability, the number of patients successfully examined and the overall cost of completing a diagnostic pathway are equally important (Ogbole, 2026).

Mobile Units and Networked Training

Mobile health units equipped with portable diagnostic devices offer another way to reach communities that have limited access to healthcare facilities; see **Table 2**. Instead of requiring patients to travel long distances, these units bring basic diagnostic services closer to them. In rural Uganda, mobile clinics have used point-of-care ultrasound to support patient assessment, with the findings helping clinicians confirm or change diagnoses and adjust treatment plans (Baker et al., 2021).

Making these innovations sustainable also requires investment in local training and research. Initiatives such as the SPARK Academy aim to equip African researchers and healthcare

professionals with the skills needed to develop and apply AI tools in medical imaging. Such efforts are important for building local expertise and ensuring that African researchers have a greater role in shaping imaging technologies and datasets (Anazodo et al., 2022). A systematic review of deep-learning approaches for detecting tuberculosis from chest X-rays also highlighted the importance of suitable training datasets and further improvements in computer-aided diagnosis systems (Oloko-Oba & Viriri, 2022).

Researchers are also exploring advanced neural network models to improve the detection of tuberculosis on chest radiographs. One study developed a convolutional neural network-based system that incorporated explainable AI to show which areas of an X-ray image influenced its predictions. This approach could help clinicians better understand and assess the results produced by AI systems (Nafisah & Muhammad, 2022). However, these tools should be introduced carefully into clinical practice. WHO guidance supports the use of computer-aided detection for TB screening and triage in adults, but appropriate follow-up testing and clinical assessment remain important for patient management (World Health Organization, 2021).

Table 2: Low-Cost Innovative Solutions

Solution Category	Setting / Application	Reported Outcomes	Limitations	Citation
POCUS / Task-Shifting	Sierra Leone, Uganda	Altered clinical management; high diagnostic agreement.	Requires continuous training and oversight.	(Sabatino et al., 2020; Epstein et al., 2018)
Artificial Intelligence	South Africa (TB screening)	Reduces read workload by over 80%; matches radiologists.	Lower accuracy in HIV patients and older demographics.	(Qin et al., 2024;Macpherson et al., 2025)
Portable Low-Field MRI	Malawi, Uganda	Operates on standard power; high infant scan completion.	Lower resolution; machines remain heavy to move.	(Obungoloch et al., 2023; Vokhiwa et al., 2026)
Teleradiology	South Africa (pediatrics)	Fast specialist opinions via global volunteer networks.	Dependent on bandwidth and external volunteer availability.	(Griggs et al., 2014)

Discussion

The evidence reviewed highlights that the conventional medical imaging model used in high-income countries cannot be directly applied to Sub-Saharan Africa without considering local healthcare needs, infrastructure and available resources. Limited electricity, poor internet connectivity, equipment maintenance challenges and shortages of trained professionals continue to affect imaging services across the region.

The findings also show that introducing advanced technologies alone is not enough. Handheld ultrasound, AI-based diagnostic tools, portable MRI and teleradiology can improve access to imaging, but their effectiveness depends on proper training, technical support and reliable infrastructure. Therefore, greater attention should be given to affordable and easy-to-maintain technologies alongside strengthening local expertise in radiology, medical physics and biomedical engineering. A more practical approach is to adapt imaging solutions to local conditions rather than simply replicate systems designed for well-resourced healthcare settings.

Policy Implications

Governments need to take greater responsibility for managing and maintaining their medical equipment. Health ministries should introduce clear policies to prevent the importation of unverified or unsuitable used equipment and ensure that all donated devices meet local healthcare requirements. Investment in the training of biomedical engineers is equally important to strengthen local maintenance capacity and establish reliable equipment support systems.

Regulatory authorities also have an important role in improving imaging safety. Developing and enforcing national Diagnostic Reference Levels (DRLs) is essential to monitor radiation doses and reduce unnecessary exposure among patients. In addition, addressing the migration of skilled radiographers requires greater attention to their working conditions. Competitive salaries, access to health insurance, better workplace support and protected time for research and professional development could help improve job satisfaction and encourage experienced professionals to remain in the healthcare system.

Evidence Gaps and Limitations

Although research on POCUS and AI is growing, several important gaps remain in the available evidence. Most AI studies conducted in the region are retrospective or focus mainly on tuberculosis. There is still a need for prospective, randomised trials to evaluate the long-term clinical and economic effects of introducing AI into national healthcare systems, particularly for the diagnosis and management of non-communicable diseases.

This review also has some limitations. It includes only articles published in English, which may have excluded relevant research from Francophone and Lusophone African countries. Furthermore, the available literature is concentrated in countries with stronger research output, meaning that the experiences of less-researched regions may not be fully represented. The challenges faced by fragile and conflict-affected countries may be even greater than those reflected in the published evidence.

Conclusion

Access to medical imaging in Sub-Saharan Africa remains limited by inadequate infrastructure, unreliable electricity and internet connectivity, unsuitable equipment donations, maintenance challenges and shortages of trained professionals. However, emerging approaches such as point-of-care ultrasound, artificial intelligence, low-field MRI, teleradiology and solar-powered imaging systems offer practical ways to improve diagnostic access in resource-limited settings. These developments show that effective imaging services do not always depend on expensive,

high-end equipment, but rather on technologies that are appropriate for local needs and can be maintained over time.

To make these solutions sustainable, greater emphasis must be placed on strengthening local capacity rather than relying mainly on imported equipment. Investment in radiology education, biomedical engineering, equipment maintenance, reliable infrastructure and appropriate regulatory systems is essential. Governments and healthcare institutions also need to support research collaborations, improve working conditions for imaging professionals and establish quality assurance measures to ensure safe and effective services. Ultimately, improving medical imaging across the region will require a balanced approach that brings together suitable technologies, skilled professionals and long-term institutional support.

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