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Review Article

Beyond Diagnostic Accuracy: Evaluating the Real-World Clinical Impact of AI-Enabled Radiology in Oncology and Nuclear

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Abstract:

Artificial intelligence (AI) has become increasingly integrated into radiology and nuclear medicine, particularly in oncology, where imaging plays a central role in diagnosis, staging, treatment planning, and response assessment. To date, evaluation of AI-enabled radiology has been dominated by diagnostic accuracy metrics derived from retrospective validation studies. While such measures are essential for technical assessment, they provide limited insight into real-world clinical value. High algorithmic performance does not necessarily translate into improved decision-making, workflow efficiency, patient outcomes, or health system performance. This narrative review critically examines AI-enabled radiology as a digital health intervention in oncology and nuclear medicine, emphasizing the need to move beyond accuracy-centric evaluation paradigms. We analyze the translational gap between controlled validation and routine clinical deployment, highlighting challenges related to dataset bias, generalizability, and human–AI interaction. Key domains of real-world impact are explored, including clinical decision-making, multidisciplinary integration, workflow and operational performance, patient-centered outcomes, and system-level implications. Methodological considerations for outcome-focused evaluation are discussed, alongside regulatory, ethical, and governance frameworks necessary for responsible implementation. We propose a clinical-impact–centered evaluation framework that links AI-assisted imaging to patient, clinician, and system-level outcomes within a continuous monitoring model. Reframing AI-enabled radiology as a clinical intervention rather than a standalone algorithm is essential for ensuring meaningful, equitable, and sustainable adoption in oncology and nuclear medicine practice.

Keywords: Artificial Intelligence; Radiology; Nuclear Medicine; Oncology Imaging; Clinical Impact; Digital Health; Decision Support Systems; Implementation Science

Introduction

Artificial intelligence (AI) has rapidly transitioned from an experimental technology to a clinically deployed tool in radiology and nuclear medicine. Advances in machine learning, particularly deep learning, have enabled AI systems to perform tasks such as lesion detection, image segmentation, disease classification, and quantitative image analysis across modalities, including CT, MRI, PET/CT, and SPECT. In oncology, where imaging underpins diagnosis, staging, treatment planning, and response assessment, AI-enabled radiology is increasingly positioned as a means to enhance precision, efficiency, and consistency in imaging interpretation [1–3].

To date, the evaluation of AI in radiology has been dominated by diagnostic accuracy metrics, such as sensitivity, specificity, and area under the receiver operating characteristic curve. While these measures are essential for initial validation, they provide a limited view of clinical value. High diagnostic performance demonstrated in retrospective or controlled settings does not necessarily translate into meaningful benefits for patient care, particularly in complex oncologic pathways where imaging findings must be interpreted in a clinical context and integrated into multidisciplinary decision-making.

In oncology and nuclear medicine, accuracy-focused evidence is especially insufficient. Imaging results directly influence downstream decisions, including tumor staging, treatment selection, eligibility for targeted therapies, and assessment of therapeutic response. An AI system that marginally improves detection performance but fails to alter clinical decisions, reduce diagnostic uncertainty, improve workflow efficiency, or positively affect patient outcomes may offer limited real-world benefit. However, reliance on accuracy metrics alone does not fully capture how AI systems influence clinical decisions, workflow integration, or patient outcomes in routine practice [4].

There is, therefore, a growing need to move beyond algorithm-centric performance metrics toward evaluation frameworks that capture real-world clinical impact. Such frameworks should assess how AI-enabled radiology influences clinical decision-making, operational workflows, patient-centered outcomes, and health system performance within routine oncology and nuclear medicine practice [5,6]. Addressing this gap is essential for guiding responsible adoption, informing regulatory and institutional decision-making, and aligning AI development with genuine clinical needs.

This review aims to critically examine AI-enabled radiology as a digital health technology in oncology and nuclear medicine, with a focus on its real-world clinical impact. Specifically, the review explores how AI affects clinical decision-making, imaging workflows, patient outcomes, and broader health system performance, and highlights key challenges and priorities for outcome-focused evaluation and future research.

This narrative review was conducted through a targeted literature search of PubMed, Scopus, and Web of Science focusing on studies published between 2018 and 2026 related to artificial intelligence in radiology, nuclear medicine, oncology imaging, and clinical impact evaluation. Keywords included combinations of 'artificial intelligence', 'radiology', 'nuclear medicine', 'clinical impact', 'workflow', and 'patient outcomes'. Articles addressing technical validation, implementation studies, and health system impact were prioritized. Relevant references cited within retrieved articles were also screened to identify additional sources. The aim was not to perform a systematic review but to synthesize key conceptual and empirical developments related to real-world clinical evaluation of imaging AI.

Conceptualizing AI-Enabled Radiology as a Digital Health Intervention

From Algorithms to Clinical Interventions

AI-enabled radiology systems are increasingly deployed not as autonomous diagnostic entities but as clinical decision support tools that augment human expertise. In routine practice, these systems assist radiologists and nuclear medicine physicians by highlighting regions of interest, quantifying imaging features, prioritizing studies, or providing probabilistic assessments that inform interpretation. This positioning reflects a deliberate shift away from the notion of AI as a replacement for clinical judgment toward a model of human–AI collaboration, which is particularly critical in oncology, where imaging findings must be interpreted within complex clinical and pathological contexts [7,8].

This distinction underscores the difference between technical validation and clinical utility. Technical validation focuses on algorithmic performance under predefined conditions, often using retrospective datasets and benchmark metrics. Clinical utility, by contrast, concerns whether an AI system meaningfully improves care when embedded in real-world workflows by influencing decisions, reducing uncertainty, improving efficiency, or enhancing patient

outcomes. An algorithm may demonstrate excellent technical performance yet fail to deliver clinical benefit if it does not align with how clinicians work, address relevant decision points, or integrate seamlessly into care pathways.

Positioning Imaging AI Within Digital Health Ecosystems

As a digital health intervention, AI-enabled radiology does not operate in isolation. Its impact depends on effective integration within broader health information infrastructures, including picture archiving and communication systems (PACS), radiology information systems (RIS), electronic health records (EHRs), and oncology-specific information systems. Seamless interoperability enables AI outputs to be available at the point of care, incorporated into structured reports, and linked with clinical, laboratory, and pathological data that collectively inform oncology decision-making [6,9].

Within multidisciplinary cancer care, imaging AI can influence workflows beyond the radiology department. Outputs from AI-assisted imaging interpretation may shape discussions in tumor boards, support therapy selection, guide biopsy or surgical planning, and inform longitudinal response assessment[10]. In nuclear medicine, where quantitative imaging and functional assessment are central, AI systems may contribute to standardized measurements, harmonized reporting, and improved reproducibility across time points and institutions[11]. Viewing imaging AI as part of a connected digital ecosystem highlights that its value lies not only in image interpretation but also in how it supports coordinated, data-driven cancer care.

Why Oncology and Nuclear Medicine Require Outcome-Focused Evaluation

Oncology and nuclear medicine represent clinical domains in which imaging plays a pivotal role across the entire care continuum. Imaging findings directly influence diagnosis, disease staging, risk stratification, treatment selection, and evaluation of therapeutic response [12]. As a result, the downstream consequences of AI-assisted imaging decisions are substantial. Misclassification, overconfidence in algorithmic outputs, or inappropriate automation can propagate errors through subsequent clinical decisions, potentially affecting patient outcomes.

Given these high stakes, accuracy-focused evaluation alone is insufficient. Small gains in diagnostic performance may not translate into meaningful clinical benefit if they do not alter management decisions or improve patient-centered outcomes. Conversely, modest technical performance improvements may have a substantial impact if they reduce delays, improve consistency, or enhance decision-making in critical points of care. Outcome-focused evaluation is therefore essential to determine whether AI-enabled radiology truly adds value in oncology and nuclear medicine, ensuring that adoption is guided by demonstrable benefits to patients, clinicians, and health systems rather than by technical performance metrics alone [13–15].

Limitations of Accuracy-Based Evaluation Paradigms

Existing literature evaluating AI in radiology has primarily focused on algorithmic performance rather than broader clinical impact. The following sections synthesize key methodological limitations identified in the literature that may affect the translation of AI systems into real-world oncology practice.

Overreliance on Retrospective and Benchmark Datasets

The majority of AI systems in radiology and nuclear medicine are developed and validated using retrospective datasets curated under controlled conditions. While such datasets are essential for algorithm training and preliminary performance assessment, they often fail to reflect the complexity and variability of real clinical environments. Patient populations in benchmark datasets may differ from routine practice in disease prevalence, case mix, comorbidities, imaging protocols, and scanner characteristics [8,16]. As a result, performance estimates derived from these datasets may overstate real-world effectiveness.

Two methodological concerns are particularly relevant. First, spectrum bias arises when validation datasets do not adequately represent the full range of disease presentations encountered in practice, leading to inflated performance metrics [17]. Second, dataset shift differences between training data and deployment environments can degrade performance once an AI system is implemented in new institutions, geographic regions, or clinical settings[18]. In oncology and nuclear medicine, where imaging protocols and disease characteristics vary substantially, these issues may significantly limit generalizability. Consequently, high reported diagnostic accuracy in retrospective validation does not guarantee reliable performance in routine clinical workflows.

Disconnect Between Diagnostic Accuracy and Clinical Benefit

Although improvements in sensitivity or specificity may demonstrate technical progress, these

gains do not necessarily translate into meaningful clinical benefit. In oncology imaging, clinical decisions depend on multidisciplinary interpretation that integrates imaging findings with pathological and clinical information. As a result, incremental improvements in detection performance may have limited influence on treatment planning or patient outcomes [19,20].

This disconnect underscores a central limitation of accuracy-based evaluation: it treats image interpretation as an endpoint rather than as one component within a broader clinical pathway. In oncology, the ultimate value of imaging lies in its contribution to improved decision-making, timely treatment initiation, and optimized outcomes. Without evidence demonstrating that AI-enabled radiology influences these downstream endpoints, claims of clinical value remain incomplete [21]. Evaluating AI solely on diagnostic performance risks conflating technical excellence with real-world effectiveness.

Human–AI Interaction and Contextual Use

Clinical deployment of AI is inherently shaped by human–AI interaction. Radiologists and nuclear medicine physicians interpret algorithm outputs within the context of patient history, prior imaging, and multidisciplinary input. Trust in AI systems, perceived reliability, and familiarity with tool limitations influence how outputs are used in practice. Overreliance on algorithmic suggestions may lead to automation bias, whereas underutilization due to skepticism may negate potential benefits [22].

Explainability and user interface design also play critical roles. AI outputs that are opaque or poorly integrated into reporting workflows may increase cognitive load or create ambiguity, reducing efficiency and acceptance. Conversely, clear visualization of findings, confidence estimates, and structured integration into reports can support informed decision-making. Because accuracy metrics alone do not capture these contextual and behavioral factors, comprehensive evaluation of AI-enabled radiology must account for human factors, usability, and workflow integration. Without this broader perspective, assessments of performance remain incomplete and may misrepresent the true clinical impact of AI systems in oncology and nuclear medicine [23,24].

Domains of Real-World Clinical Impact

AI-enabled radiology can influence oncology and nuclear medicine practice through multiple interconnected pathways that extend well beyond diagnostic accuracy. While conventional evaluation has focused primarily on performance metrics, meaningful clinical value emerges only when AI systems demonstrably shape decision-making processes, improve workflow efficiency, enhance patient-centered outcomes, and contribute to health system performance [2].

To organize the existing literature, the potential impact of AI-enabled radiology can be examined across four interrelated domains: clinical decision-making, workflow efficiency, patient-centered outcomes, and health system performance.

In high-stakes oncologic care, imaging functions as a pivotal decision node across diagnosis, staging, treatment planning, and response assessment; therefore, impact must be assessed across these broader domains. To clarify the distinction between traditional accuracy-based evaluation and outcome-oriented assessment, Table 1 contrasts commonly used diagnostic performance metrics with measures that capture real-world clinical and system-level impact of AI-enabled radiology. This framework provides the foundation for examining the specific domains in which clinical value may be realized [25].

Table 1. Comparison of Diagnostic Accuracy Metrics and Real-World Clinical Impact Measures in AI-Enabled Radiology

Evaluation Dimension	Accuracy-Focused Evaluation	Real-World Clinical Impact Evaluation
Primary objective	Measure algorithmic performance	Assess meaningful clinical and system-level value
Typical metrics	Sensitivity, specificity, AUROC, precision, recall	Decision changes, workflow efficiency, patient-centered outcomes
Study setting	Retrospective, curated datasets	Routine clinical practice, prospective or pragmatic settings
Clinical context	Isolated image interpretation	Embedded within oncology and nuclear medicine care pathways
Relevance to management	Limited insight into downstream care	Direct assessment of staging, treatment planning, and response assessment

Table 1. *Cont.*

Evaluation Dimension	Accuracy-Focused Evaluation	Real-World Clinical Impact Evaluation
Human–AI interaction	Rarely considered	Explicitly evaluates clinician trust, adoption, and cognitive impact
Workflow impact	Not evaluated	Reporting time, prioritization, and workload distribution
Patient-centered outcomes	Typically not assessed	Time-to-diagnosis, time-to-treatment, treatment modification
Generalizability	Often limited by dataset bias	Assessed across institutions and patient populations
Health system implications	Not captured	Resource utilization, scalability, cost, and sustainability
Regulatory relevance	Primarily supports pre-market approval	Informs post-deployment monitoring and lifecycle evaluation
Key limitation	May overestimate clinical value	Requires complex, longitudinal assessment

Impact on Clinical Decision-Making

One of the most important domains in which AI-enabled radiology may exert clinical value is its influence on diagnostic decision-making. By providing quantitative assessments, highlighting subtle imaging features, or offering standardized interpretations, AI tools have the potential to increase diagnostic confidence and reduce inter- and intra-observer variability. In oncology and nuclear medicine, improved reporting consistency is particularly relevant for longitudinal assessment, where changes in tumor burden or functional activity over time directly inform therapeutic decisions [26].

Beyond confidence and consistency, AI-assisted imaging may influence higher-level clinical decisions, including disease staging, risk stratification, and treatment planning. Accurate and reproducible identification of tumor extent, nodal involvement, or metastatic disease can affect eligibility for surgery, radiotherapy, systemic therapies, or targeted interventions [11,27]. In this context, the value of AI lies not merely in detection accuracy but in its ability to support clinically actionable interpretations that align with established oncologic decision frameworks.

AI outputs may also play a role in multidisciplinary tumor boards, where imaging findings are discussed alongside pathological, molecular, and clinical data. By contributing standardized measurements or visual summaries, AI-enabled radiology has the potential to facilitate shared understanding, support consensus-building, and reduce ambiguity in complex cases. Evaluating impact at this level requires assessing whether AI alters recommendations or improves confidence in collective decision-making, rather than focusing solely on individual diagnostic performance [28].

Workflow and Operational Impact

Operational efficiency represents another key domain of real-world impact. AI-enabled radiology systems are frequently promoted as tools to reduce reporting time, manage increasing imaging volumes, and optimize workload distribution. Applications such as automated segmentation, preliminary measurements, and structured reporting may streamline routine tasks, allowing radiologists and nuclear medicine physicians to focus on complex interpretive and consultative activities [9,29].

Several early implementation studies have reported reductions in reporting time and improved prioritization of urgent imaging findings when AI-based triage systems are integrated into radiology workflows, particularly in high-volume clinical environments [9,29].

AI-driven triage and prioritization systems may further influence workflow by identifying urgent or abnormal studies for expedited review. In oncology settings, timely detection of critical findings, such as disease progression or treatment-related complications, can have direct implications for patient management. In nuclear medicine, workflow considerations also include protocol standardization, quantitative analysis, and harmonization of imaging outputs across time points and institutions. The true operational value of these tools depends on how effectively they integrate into existing workflows without introducing additional complexity or inefficiency [30].

Patient-Centered and Outcome-Level Effects

Ultimately, the clinical relevance of AI-enabled radiology must be judged by its impact on patient-

centered outcomes. Potential benefits include reductions in time-to-diagnosis and time-to-treatment, which are particularly important in oncology, where delays may affect prognosis and patient experience. AI-assisted prioritization and decision support may accelerate diagnostic pathways and facilitate earlier clinical intervention by reducing diagnostic uncertainty [31]. However, most currently available studies evaluate intermediate outcomes such as diagnostic confidence, workflow efficiency, or decision modification rather than long-term clinical outcomes such as survival or quality of life [31,32].

AI may also influence treatment modification and response monitoring by enabling more precise and consistent assessment of disease burden over time. In nuclear medicine, quantitative imaging supported by AI could enhance the evaluation of metabolic or functional response, potentially informing adaptive treatment strategies. However, evidence linking AI-enabled radiology directly to improved clinical outcomes remains limited. Existing studies often focus on intermediate endpoints rather than survival, quality of life, or long-term disease control, underscoring the need for more rigorous outcome-focused research [32].

Health System and Economic Implications

At the health system level, AI-enabled radiology has implications for resource utilization,

efficiency, and sustainability. Potential benefits include improved throughput, reduced repeat imaging, and more efficient allocation of specialist expertise within high-volume oncology centers. When appropriately implemented, these gains may help address workforce constraints and increase imaging demand[33]. Early health system evaluations suggest that AI-supported imaging analysis may improve throughput and optimize specialist resource allocation, although comprehensive economic evaluations remain limited [33,34].

Scalability is a critical consideration, particularly in large oncology networks and tertiary care centers where imaging volumes are substantial. However, scalability must be balanced against costs associated with acquisition, integration, maintenance, and ongoing performance monitoring of AI systems. Economic evaluations that consider both direct and indirect costs, as well as long-term sustainability, are therefore essential. Without evidence demonstrating favorable cost–benefit profiles and system-level value, the widespread adoption of AI-enabled radiology may be difficult to justify, regardless of technical performance [34].

Methodological Approaches to Evaluating Clinical Impact

Recent studies have proposed several methodological approaches to evaluate the real-world impact of AI-enabled radiology beyond traditional accuracy metrics.

Study Designs Used in Real-World AI Evaluation

Evaluating the real-world clinical impact of AI-enabled radiology requires study designs that extend beyond retrospective validation and controlled testing. Observational studies conducted in routine clinical settings are commonly used to assess how AI tools perform once integrated into everyday workflows. These studies can provide valuable insights into utilization patterns, clinician behavior, and early signals of clinical or operational impact, although they are inherently limited by potential confounding and selection bias.

Prospective studies offer stronger evidence by assessing AI performance and impact in real time, often before and after implementation within the same clinical environment. Such designs allow for direct measurement of changes in decision-making, workflow efficiency, or patient management attributable to AI adoption. Pragmatic trials and hybrid effectiveness–implementation designs are particularly well suited for

this purpose, as they balance internal validity with real-world relevance. By embedding evaluation within routine practice, these approaches can capture both clinical outcomes and implementation factors that influence adoption and sustainability in oncology and nuclear medicine settings [35]. The outcome domains outlined in Table 1 highlight the need for evaluation frameworks that extend beyond accuracy-based metrics.

Outcome Measures Beyond Accuracy

A central challenge in impact evaluation is the selection of outcome measures that reflect meaningful clinical value. Clinical endpoints may include changes in diagnosis, staging, or treatment decisions attributable to AI-assisted imaging, as well as downstream effects on therapeutic pathways. Measuring decision changes, diagnostic confidence, or concordance with multidisciplinary recommendations can provide insight into how AI influences care processes, even when ultimate patient outcomes are difficult to assess [21,36].

Workflow and safety metrics are also critical components of a comprehensive evaluation. These may include reporting time, case prioritization efficiency, error rates, and detection of clinically significant

findings. In parallel, implementation and usability indicators such as user adoption rates, frequency of AI output utilization, perceived usefulness, and integration into reporting systems help determine whether an AI tool is practically viable in routine oncology and nuclear medicine practice [37]. Together, these measures provide a multidimensional view of impact that cannot be captured by accuracy metrics alone.

Challenges in Evidence Generation

Generating high-quality evidence on the clinical impact of AI-enabled radiology presents several methodological challenges. Confounding factors, such as concurrent workflow changes, evolving clinical guidelines, or differences in clinician experience, can make it difficult to attribute observed effects directly to AI implementation. In addition, the complexity of oncology care pathways complicates causal inference, as imaging is only one of multiple inputs influencing clinical decisions and outcomes [38].

Reporting heterogeneity further limits comparability across studies. Variations in study design, outcome definitions, and reporting standards hinder the synthesis of evidence and impede the development of generalizable conclusions. The absence of standardized evaluation frameworks for AI-enabled radiology exacerbates these challenges, leading to fragmented and often incomplete assessments of impact. Addressing these limitations will require consensus on core outcome sets, transparent reporting practices, and methodologically robust study designs tailored to the realities of oncology and nuclear medicine practice [39].

Regulatory, Ethical, and Implementation Considerations

Regulatory Pathways and Post-Deployment Monitoring

Regulatory approval of AI-enabled radiology systems has largely focused on pre-market evaluation of technical performance, safety, and intended use. While such assessments are necessary to establish baseline reliability, they are typically conducted under controlled conditions that may not fully reflect real-world clinical complexity. Pre-market studies often rely on retrospective datasets and narrowly defined endpoints, which may limit their ability to predict performance across diverse patient populations, imaging protocols, and institutional environments encountered in oncology and nuclear medicine practice [40].

Given these limitations, post-deployment monitoring becomes essential. Continuous performance assessment in real-world settings can identify degradation due to dataset shift, evolving clinical practices, or changes in imaging technology. Ongoing surveillance mechanisms such as periodic revalidation, audit of performance metrics, and monitoring of unintended consequences are critical to ensure sustained safety and effectiveness [41]. In oncology, where imaging results directly influence high-stakes therapeutic decisions, a static, one-time evaluation model is insufficient. Regulatory and institutional frameworks must therefore support lifecycle oversight of AI systems rather than treating approval as the endpoint of evaluation.

Ethical and Equity Considerations

Ethical considerations in AI-enabled radiology extend beyond technical performance to issues of bias, fairness, and representativeness. Algorithms trained on datasets that underrepresent certain demographic groups, disease subtypes, or geographic regions may exhibit differential performance across populations. In oncology imaging, such disparities could lead to inequitable diagnostic accuracy, delayed treatment, or inappropriate management for vulnerable groups. Ensuring diversity in training data and conducting subgroup performance analyses are therefore essential components of responsible AI development and deployment [42].

Access disparities also warrant careful consideration. Advanced AI systems may be more readily adopted in well-resourced tertiary oncology centers, potentially widening gaps between institutions with differing infrastructure or financial capacity. Additionally, algorithmic generalizability across healthcare settings—including low-resource environments—remains uncertain. Without deliberate efforts to promote equitable access and validate performance across diverse contexts, AI-enabled radiology risks reinforcing existing healthcare inequities rather than mitigating them.

Clinical Governance and Responsibility

Effective implementation of AI-assisted imaging requires clear governance structures that define roles, responsibilities, and accountability. AI outputs should support, not replace, professional judgment. Human oversight remains essential, particularly in complex oncologic cases where imaging findings must be interpreted alongside clinical, pathological, and molecular information. Clear policies regarding how AI recommendations are reviewed, documented, and incorporated into reports can reduce ambiguity and enhance transparency [43,44].

Institutional accountability also includes providing appropriate training and education for

radiologists, nuclear medicine physicians, and allied healthcare professionals. Familiarity with system capabilities, limitations, and potential failure modes is necessary to prevent overreliance or misuse. Structured training programs and ongoing competency assessment can facilitate safe integration into clinical workflows. Ultimately, governance frameworks must ensure that AI-enabled radiology operates within established standards of care, with clearly defined human responsibility for final clinical decisions.

Toward a Clinical-Impact–Centered Evaluation Framework

Figure 1 presents a conceptual framework for evaluating the real-world clinical impact of AI-enabled radiology in oncology and nuclear medicine, linking imaging outputs to patient-, clinician-, and system-level outcomes within a continuous evaluation model.

Figure 1. Clinical-Impact Framework for AI-Enabled Radiology in Oncology and Nuclear Medicine
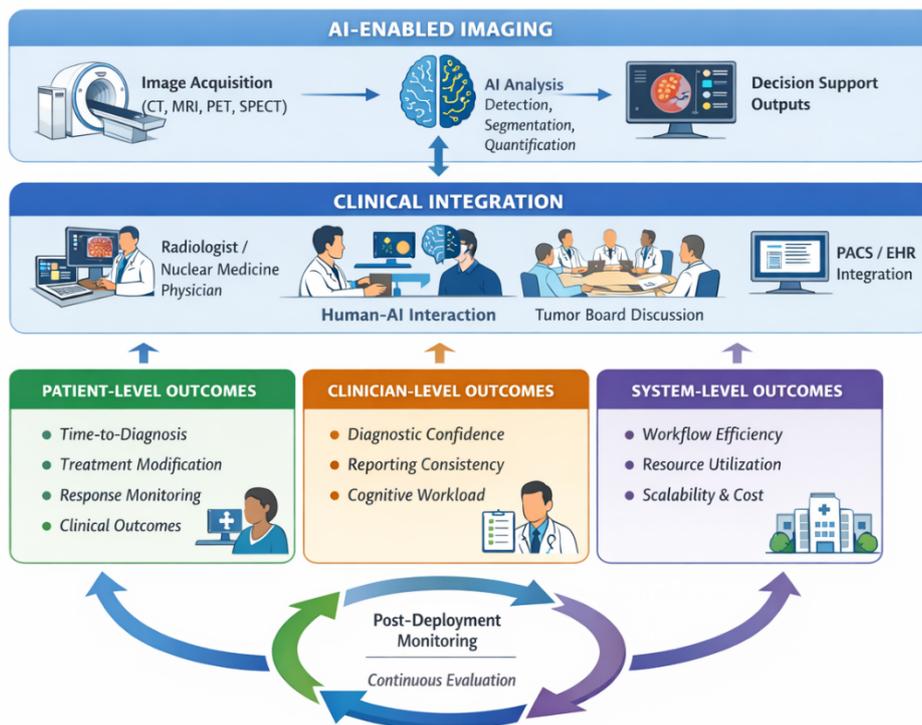
Figure 1. Clinical-Impact Framework for AI-Enabled Radiology in Oncology and Nuclear Medicine.

Conceptual framework illustrating how AI-enabled imaging systems transition from image acquisition and algorithmic analysis to integrated clinical use and downstream impact. The model highlights human–AI interaction, multidisciplinary integration, and the influence of AI-assisted imaging on patient, clinician-, and health system–level outcomes, supported by continuous post-deployment monitoring within a learning oncology system.

Evaluation of AI-enabled radiology should be situated within the broader oncology care continuum, where imaging informs diagnosis, staging, treatment planning, response monitoring, and surveillance. Rather than focusing solely on isolated interpretive performance, assessment should consider how AI-assisted imaging contributes to sequential clinical decisions across these stages. This perspective recognizes that the value of imaging AI emerges through its integration into coordinated care pathways and cumulative decision-making processes [43].

A clinical-impact–centered framework must explicitly link imaging AI to outcomes at the level of patients, clinicians, and health systems. At the patient level, this includes effects on timeliness of care, treatment appropriateness, and clinically meaningful outcomes. At the clinician level, relevant outcomes encompass diagnostic confidence, consistency of interpretation, cognitive workload, and quality of multidisciplinary communication. At the system level, evaluation should address workflow efficiency, resource utilization, safety, and sustainability. Assessing these interconnected outcome domains provides a more comprehensive understanding of value than isolated performance metrics and allows trade-offs between technical gains and real-world benefits to be transparently examined [45,46].

Central to this framework is the principle of human-centered and context-aware evaluation. AI-enabled radiology systems are embedded within sociotechnical environments shaped by clinician behavior, institutional workflows, and patient characteristics. Their impact is therefore contingent on usability, interpretability, and alignment with clinical needs. Evaluation strategies must account for human–

AI interaction, including how clinicians perceive, trust, and act upon AI outputs in practice. By incorporating contextual and behavioral dimensions alongside clinical outcomes, a clinical-impact–centered framework offers a more realistic and ethically grounded basis for assessing the true contribution of AI-enabled radiology in oncology and nuclear medicine.

Future Directions and Research Priorities

Future research on AI-enabled radiology must prioritize a clear shift from accuracy-centric evaluation toward outcome-centric assessment. While diagnostic performance will remain a necessary foundation, it should no longer be treated as a surrogate for clinical value. Instead, studies should be designed to determine whether AI meaningfully influences clinical decisions, improves care delivery, and contributes to better patient outcomes in oncology and nuclear medicine. This transition requires reframing research questions to focus on impact along the clinical pathway rather than isolated interpretive tasks [34].

A critical priority is the development and adoption of standardized clinical impact metrics. The current heterogeneity in outcome definitions and reporting limits comparability across studies and impedes evidence synthesis. Consensus on core outcome sets encompassing clinical decision changes, workflow efficiency, safety, and patient-centered endpoints would enable more rigorous evaluation and facilitate translation into practice. Standardization would also support regulatory review, institutional decision-making, and benchmarking across AI systems and clinical settings [47].

Prospective, multi-center studies are essential to generate robust and generalizable evidence. Single-center or retrospective evaluations may not capture variability in patient populations, imaging protocols, and institutional workflows that characterize real-world oncology practice. Multi-center designs can help assess generalizability, identify context-specific effects, and clarify how implementation factors influence impact. Embedding such studies within routine care pathways will further enhance relevance and feasibility [28].

Finally, AI-enabled radiology should be considered within the broader evolution toward adaptive and learning oncology systems. When coupled with continuous data collection and feedback, AI has the potential to support dynamic improvement in imaging interpretation and decision support over time. Realizing this potential will require careful governance, ongoing evaluation, and alignment with clinical priorities. Future research should therefore explore not only whether AI works, but how it can be safely and effectively integrated into learning health systems that continuously refine cancer care based on real-world evidence.

Conclusion

AI-enabled radiology has reached a level of technical maturity that has prompted widespread interest and growing clinical adoption in oncology and nuclear medicine. However, this review highlights that diagnostic accuracy alone provides an incomplete and often misleading assessment of clinical value. Evidence based primarily on retrospective performance metrics fails to capture how AI systems function within real-world workflows, influence clinical decision-making, or contribute to meaningful patient and health system outcomes. A broader evaluative perspective is therefore essential to understand the true impact of AI in advanced imaging practice.

This review has several limitations that should be acknowledged. As a narrative review, the article does not provide a systematic synthesis of all available evidence and may therefore be subject to selection bias. Additionally, the rapidly evolving nature of artificial

intelligence research means that new studies and technologies may emerge after the literature included in this review. Future systematic reviews and prospective multi-center studies will be important to further quantify the real-world clinical impact of AI-enabled radiology in oncology and nuclear medicine.

Reframing AI-enabled radiology as a clinical intervention rather than a purely technical tool underscores the need for outcome-focused evaluation. Like other interventions in oncology care, imaging AI should be assessed based on its effects on diagnosis, staging, treatment planning, response assessment, and longitudinal patient management. As illustrated in Figure 1, the clinical value of AI-enabled radiology emerges through its integration into oncology care pathways, where imaging outputs influence patient-, clinician-, and system-level outcomes rather than serving as isolated diagnostic results. This perspective

emphasizes the importance of human–AI collaboration, workflow integration, and contextual use, recognizing that the value of AI emerges through its interaction with clinicians and healthcare systems rather than through algorithmic performance in isolation.

Responsible adoption of AI-enabled radiology in oncology and nuclear medicine requires a deliberate shift toward outcome-driven evidence generation, robust governance, and continuous performance monitoring. By aligning evaluation frameworks with patient-centered and system-level outcomes, stakeholders can ensure that AI technologies are deployed in ways that enhance care quality, support clinical decision-making, and promote equity and sustainability. Such an approach is critical for translating technological innovation into genuine clinical benefit and for guiding the future role of AI in imaging-driven cancer care.

Acknowledgement

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