Science Discovery Health
2026, Vol. 1, No. 2, pp. 49–56
https://doi.org/10.11648/j.sdh.20260102.11

Review Article

Artificial Intelligence in Radiology: A Survey on Transforming Diagnostic Accuracy and Clinical Decision-Making

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Abstract

Artificial Intelligence (AI) has emerged as a transformative force in modern radiology, driven by rapid advances in machine learning (ML) and deep learning (DL) techniques. As radiology is a data-intensive specialty, the increasing volume and complexity of medical imaging have created a growing demand for intelligent tools that can enhance diagnostic accuracy, efficiency, and clinical decision-making. This survey-based review aims to evaluate and assess the current role of AI in radiology and its impact on diagnostic performance and clinical practice. This study systematically reviews and synthesizes peer-reviewed literature published between 2019 and 2025, focusing on AI applications across major imaging modalities, including computed tomography (CT), magnetic resonance imaging (MRI), X-ray, mammography, ultrasound, and positron emission tomography (PET). Relevant studies were identified through major academic databases, and the findings were analyzed narratively to assess improvements in diagnostic accuracy, workflow optimization, and decision-support capabilities. Particular attention was given to commonly used AI algorithms, such as convolutional neural networks (CNNs), ResNet, DenseNet, transformer-based models, and radiomics-driven machine learning approaches. The reviewed evidence demonstrates that AI-assisted radiology systems consistently achieve high levels of diagnostic accuracy, sensitivity, and specificity, in many cases comparable to or exceeding those of expert radiologists. AI tools also contribute to reduced reporting times, improved interobserver consistency, and enhanced prioritization of urgent cases. Furthermore, the integration of AI into clinical decision support systems enables predictive analytics that support personalized treatment planning and disease monitoring. Despite these benefits, this survey highlights several challenges that limit widespread clinical adoption, including data heterogeneity, limited external validation, algorithmic bias, lack of transparency, and evolving ethical and regulatory frameworks. In conclusion, AI represents a powerful complementary tool that enhances, rather than replaces, the role of radiologists. Continued interdisciplinary collaboration, rigorous validation, and responsible governance are essential to ensure the safe and effective integration of AI into radiological practice.

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Received: 11 January 2026; **Accepted:** 21 January 2026; **Published:** 15 April 2026

Keywords

Artificial Intelligence, Radiology, Deep Learning, Diagnostic Accuracy, Clinical Decision-making, Medical Imaging, Machine Learning

1. Introduction

In the last ten years, artificial intelligence (AI) has significantly transformed various areas of healthcare, with radiology leading this digital evolution. As a data-heavy specialty, radiology generates vast amounts of imaging data daily, making it an ideal field for AI applications [1-3]. The rise of advanced imaging technologies like CT, MRI, ultrasound, and PET has resulted in increased workloads and greater complexity in image interpretation for radiologists. AI, driven by deep learning (DL) and convolutional neural networks (CNNs), has shown exceptional abilities in automating image analysis, enhancing diagnostic accuracy, and streamlining radiological workflows [4-6].

Initially, AI applications in radiology were mainly centered on image recognition and pattern detection. Early research indicated that DL algorithms could recognize disease features—such as pulmonary nodules, breast lesions, and cerebral infarctions—at a level comparable to expert radiologists. Recent developments have broadened AI's role beyond mere detection, allowing for lesion segmentation, risk assessment, and even predictive analytics. AI systems now aid clinicians in interpreting multimodal imaging data by integrating radiological findings with patient histories, laboratory results, and genomic information to facilitate personalized decision-making [1-3].

While several previous studies have demonstrated the effectiveness of artificial intelligence applications in specific radiological tasks, many of these investigations remain limited in scope. Most studies focus on single imaging modalities, are based on single-center datasets, or evaluate a narrow range of AI algorithms without comprehensive comparison. In addition, variations in data quality, imaging protocols, and validation strategies reduce the generalizability of their findings. Therefore, a comprehensive survey that evaluates and assesses AI applications across multiple imaging modalities and algorithms is required. The present survey addresses these gaps by providing a structured and critical overview of recent advances in artificial intelligence in radiology.

The intersection of artificial intelligence (AI) and radiology offers opportunities that go beyond simple automation. It heralds a significant change in diagnostic medicine, shifting from reactive analysis to proactive and predictive analytics. AI can quickly analyze thousands of images, identify abnormalities, and prioritize urgent cases, which helps minimize diagnostic delays and improve patient outcomes. Additionally, AI-powered radiomics and natural language processing (NLP) tools are converting unstructured radiology reports into organized, quantifiable data that can be utilized for clinical research and population health management [1-4].

Nonetheless, the incorporation of AI into radiological practices faces several challenges. Issues such as algorithmic bias, data privacy, the need for transparency, and the necessity for thorough validation across diverse populations remain concerns. Radiologists and clinicians must also adjust to new workflows and enhance their digital skills to effectively work alongside AI systems. Moreover, ethical and regulatory frameworks are still developing to ensure the safe and responsible use of AI in healthcare [5-7].

This review paper intends to critically assess the advancements, challenges, and future prospects of AI in radiology. It will specifically investigate how AI technologies improve diagnostic accuracy and aid clinical decision-making while examining the limitations and considerations associated with their application. By systematically reviewing peer-reviewed studies published between 2019 and 2025, this paper aims to provide a thorough overview of the scientific, technical, and ethical context that characterizes the current landscape of AI in radiology [8-10].

2. Objectives and Research Questions

2.1. Research Objectives

The main goal of this review is to analyze the ways in which Artificial Intelligence (AI) is transforming radiology by enhancing diagnostic accuracy and supporting clinical decision-making. More specifically, this paper seeks to:

1) To evaluate and assess the development and effectiveness of artificial intelligence techniques, particularly machine learning and deep learning, across different radiological imaging modalities.
2) Explore the role of AI in clinical decision support systems (CDSS) and its impact on evidence-based medical decisions.
3) Identify significant barriers, including ethical, regulatory, and implementation challenges, that hinder the integration of AI into clinical radiology practice.
4) Evaluate the future directions and sustainability of AI-driven radiology in the context of precision medicine.

2.2. Research Questions

In line with the aforementioned objectives, this review is guided by the following research questions:

1) How has artificial intelligence (AI) progressed in the field of radiology over the last ten years, and what are the key technological developments?
2) To what extent does artificial intelligence enhance diagnostic accuracy, reduce diagnostic errors, and improve clinical and operational performance compared with conventional radiological practices?
3) What ethical and regulatory challenges hinder the broad implementation of AI in diagnostic imaging?
4) How can AI be responsibly integrated to promote transparency, fairness, and patient trust in clinical decision-making?

3. Methodology

3.1. Research Design

This study utilizes a systematic literature review approach, compiling insights from peer-reviewed articles, systematic reviews, and clinical studies published between 2019 and 2025. The review aims to identify trends, advancements, and limitations in the application of AI in radiology.

3.2. Data Sources

A thorough search was conducted across academic databases and digital libraries, including:

1) PubMed
2) IEEE Xplore
3) ScienceDirect
4) Scopus
5) Google Scholar

The search terms employed included: "Artificial intelligence in radiology," "deep learning in medical imaging," "machine learning diagnostic accuracy," "AI clinical decision support," "radiomics," and "computer-aided diagnosis."

3.3. Search Strategy

The search strategy was based on a combination of keywords and medical subject headings, including: "artificial intelligence in radiology," "deep learning in medical imaging," "machine learning diagnostic accuracy," "AI clinical decision support," and "radiomics." Boolean operators were applied to refine the search and retrieve relevant studies published between 2019 and 2025.

3.4. Inclusion and Exclusion Criteria

Inclusion Criteria:

1) Studies published from January 2019 to October 2025.
2) Peer-reviewed journal articles or conference proceedings.
3) Research centered on AI applications in radiology, diagnostic imaging, or decision support.
4) Studies assessing diagnostic accuracy, workflow improvements, or clinical outcomes.

Exclusion Criteria:

1) Articles not published in English.
2) Studies lacking empirical or analytical data.
3) Non-peer-reviewed materials such as blogs, opinion articles, or editorials.

3.5. Data Extraction and Analysis

The selected articles were evaluated for relevance and categorized based on imaging modality and AI methodology. The data extracted were organized into key thematic areas:

1. Improvements in diagnostic accuracy.
2. Enhancements in workflow and efficiency.
3. Support for clinical decision-making.
4. Ethical and regulatory issues.

A narrative synthesis method was employed to summarize the evidence from the chosen literature.

Quantitative data (e.g., accuracy rates, sensitivity, specificity) were compiled in the Results section to emphasize comparative findings across different studies.

3.6. Limitations of the Methodology

As this study is based on a review, it is constrained by the availability and quality of existing literature. Differences in datasets, evaluation methods, and clinical environments among studies may affect the generalizability of the findings. Furthermore, the rapid advancement of AI technology may make some results time-sensitive.

4. Results

4.1. Summary of Findings

The review evaluated 72 peer-reviewed articles published from 2019 to 2025 that explored the application of Artificial Intelligence (AI) in various radiological techniques.

Most of these studies concentrated on deep learning (DL) and convolutional neural networks (CNNs) in diagnostic imaging modalities such as CT, MRI, and X-ray. The overall results suggest that AI significantly enhances diagnostic accuracy, sensitivity, and workflow efficiency across a range of medical fields, including oncology, neurology, and cardiology.

The majority of the studies indicated that AI systems can identify abnormalities with accuracy that is equal to or exceeds that of human radiologists in tasks like nodule detection, tumor segmentation, and fracture identification. Additionally, AI-assisted tools improved reading speed by 25–40% while preserving clinical reliability.

4.2. AI Performance Across Imaging Techniques

To provide a comprehensive overview of artificial intelligence applications in diagnostic imaging, this survey includes multiple radiological modalities such as X-ray, mammography, and ultrasound in addition to CT and MRI, as these modalities represent common clinical use cases for AI-assisted diagnosis. As shown in Table 1, AI-assisted systems demonstrate higher diagnostic accuracy across most imaging modalities.

Table 1. *AI performance across radiological imaging modalities.*

Imaging Modality	AI Technique Used	Clinical Application	Average Accuracy (%)	Sensitivity (%)	Specificity (%)	Source (Year)
CT Scan	CNN, ResNet-50	Lung nodule detection	94.3	92.8	93.7	Ardila et al., 2020
MRI	Deep CNN	Brain tumor segmentation	96.5	95.1	94.8	Pereira et al., 2021
X-ray	DenseNet121	Pneumonia classification	93.4	91.6	90.2	Rajpurkar et al., 2022
Mammography	Hybrid CNN-RNN	Breast cancer detection	95.7	94.9	93.1	McKinney et al., 2020
Ultrasound	Transfer Learning CNN	Thyroid nodule differentiation	90.2	88.5	89.4	Kim et al., 2021
PET/CT	AI Radiomics	Tumor response prediction	92.8	91.3	90.5	Sun et al., 2023

4.3. Diagnostic Accuracy and Clinical Impact

The incorporation of AI markedly enhanced diagnostic consistency and decreased human error rates.

The Table 2 below summarizes the comparative diagnostic performance of AI-assisted radiology versus traditional radiology.

Table 2. *Comparison between traditional and AI-assisted radiology performance.*

Parameter	Traditional Radiology (Mean ± SD)	AI-Assisted Radiology (Mean ± SD)	% Improvement
Diagnostic Accuracy	3.1 ± 87.5	2.4 ± 95.6	9.2% +
Sensitivity	4.0 ± 85.3	2.8 ± 93.8	8.5% +
Specificity	3.6 ± 86.7	3.0 ± 92.4	6.6% +
Reading Time (per case)	7.4 ± 1.2 min	4.5 ± 0.9 min	39% -
Interobserver Variability	High	Low	Reduced variability

These findings indicate that AI significantly improves both accuracy and efficiency, alleviating workload pressures on radiologists while ensuring diagnostic integrity.

4.4. AI in Clinical Decision Support Systems (CDSS)

A subset of 28 studies investigated the role of AI in clinical decision-making. AI-driven CDSS tools offered predictive analytics that assisted in treatment planning and follow-up recommendations [10-12].

A comparative analysis between conventional radiology and AI-assisted radiology is presented in Table 3, showing notable improvements in diagnostic accuracy, sensitivity, and reporting efficiency with the use of artificial intelligence.

***Table 3**. Comparison of diagnostic performance between traditional radiology and AI-assisted radiology.*

Domain	AI Model	Clinical Use	Outcome Improvement	Reference
Oncology	Radiomics + ML	Predicting tumor recurrence after surgery	20–30% enhancement in predictive accuracy	Park et al., 2021
Cardiology	Deep Learning ECG + Imaging	Risk assessment in coronary artery disease	18% improvement in diagnosis	Hannun et al., 2020
Neurology	CNN + MRI	Early diagnosis of Alzheimer's disease	92% accuracy in early detection	Lu et al., 2022
Pulmonology	CNN for Chest CT	Grading severity of COVID-19	40% faster triage	Wang et al., 2020
Orthopedics	DL for X-ray	Detection of fractures	95% sensitivity; decreased reporting time	Lindsey et al., 2021

4.5. Summary of Key Findings

The AI algorithms reported in this survey include convolutional neural networks (CNN), ResNet, DenseNet, transformer-based models, and radiomics-based machine learning approaches. The range of artificial intelligence algorithms and their associated clinical applications included in this survey are outlined in Table 4, highlighting the diversity of models employed across different imaging modalities [4-6].

***Table 4**. Summary of artificial intelligence algorithms and their clinical applications in radiology.*

Category	Findings Summary
AI Algorithms	Deep learning techniques (CNN, ResNet, Transformer-based) are prevalent in radiological AI research.
Modalities Impacted	The highest accuracy is observed in applications based on MRI and CT.
Clinical Benefits	Enhanced diagnostic accuracy, quicker interpretation, and minimized human bias.
Operational Benefits	Improved workflow efficiency, prioritization of urgent cases, and automated reporting processes.
Challenges Identified	Variability in data quality, insufficient external validation, and uncertainties regarding ethical and regulatory issues.
Overall Impact	AI serves as a dependable supplementary tool that enhances the work of radiologists rather than replacing them.

5. Discussion

5.1. Interpretation of Results

The results of this review clearly indicate that Artificial Intelligence (AI) has transformed the field of diagnostic radiology, leading to significant enhancements in diagnostic precision, sensitivity, and efficiency. In various imaging modalities such as CT, MRI, mammography, and ultrasound, AI-driven systems—especially those utilizing deep learning (DL)—have achieved accuracy rates often ranging from 90% to 96%, matching or even surpassing the performance of expert radiologists in certain detection and classification tasks.

These results highlight that AI can effectively serve as a valuable support tool, enhancing rather than replacing human expertise. Radiologists continue to play a crucial role in interpretation, context, and ethical decision-making, while AI aids in minimizing errors, identifying subtle patterns, and maintaining consistent performance during high-demand situations.

The incorporation of AI-based clinical decision support systems (CDSS) has broadened the scope of AI from merely interpreting images to comprehensive patient management, facilitating personalized and predictive healthcare. AI models that integrate imaging data with genomics, clinical history, and laboratory results offer a more comprehensive understanding of diseases—something that traditional radiology alone cannot provide.

5.2. Comparison with Previous Studies

Previous research conducted before 2019 mainly showcased the potential of AI using experimental or limited datasets. However, recent studies from 2019 to 2025 have shifted focus towards clinical validation and real-world implementation, indicating advancements in algorithm performance and dependability. For instance, studies by McKinney et al. (2020) and Ardila et al. (2020) demonstrated AI's capability to achieve or surpass radiologist-level accuracy in breast and lung cancer screenings, respectively, which aligns with the findings presented in this review.

Moreover, multi-center trials and FDA-approved AI tools—such as IDx-DR for diabetic retinopathy and Aidoc for brain hemorrhage triage—illustrate the transition of AI from research settings to clinical practice. This evolution signifies a move from “proof-of-concept” to “clinical reality.”

However, comparative studies indicate that AI performance can vary significantly based on factors such as data diversity, imaging quality, and the environments in which algorithms are trained. Models developed on uniform datasets may struggle when applied to diverse patient populations, highlighting the necessity for thorough external validation and collaboration across institutions.

5.3. Ethical and Regulatory Considerations

While AI offers remarkable diagnostic accuracy, it also brings forth ethical, legal, and social challenges that need careful attention:

1. Bias and Fairness:

AI models developed using unbalanced datasets may reinforce existing healthcare inequalities. If certain ethnic or demographic groups are underrepresented in the training data, it can result in algorithmic bias, leading to disparities in diagnostic accuracy, especially in fields like oncology and cardiology imaging [13, 14].

2. Transparency and Explainability:

The "black-box" characteristic of deep learning systems makes them difficult to interpret. Clinicians might find it challenging to understand the rationale behind an algorithm's decisions, which can erode trust and accountability in clinical settings. Emerging approaches like Explainable AI (XAI) are essential to overcome this challenge [16-18].

3. Data Privacy and Security:

Medical imaging data often includes sensitive patient information. Adhering to GDPR and HIPAA regulations is crucial for ensuring secure data management, particularly when utilizing cloud-based AI solutions [17, 18].

4. Regulatory Approval:

AI tools must undergo thorough testing prior to clinical use. Regulatory agencies such as the FDA and EMA are developing pathways for the approval of AI-driven medical devices, focusing on transparency, reproducibility, and ongoing monitoring after market release [14-19].

5.4. Clinical Implications

The integration of AI in radiology goes beyond mere automation. Its impact is felt throughout the entire diagnostic process, including:

1) Image Acquisition: AI-enhanced reconstruction techniques improve image quality while minimizing radiation exposure.
2) Triage and Prioritization: AI can automatically identify urgent cases (such as intracranial hemorrhage), speeding up the response time for radiologists.
3) Quantitative Imaging: AI offers objective metrics (like tumor volume, texture, and perfusion), enhancing precision in long-term follow-ups.
4) Reporting and Integration: Natural Language Processing (NLP) facilitates structured reporting and integration with electronic health records (EHRs).

These applications illustrate a collaborative dynamic between AI and radiologists, where AI handles repetitive and data-intensive tasks, allowing radiologists to focus on critical thinking and patient-centered care.

5.5. Limitations and Future Perspectives

Despite significant advancements, several challenges persist:

1) Data Heterogeneity: Differences in scanner types, imaging protocols, and the quality of annotations can impact the generalizability of models.
2) Need for Interpretability: Clinicians must be able to trust and comprehend AI predictions to effectively incorporate them into their practice.
3) Interdisciplinary Gaps: Collaboration among radiologists, data scientists, and engineers is still lacking.
4) Dynamic Learning and Updates: Continuous retraining of models is necessary to keep pace with changing imaging standards.

Looking forward, the upcoming generation of AI in radiology is anticipated to incorporate multimodal data fusion—merging imaging, genomics, and clinical information—as well as federated learning techniques that enable collaborative training among institutions without the need to share raw data. These innovations could help address existing issues related to generalizability, security, and transparency.

6. Conclusion

The incorporation of Artificial Intelligence (AI) into radiology marks a significant advancement in contemporary medical science. This study shows that AI has greatly improved diagnostic precision, minimized human errors, and transformed clinical decision-making across various imaging techniques, including CT, MRI, ultrasound, and mammography. Deep learning algorithms, especially convolutional neural networks (CNNs), have demonstrated diagnostic capabilities that are on par with or even surpass those of seasoned radiologists in areas such as early cancer detection, automated fracture identification, and analysis of neurological disorders.

Moreover, the impact of AI in radiology goes beyond mere image analysis. It supports the development of intelligent clinical decision-support systems that enhance workflow efficiency, shorten report turnaround times, and aid in prioritizing high-risk patients. AI's ability to model predictions allows for tailored treatment planning and ongoing patient monitoring, paving the way for precision medicine. Additionally, AI systems can continually learn from extensive datasets, leading to ongoing improvements in diagnostic accuracy and prognostic predictions—something traditional methods struggle to achieve.

Despite these advancements, several obstacles hinder the widespread adoption of AI in clinical radiology. Ethical issues are critical, particularly concerning data privacy, transparency of algorithms, and potential biases in training datasets. Radiologists also face challenges related to the opaque nature of AI decision-making, which can undermine interpretability and trust among clinicians. Furthermore, disparities in data access between high-resource and low-resource healthcare environments risk exacerbating the digital divide in diagnostic quality.

To ensure responsible integration, collaboration among radiologists, data scientists, ethicists, and policymakers is crucial. Developing strong regulatory frameworks and standardized validation processes will improve algorithm reliability and patient safety.

Ongoing professional development should be emphasized so that radiologists can collaborate with AI rather than be replaced by it—utilizing AI as a tool that enhances human intelligence instead of replacing it.

Looking ahead, the merging of AI with radiomics, genomics, and electronic health record analytics holds the promise of a future characterized by fully integrated, data-driven medicine. As AI systems progress toward more explainable, transparent, and interoperable models, their potential to transform diagnostic imaging will grow significantly.

In the coming decade, radiology is expected to evolve from merely interpreting images to providing integrated diagnostic intelligence, with AI playing a pivotal role in predictive analytics, population health monitoring, and personalized patient care.

Overall, the convergence of artificial intelligence and human expertise represents a key pillar of high-performance medicine, where AI enhances clinical decision-making while preserving the central role of physicians [20].

In the end, the future of radiology is not about a competition between humans and machines, but rather about the collaboration between the two. With a strong focus on ethics, clear governance, and teamwork in clinical settings, AI will not only change the way diseases are identified and treated, but it will also reshape the core principles of evidence-based medical practice [16-18].

Acknowledgments

The author would like to express deep appreciation for the significant contributions made by the global radiology and artificial intelligence research community. The knowledge gained from studies published between 2019 and 2025 has formed the scientific basis for this review. Special thanks go to the engineers, clinicians, and data scientists who are pushing the limits of diagnostic imaging through advancements in deep learning, computer vision, and medical data analysis.

The author also wishes to thank the academic reviewers and radiology professionals whose insights and clinical knowledge play a crucial role in the responsible implementation of AI in healthcare. Their collaboration ensures that AI is not just a technological tool, but a human-centered resource aimed at enhancing patient outcomes and achieving clinical excellence.

Author Contributions

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Conflicts of Interest

The authors declare no conflicts of interests.

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