REVIEW ARTICLE

Artificial Intelligence in Radiology: A Narrative Review

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Abstract

Radiology undoubtedly plays a crucial role as the backbone of diagnostic imaging. It is one of the most sought-after specialities owing to a work-life balance and minimal patient interaction. The advent of Artificial Intelligence has undoubtedly proven to be a boon with online prescriptions, telemedicine, and advanced technology, revolutionising image-based diagnostic techniques. It is bound to bring tremendous changes in how one predicts the course of a disease, especially for those who rely on pattern recognition. The practice of radiology is set to undergo a seismic shift in the coming years, driven by the increasing application of machine learning and deep learning. It is high time to embrace these changes and remain up to date with recent developments, as virtual medical assistants powered by AI can give doctors the much-needed gift of time while improving the precision in diagnosis and management. This article summarizes **the** past foundations, present practice, and future opportunities of AI in radiology and the concepts essential to understand this integration. It also highlights the fact that careful implementation can ensure equity and efficiency in patient management.

Keywords

Artificial Intelligence, Machine learning, Diagnostic imaging, Patient care, Convolutional neural network

Introduction

Artificial intelligence (AI) is transforming healthcare by automating routine tasks such as patient monitoring, documentation, decision support, and clinical prioritization. The subject of medical image analysis is advancing quickly thanks to a variety of techniques, from variational autoencoders to convolutional neural networks.

In diagnostic imaging, AI enhances both speed and accuracy, rapidly analyzing medical images and reducing human error, a critical advantage in emergencies (1). The National Academy of Medicine highlights AI's potential to support clinicians, offset human limitations like fatigue, and minimize machine-related errors. While its promise is clear, careful implementation is essential. (2) The widespread digitization of healthcare data and rapid technology adoption are driving AI integration. Nonetheless, challenges remain, including secure multimodal data integration, federated learning, which requires advances in privacy and large-scale machine learning, and concerns over model performance and bias. Addressing these issues is crucial to realizing AI's full potential in improving patient care. (3,4)

"Artificial Intelligence" was coined by John McCarthy in 1955. Excessive amount of pessimism, lack of research outputs, and paucity in funding led to the well-known "AI winter" in the subsequent two decades. By the late 1980s, the concept of "deep learning" emerged, and the interest revived not just within the AI community but across different industries as a whole. The public interest started to rise when the then world chess champion, Gary Kasparov, was defeated by IBM's supercomputer 'Deep Blue' in 1997. The interest was further rekindled when self-driving cars became a reality in 2004. Three years later ImageNet project was launched with a massive database of 15 million labelled images. The idea has been to create a large visual database designed for use in visual object recognition software.

These huge resources came in handy as the most useful tool for computer vision. Natural language processing for speech recognition based on a Deep Neural Network was also moving in full swing at Microsoft and Google. The research team at the University of Toronto made significant contributions to image recognition at scale, back in 2012 (5). Notable breakthrough in recognition of unlabeled images also happened in the same year when Google Brain's team developed a system based on one hundred computers and 10 million images that could recognize cats in YouTube videos. Many of AI's wonders are underpinned by the success of the deep neural network (DNN). The deeper the network by the number of layers, the more complex work it can perform. These networks have successfully been applied in games, images, voice & speech, and driverless cars before being used in medicine. While recognition of human faces became the point of interest for biometric passwords to unlock various gadgets, facial features were used to help diagnose rare congenital diseases through the Face2Gene app (6). Thus, the past two decades have been particularly eventful in the field of AI and its increasingly successful applications in medicine. Recent advances in AI research have given rise to new, non-deterministic, deep learning algorithms that do not require explicit feature definition, representing a fundamentally different paradigm in machine learning (7-9).

Convolutional neural networks (CNNs) are now the most often used deep learning architectural typologies in medical imaging, even though other deep learning architectures have been investigated to handle varied objectives.

AI has undoubtedly revolutionized various strata in the field of medicine. It is expanding its capabilities with every passing day.AI helps in recognizing complex patterns in imaging data and can provide a quantitative assessment in an automated fashion in contrast to trained physicians whose assessment at times becomes subjective .AI uses machine learning and deep learning can automate operations like tumor tracing, prioritize urgent cases, improve image quality, and help with treatment planning by analyzing medical images (X-rays, CT, MRI) for quicker, more accurate diagnosis; nevertheless, human oversight is still essential for complex situations and complex clinical context.

Objective: To thoroughly review and synthesize the current evidence on the role, applications, and future prospects of artificial intelligence in radiology, focusing on its impact on diagnostic accuracy, workflow efficiency, and patient care.

Material & Methods

Search Strategy and Study Selection:

A comprehensive narrative literature search was performed to identify key evidence on the role of artificial intelligence in radiology. Major electronic databases, including PubMed/MEDLINE, Embase, Scopus, and the Cochrane Library, were searched for studies published from January 2000 to December 2025, considering the rapid development of artificial intelligence in healthcare. Relevant Medical Subject Headings (MeSH) and keywords such as "Artificial Intelligence," "Machine Learning," "Deep Learning," "Radiology," and "Diagnostic Imaging" were used together with Boolean operators.

Inclusion criteria: (i) original research articles, (ii) systematic and narrative reviews, (iii) clinical trials, and (iv) clinical practice guidelines focusing on AI applications in radiology, published in English. Priority was given to randomised controlled trials, high-quality observational studies, systematic reviews, and influential guidelines from international societies.

Exclusion criteria: (i) non-English publications, (ii) conference abstracts without full texts, (iii) editorials or opinion pieces lacking substantial evidence, and (iv) studies not directly related to radiological applications of artificial intelligence.

Additionally, reference lists of relevant review articles, consensus statements, and clinical guidelines were manually screened to identify significant studies not captured through database searches.

The study selection process was based on relevance to the topic and the contribution to understanding AI's role, applications, and implications in radiology. Since this is a narrative review, formal quality assessments and meta-analyses were not conducted. Consequently, the findings may be subject to selection bias and may not include all available evidence.

Results

Need for artificial intelligence in radiology: In countries like India, with a population expanding at a rapid pace, causing a serious shortage and unequal distribution of radiologists and equipment, especially in rural regions, are the main causes of India's lack of advanced radiography at the Primary Health Care (PHC) level. For modern diagnostics like CT scans or MRIs, the majority of PHCs lack the staff and facilities necessary, which causes delays in diagnosis and substantial out-of-pocket costs for patients who have to travel to urban areas. Retaining skilled healthcare professionals, including radiologists and technicians, in rural and remote areas is difficult due to factors like limited career prospects, lower pay, and a lack of adequate infrastructure. To bridge this gap, technology-driven solutions are being implemented. Artificial intelligence (AI) technologies are being used to automate routine image processing, assist frontline healthcare providers in providing prompt diagnoses, and serve as a force multiplier for the small number of radiologists.

Potential of artificial intelligence in radiology: Image analysis, workflow optimization, personalized care, and research are just a few of the areas in radiology where AI has the potential to greatly improve accuracy and efficiency. Recent advancements in image segmentation, categorization, and computer-aided diagnosis (CAD) using radiomics and predictive analytics are revolutionizing both patient care and the role of the radiologist in the multidisciplinary care team. (10) Subtle pathologies like lung nodules, small malignancies, diabetic retinopathies, age related macular degeneration are susceptible to human oversight, clinical bias, fatigue on part of radiologist leading to missing the diagnosis. Convolutional Neural Networks(CNN's) have demonstrated superiority in diagnosing these. Integrating AI in diagnostic imaging can provide predictive analytics and personalized diagnostics by incorporating vast amounts of historical data and patient-specific characteristics into imaging analysis, enabling earlier diagnosis and more targeted interventions (Table 1).

Table-1: Role of artificial intelligence in radiology

Domain	Role of AI	Examples	Impact
Image acquisition	Optimisation of protocols	Automated dose adjustment in CT/MRI	Decreases radiation hazards, improves efficiency
Image Interpretation	Detection	Lung nodule detection, Breast cancer screening	Increases diagnostic accuracy
Workflow management	Helps in prioritisation	Identifying urgent cases	Decreases delays in reporting
Quantitative analysis	Measurement automation	Segmentation of tumor volume, measurement of bone mineral density	Standardises reporting
Decision Support	Clinical integration	Predictive models for treatment response	Supports personalised medicine

Examples of clinical application areas of artificial intelligence: Artificial intelligence (AI) can help in the early identification of pulmonary nodules in lung carcinoma and categorize them as benign or malignant. For example, AI-automated strain assessments provide more efficient aid in risk stratification after myocardial infarction (11). In the field of oncology, deep learning models have successfully predicted overall survival in prostate cancer patients and have helped tailor treatment approaches by identifying those at higher risk of morbidity/mortality (12). Radiomics is a new area of medical imaging that extracts a large number of quantitative features from digital images, such as CT, MRI, or PET scans, using sophisticated data-characterization algorithms. Radiomics reveals disease features, including tumor heterogeneity, that are frequently invisible to the human eye by transforming these images into mineable, high-dimensional data. A retrospective study by A. Govindarajan et al. stated that deep learning algorithms could successfully process 65,604 CXRs; when used in routine workflow, they flagged abnormalities and triaged studies, leading to measurable workflow changes (reduced reporting turnaround for flagged studies). The paper reports improvement in detection/triage performance in the deployed network (13) A study by P. Gupta et al. on Deep-learning enabled ultrasound detection of gallbladder cancer (GBC) also showed promising results depicting a superior detection accuracy compared with unaided radiologists for distinguishing malignant GBC from benign gallbladder lesions on ultrasound The authors conclude deep learning can improve early detection of GBC on Ultrasound (14). A study by U. Bhattacharjya et al. assesses the chest CT features of COVID-19 and reports the development/assessment of AI-based predictive techniques using CT findings. The paper presents diagnostic utility of CT features and potential for AI models to classify COVID-19 and post-COVID patterns (15) A study by S. Goyal et al on Knowledge, Attitudes, Perceptions & Practices related to AI in Radiology among Indian Radiologists & Residents showed 95.3% interested in learning AI; 86.6% support AI curriculum during residency; many anticipate collaboration with industry but ~28% express job-loss concerns. Provides insight into readiness for AI adoption in Indian radiology practice. (16)

AI has successfully been used in screening conditions like diabetic retinopathy using AIDRSS (AI-based diabetic retinopathy screening system) assisted automatic fundus camera image analysis, and assessing the prevalence of Diabetic retinopathy. The study by Amit Dey et al revealed the prevalence of DR 13.7% (overall) and 38.2% (elevated glucose subgroup); 92% sensitivity, 88% specificity overall; 100% sensitivity for referable DR (DR3/DR4) (17)

A study by Subramaniam et al on Autonomous AI for Multi-Pathology Detection in Chest X-Rays stated that the AI system achieved up to 98% precision and over 95% recall for multi-pathology classification, with stable performance across demographic and equipment subgroups. For normal vs. abnormal classification, it reached 99.8% precision, 99.6% recall, and 99.9% negative predictive value (NPV). It was deployed in 17 major healthcare systems in India, including diagnostic centers, large hospitals, and government hospitals. Over the deployment period, the system processed over 150,000 scans, averaging 2,000 chest X-rays daily, resulting in reduced reporting times and improved diagnostic accuracy. The system detected TB and lung nodules with comparable accuracy (18)

The high incidence and burden of breast cancer represent a tremendous challenge and opportunity for breast cancer screening programs. The purpose of any breast cancer screening program is to reduce the morbidity and mortality of breast cancer by identifying early, small breast cancers to ensure accurate diagnosis and optimal treatment. Screening mammography is the only breast cancer screening modality with a proven mortality benefit, leading to the widespread adoption of mammography-based screening programs throughout the world. Study by Chartand et al states Deep learning utilizing convolutional neural networks has seen an explosion of possibilities and practical uses for image analysis to perform clinically meaningful tasks such as classification (presence or absence of disease), segmentation (quantitative analysis of organs or lesions for surgical planning), and detection (determining the presence or absence of a lesion or nodule) amongst many other diverse applications for AI in radiology (19). A study by McKinney S.M. et al on International evaluation of an AI system for breast cancer screening stated that the AI system outperformed all of the human readers: the area under the receiver operating characteristic curve (AUC-ROC) for the AI system was greater than the AUC-ROC for the average radiologist by an absolute margin of 11.5%. **(20)** The notion that AI will replace radiologists in the future has gained popularity amongst the medical fraternity and budding medical students. Around 40% of medical students say that the integration of AI has made the field less appealing. (21)

Table 2: Comprehensive evidence of successful use of AI in diagnosis and treatment strategies

Author's name (paper / short title)	Year of study	Type of study	Country / State	Sample Size	Findings of the study
A.Govindarajan et al. — Role of an Automated Deep Learning Algorithm in Chest X-ray Workflow	2022	Retrospective observational study	India	65,604 chest X-rays processed during the study period	The DL algorithm processed 65,604 CXRs, flagged abnormalities, and enhanced workflow by decreasing reporting turnaround time (13)
U.Bhattacharjya et al. — Automated diagnosis of COVID-19 using radiological features / Chest CT	2022	Retrospective CT database study / AI-feature appraisal	India	HRCT / chest CT database	A study appraises chest CT features of COVID-19 and reports the development/assessment of AI-based predictive techniques using CT findings. The paper presents the diagnostic utility of CT features and the potential for AI models to classify COVID-19 and post-COVID patterns (15)
S. Goyal et al. — Knowledge, Attitudes, Perceptions & Practices related to AI in Radiology among Indian Radiologists & Residents	2024	Nationwide multicenter survey	India	404 respondents (radiologists and residents)	Key findings: 95.3% interested in learning AI; 86.6% support AI curriculum during residency; many anticipate collaboration with industry, but ~28% express job-loss concerns. Provides insight into readiness for AI adoption in Indian radiology practice. (16)
Bargava Subramanian et al. – Autonomous AI for Multi-Pathology Detection in Chest X-Rays	2025	Deep learning development & deployment	Across India	>5 million chest X-rays (training); deployment in 17 systems, ~150,000 scans processed	98% precision, >95% recall for multi-pathology; 99.8% precision, 99.6% recall, 99.9% NPV for normal vs abnormal; higher accuracy and faster reports. (18)
Amit Kr Dey et al. – AI-Driven Diabetic Retinopathy Screening (AIDRSS)	2025	Cross-sectional validation study	Kolkata, India	5,029 participants; 10,058 fundus images	Prevalence of DR 13.7% (overall) and 38.2% (elevated glucose subgroup); 92% sensitivity, 88% specificity overall; 100% sensitivity for referable DR (DR3/DR4) (17)
McKinney S.M. et al.	2020	Clinical validation (breast cancer screening)	UK & USA	25,856 mammograms	AI reduced false positives and negatives in breast cancer detection. (20)
Q. Miró-Catalina et al. — Real-world external validation	2024	External validation	Multi-centre (external	Real-world primary care cohorts (size	External validation showed the classifier's performance

of CXR normal/abnormal classifier (external validation study)	using primary care cohorts (real-world testing)	cohort includes primary care sites; not India only)	reported in paper)	dropped when applied to a different clinical setting than its training data — authors emphasize the need for local retraining/calibration before deployment. This has direct relevance to Indian deployments (i.e., need local validation). (21)

AI platforms like ChatGPT are getting even more accurate with each passing day (22). Given the ever-increasing workload and image interpretation, the integration of AI ensures workplace optimization and has also shown to reduce diagnosis time considerably (23). In other words, AI acts as an autopilot for radiologists that would help tackle backlogs and reduce workload without compromising the standard of care. (24)

However, some studies highlight that it is a team of expert radiologists feeding annotated data to the AI platform, which is processed by convolutional neural networks and natural language processors. This helps streamline data for radiologists using the specific software platform. Thus providing light to the fact that radiologists can't be replaced by AI (25). A study from Harvard argues that AI should be tailored to individual needs as opposed to a "one size fits all "approach, thus ensuring the best possible patient care (26). Medical AI researcher Dr Curtis Langlotz, in his 2017 keynote, emphasised that AI could never replace radiologists, but those who can use AI would definitely replace those who don't. (27)

AI has also emerged as an option in triage and workflow prioritization, so that urgent studies or cases are taken up first, which in turn reduces the turnaround times and improves outcomes in emergencies like stroke and trauma. AI also aided triage for COVID-19 pneumonia during surges.

Future perspectives and advancements of artificial intelligence

With increasing challenges from rising imaging volumes, workforce shortages, and growing complexity of medical images, specialised capabilities from foundation models have the potential to accelerate the development of tools to scale global healthcare.

Harrison.rad.1 is a specialised multimodal LLM for radiology; it is not a medical device, but rather an enabling technology that supports innovation across the radiology workflow. Launched in 2024, we are actively exploring its applications and welcome collaboration with partners to research this emerging field(28).AI in the form of edge deployment enables offline use in rural areas, supporting TB screening where the internet is limited. Genki, an AI-based CAD-e software, was deployed in four mobile diagnostic units in remote areas of Chennai, India, for TB screening. Genki demonstrated an aggregated sensitivity of 98%, specificity of 96.9%, and accuracy of 96.9% in detecting TB from chest X-ray scans of the screened population (29). The emerging AI application areas in healthcare, detailing the types of development in each field and the anticipated clinical impact outcomes is presented in Table 3

Table 3: Future Perspectives and Development

Field of application of AI	Development	Outcome
Explainable AI	Transparent algorithms	Increased trust of clinicians
Federated Learning	Training across institutions without data sharing	Better generalizability
Hybrid Models	AI + radiologist collaboration	Optimal diagnostic accuracy
Precision Medicine	Linking imaging with genomics	Tailored treatment strategies
Global Health	AI-driven teleradiology	Improved access in rural areas

CONCLUSION

AI is changing radiologists' roles, but complete replacement is unlikely. Radiologists are still necessary for complex cases, clinical judgment, patient communication, and ethical monitoring, even though current research indicates that AI is excellent at pattern recognition and routine imaging jobs. Despite AI performing rapid pattern recognition in large datasets, detecting common abnormalities (e.g., lung nodules, fractures), handling repetitive tasks, and reducing workload, there still exist drawbacks like the "Black box" problem(limited transparency in decision-making), Ethical and regulatory challenges (accountability, patient privacy), which cannot be overcome without human perception and intervention. A new field, called 'radiomics', has emerged to extract a large number of quantitative features from medical images using data characterization algorithms The improved data assessment has the potential to interpret disease characteristics well beyond the capacity of human vision. Embracing the new technologies would add holistic value to patient care.

Future research directions: Future research should focus on large-scale, multicenter validation studies to enhance the applicability of results across diverse populations and healthcare settings. Developing explainable AI models will be key to increasing transparency and building clinician trust. Creating standardized evaluation metrics and reporting guidelines will improve comparability among studies. It is also important to explore ethical AI frameworks, strategies for reducing bias, and methods for integrating AI into clinical workflows. Strengthening regulatory processes and implementing secure, privacypreserving data-sharing techniques like federated learning will support the safe and effective adoption of AI in healthcare radiology.

Limitation of the Study

Limitations of Artificial Intelligence in Radiology:

Despite its potential uses, AI in radiology faces several challenges. Many algorithms are developed using curated datasets that may not reflect the full diversity of real-world clinical scenarios, thereby limiting their generalizability. Their performance can drop when used with different populations, imaging methods, or healthcare environments. Moreover, most AI systems operate as "black boxes," providing little insight into how decisions are made, which can undermine trust among clinicians. Issues such as overfitting, dataset bias, and a reliance on high-quality annotated data also hinder their broader adoption.

Ethical Issues:

Applying AI in radiology presents multiple ethical challenges. Bias in algorithms might cause healthcare disparities, especially if certain populations are underrepresented in training data. Accountability issues also emerge, as responsibility for diagnostic mistakes involving AI remains unclear. The opaque nature of AI decision-making (black-box problem) further hinders ethical acceptance. There are also concerns that radiologists may lose skills due to reliance on automated systems and the risk of excessive reliance on these technologies.

Regulatory, Data Privacy, and Security Challenges:

AI healthcare regulation is evolving, posing safety and standardisation challenges. Agencies like the FDA and European Medicines Agency issue guidelines, but adaptable AI makes approval and monitoring harder. In countries like India, oversight is developing, highlighting the need for strong policies to validate and oversee AI in radiology. AI systems require large patient datasets, raising privacy concerns. Risks include unauthorised access, breaches, and misuse. Ensuring compliance with data laws, anonymising data, and secure sharing is essential. In India, laws like the Digital Personal Data Protection Act are crucial to protect patient confidentiality.

Authors Contribution

All authors have contributed equally.

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Conflict of Interest

There are no conflicts of interest.

Declaration of Generative AI and AI Assisted Technologies in the Writing Process

The authors haven't used any generative AI/AI assisted technologies in the writing process.

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