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The Changing Role of Physicians in the Era of Artificial Intelligence

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ABSTRACT

Artificial intelligence (AI) is transforming the practice of medicine by reshaping how physicians diagnose, plan treatment, communicate with patients, and manage information. This review synthesizes evidence from recent clinical trials, systematic reviews, and policy guidance to evaluate the changing role of physicians in an AI-driven era. Current AI applications—ranging from imaging interpretation and predictive analytics to ambient documentation and decision support—demonstrate measurable benefits in efficiency and diagnostic accuracy, yet they introduce new ethical, technical, and professional complexities. Physicians are evolving from sole decision-makers to human-in-the-loop supervisors who interpret, validate, and contextualize algorithmic outputs. The article outlines the competencies required for this transition—AI literacy, data governance awareness, and critical evaluation of bias and interpretability—and reviews emerging educational frameworks that embed these skills into undergraduate and postgraduate curricula. Ethical and legal analysis reveals the need for shared accountability among clinicians, institutions, and developers, along with transparent communication to sustain patient trust. Persistent challenges include technical limitations, workflow misalignment, and equity gaps in low- and middle-income settings. The paper concludes with forward-looking recommendations for physicians, health-care organizations, and policymakers to foster safe, equitable, and outcome-driven integration of AI in clinical care, emphasizing research priorities such as long-term patient outcomes, bias mitigation, and lifecycle monitoring of adaptive

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models.

Keywords: Artificial Intelligence, Physicians, Clinical Decision Support, Medical Education, Ethics, Accountability, Equity, Digital Health.

Introduction

Current context: what AI technologies are being deployed in medicine (diagnostics, imaging, decision support)

Artificial Intelligence (AI) is rapidly transitioning from experimental research into real-world clinical applications, spanning diagnostics, imaging, and decision-support systems. In medical imaging, for example, AI-driven algorithms are increasingly used for image segmentation, lesion detection, pattern recognition of radiographs, CT and MRI scans, and workflow optimisation of radiology departments (Najjar, 2023). A recent systematic review and meta-analysis found that when AI served as a secondary reader in imaging tasks it frequently improved efficiency and diagnostic performance — though heterogeneity limited firm conclusions (Wenderott et al., 2024).

For clinical decision support, AI-powered tools now assist physicians by analysing large-scale, multimodal data (for example, combining structured health records, unstructured clinical notes, imaging data) to offer risk stratification, personalized treatment suggestions and early intervention flags (Elhaddad & Hamam, 2024; Khosravi et al., 2024). One review noted that AI-based clinical decision support systems (AI-CDSS) have been applied for diagnosis, treatment planning, complication prediction and even documentation tasks (Karuppan Perumal et al., 2025). In diagnostics more broadly, AI applications include early detection of cancers, analysis of pathology slides, skin lesion classification, and even triage of patients in primary care (Alhejaily, 2025). The overall current context shows a shift: from AI as niche aid to AI embedded in key steps of patient care workflows.

Why this matters for physicians: opportunities and threats

Opportunities

For physicians, the burgeoning role of AI presents substantial opportunities. First, AI can augment human performance: by automating repetitive, data-intensive or time-consuming tasks (such as image review, documentation or triage), it frees up clinician time for higher-value activities like patient-communication, shared decision-making and complex judgement (Chustecki, 2024). Second, AI's ability to uncover subtle patterns in large-scale data (beyond human cognition) may improve diagnostic accuracy, reduce missed conditions, accelerate time-to-treatment, and enable more personalized care (Alowais et al., 2023). Third, at a system level, AI may address workforce constraints (such as radiologist shortages), enable continuous monitoring, support population-health management, and promote scalability of high-quality care (Wenderott et al., 2024).

Threats and challenges

However, these changes also pose real threats and challenges for physicians. One threat

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is automation bias: overreliance on algorithmic output can degrade critical thinking or lead to mis-diagnosis if the AI errs or faces out-of-distribution cases (Siafakas & Vasarmidi, 2024). Legal and accountability concerns also loom: who bears responsibility when AI recommendations are wrong - the physician, the institution, or the vendor? Some physicians express concern about job displacement, shift in scope of practice, or erosion of professional autonomy (Arvai et al., 2025). Furthermore, integration challenges (workflow mismatch, poor usability, trust issues, bias in datasets) can undermine adoption and may even raise equity issues if AI tools perform less well in under-represented patient groups (Farah et al., 2025; Mello-Thoms & Mello, 2023). Thus, the evolving role of physicians in the AI era is one of augmentation rather than replacement, but it demands new competencies, vigilance around risks, re-definition of workflows, and engagement with the ethical-legal-technical implications.

Overview of AI in Medicine

Types of AI / Machine Learning Applications in Clinical Practice

Artificial Intelligence (AI) in medicine encompasses a variety of techniques and deployment formats, each suited to specific tasks within care pathways (Figure 1). Broadly, these include:

Predictive and prognostic models using supervised machine learning (ML) or deep learning (DL) These algorithms ingest structured patient data (e.g., demographics, labs, vitals) to estimate risks of disease onset, complications or readmission (Mateussi et al., 2024).

Image recognition and computer-vision applications. Convolutional neural networks (CNNs) and other DL architectures analyse medical imaging — for example radiographs, CT/MRI scans, histopathology slides — to detect, classify or segment lesions (Al Kuwaiti et al., 2023).

Natural language processing (NLP) and unstructured data mining. NLP workflows extract meaning and insights from clinical notes, electronic health record (EHR) text and free-text reports to support diagnosis, documentation, triage or decision support (Mateussi et al., 2024).

Ambient and workflow-automation tools. These include AI-driven scribes (auto-documentation), inbox-triage bots, real-time monitoring alarms, and clinical decision-support systems (CDSS) that incorporate AI modules to assist clinicians. These may not always be “learning” systems, but still form part of the AI ecosystem in practice (Al Kuwaiti et al., 2023).

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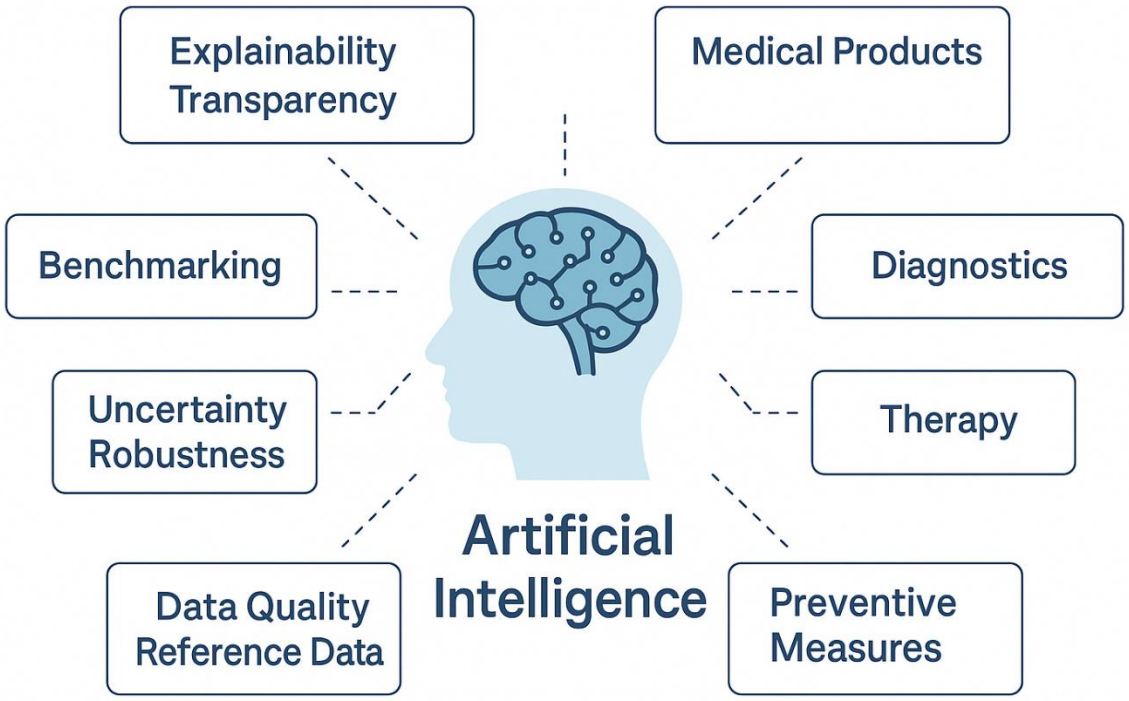

Figure 1. Applications and Quality Factors of Artificial Intelligence in Healthcare. A structured overview of AI's role across healthcare—from diagnostics to preventive measures-highlighting key elements like transparency, data quality, and robustness essential for reliable implementation.

These modalities differ in maturity, clinical integration, regulatory oversight and evidence base. A taxonomy might categorise AI by input type (imaging, text, tabular, sensor), purpose (screening, diagnosis, treatment-planning, monitoring), or deployment model (assistive vs autonomous) (Morone et al., 2025a). From the physician's perspective, recognising which type of AI is involved is critical for appropriate calibration of trust, workflow integration and oversight (Table 1).

Table 1. Overview of Key AI Applications in Medicine and Their Implications for Physicians

Domain / Task	AI Modality / Technology	Representative Clinical Applications	Demonstrated Benefits	Limitations / Challenges	Implications for Physicians' Role
Medical Imaging	Deep learning (CNNs, segmentatio	Radiology (lesion detection, triage),	↑ Diagnostic accuracy, ↓ workload, faster	Dataset bias, overfitting, limited	Shift from primary detection →

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	n models)	pathology (digital slide analysis), ophthalmology (retinopathy screening)	turnaround	generalizability	adjudication & oversight of AI output
Predictive Analytics	Supervised ML models using structured EHR data	Risk prediction (readmission, sepsis, AKI), early warning systems	Early detection, proactive management	False positives, "alarm fatigue," drift over time	Physicians interpret alerts, adjust thresholds, monitor model performance
Decision Support Systems (AI-CDSS)	Integrated AI modules combining multimodal data	Treatment planning, personalized medicine, care pathway optimization	Standardized, data-driven recommendations	Workflow mismatch, interpretability issues	Physicians act as human-in-the-loop verifiers and contextualizers
Natural Language Processing (NLP)	Large language models, text mining	Automated documentation, triage, information retrieval	Reduced documentation time, cognitive relief	Privacy concerns, hallucination risk	Clinicians remain accountable for record accuracy and disclosure
Ambient / Conversational AI	Speech recognition, context-aware systems	Ambient scribes, virtual assistants	↓ Burnout, ↑ patient engagement	Errors in transcription, trust issues	Physicians verify notes, disclose AI use to patients
Monitoring / Wearable AI	Time-series & anomaly detection models	ICU monitoring, remote patient management	Early detection of deterioration	Integration with EHR, false alarms	Physicians supervise, interpret, and act on alerts

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Population Health / Public Health AI	Predictive & epidemiological models	Screening, outbreak prediction, health resource allocation	Improved planning and efficiency	Data privacy, lack of standardization	Physicians collaborate on governance and ethical oversight

Evidence of Effectiveness: Where AI Has Made Impact

A growing body of literature demonstrates that AI applications in healthcare are not only theoretical but are producing measurable impacts. Key findings include:

A landmark review of 86 randomised controlled trials (RCTs) of AI in clinical practice found that 81% (70/86) reported a favourable result for the primary endpoint; of trials comparing AI-assisted clinicians to unassisted clinicians, 71% (46/65) showed improvement with AI assistance (Han et al., 2024).

In imaging-dominated fields (e.g., radiology, pathology), systematic reviews report that AI augmentation frequently improves diagnostic accuracy, reduces false negative rates and accelerates workflow For example, one review noted that AI integration enabled better, faster and lower-cost care (Al Kuwaiti et al., 2023).

In patient-safety and monitoring applications, AI has demonstrably reduced error rates: one systematic review found that AI interventions improved or out-performed traditional methods in real-world safety reporting, alarm fatigue reduction, and anomaly detection (Choudhury & Asan, 2020; Liaqat et al., 2025a).

A broader review of AI in clinical medicine covering 161 systematic reviews across ~7,500 primary studies observed that AI is most thoroughly studied in oncology, neurology and radiology, and less so in other fields (Morone et al., 2025b).

Despite favourable early outcomes, the literature also highlights limitations: heterogeneity of studies, variable external validation, lack of long-term follow-up in many deployments, and methodological concerns (Liaqat et al., 2025; Younis et al., 2024).

In summary: AI is already making positive contributions in multiple domains of medical practice — particularly where large, structured datasets and imaging predominate — but the evidence base remains uneven, and widespread integration still requires stronger "real-world" proof of benefit, generalisability and safety.

Implications for Physicians' Roles

How traditional roles are being altered

Diagnosis. In many specialties, AI has shifted physicians' diagnostic work from primary detection to verification, adjudication, and exception handling. Randomized and prospective trials increasingly show AI can raise diagnostic yield (especially in imaging and endoscopy), while physicians decide when to trust, override, or further test AI suggestions. This widens clinicians' responsibilities around triage of AI alerts, calibration to local prevalence, and managing disagreement between AI and clinician impressions. Evidence syntheses of randomized trials report mostly positive primary endpoints for AI-assisted clinician arms, but also highlight heterogeneity and the need

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for real-world validation—so clinicians must interpret outputs with attention to context and uncertainty (Han et al., 2024; Muhammad et al., 2025).

Treatment planning. AI-enabled decision support (from risk prediction to care-pathway recommendations) can compress time to decision and standardize care, but it also elevates the physician's duty to check for population mismatch, bias, and appropriateness of recommendations for the individual in front of them. Regulatory frameworks now expect lifecycle oversight (e.g., predetermined change-control plans for adaptive models), which in practice means physicians and governance committees help define safe update policies and escalate signal drift or safety events to manufacturers.

Patient communication and documentation. Ambient AI "scribes" are already changing encounter dynamics by drafting notes from clinician–patient conversations. A large multicenter JAMA Network Open study (263 clinicians, 6 systems) found 30 days of an ambient AI scribe was associated with a drop in burnout (51.9%→38.8%) and improvements in cognitive task load and after-hours documentation time—freeing attention for the patient interaction itself. Clinicians, however, still retain accountability for accuracy and completeness of records (Olson et al., 2025).

Safety and professionalism. Classic risks such as automation bias (over-reliance on automated advice) become front-line concerns that physicians must actively counter with deliberative checks and explicit verification routines. Ethical and governance guidance emphasizes transparency with patients about AI use, explainability appropriate to the decision, and equitable model performance—work that now sits squarely within the clinician's professional remit (Challen et al., 2019).

Emerging roles for physicians

Data-interpretation oversight ("model literacy"). Physicians are increasingly expected to: understand a tool's intended use and evidence base; recognize when distribution shift or poor input quality may invalidate an output; and interpret calibration plots, confidence measures, or "uncertainty" indicators when provided. NEJM AI reports show adoption in the U.S. is still nascent and concentrated in a handful of devices—underscoring the need for clinician leaders who can judge readiness and value in their own setting (Wu et al., 2024).

(b) Human-in-the-loop safety control. Modern guidance and regulation frame clinicians as safety controllers who supervise AI, document rationale when accepting or rejecting AI advice, and report performance concerns (post-market surveillance). FDA's evolving approach (e.g., final PCCP guidance and transparency principles) explicitly anticipates human oversight across the device lifecycle, while WHO's 2025 LMM guidance calls for clear accountability, disclosure to patients, and local governance.

(c) Workflow integration and governance. Physicians increasingly sit on AI governance committees that select tools, define disclosure practices, set "rails" for use (e.g., which patient segments, which decisions), and establish audit metrics (e.g., turnaround time, alert fatigue, equity performance). Ambient documentation tools illustrate how clinicians co-design workflows to capture benefits (less admin time)

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while maintaining note quality and medico-legal integrity (Olson et al., 2025).

(d) Communicating AI use to patients. Expectations are rising that clinicians will explain that AI was used, how it influenced decisions, and what uncertainties or alternatives were considered, especially when AI outputs conflict with clinical judgment. Professional bodies (e.g., AMA) now publish policies on transparency, liability, and governance to support this counseling role.

(e) Monitoring for bias and equity. Physicians are pivotal in flagging disparate performance across subgroups and advocating for remediation, dataset enrichment, or guarded deployment. Recent reviews catalog bias sources across the ML pipeline and recommend clinician-informed mitigation and monitoring plans (Cross et al., 2024).

Skills & Training Needs

What physicians need to know about AI

As AI becomes more embedded in clinical care, physicians must acquire new competencies beyond traditional medical knowledge. Key domains include:

Foundations of AI and machine learning: Physicians need to understand the underlying principles of AI systems (e.g., supervised vs unsupervised learning, deep neural networks, overfitting, model drift) so they can critically evaluate when an AI tool is valid and trustworthy. For example, a scoping review proposed four dimensions of "AI literacy" for medical students: Foundational, Practical, Experimental, and Ethical (Ma et al., 2024). Understanding data sources (quality, bias, missingness), model outputs (confidence scores, calibration), and system limitations (generalizability, distribution shift) is essential (Liaqat et al., 2023).

Limitations, biases, and interpretability: Physicians should be familiar with common failure modes in AI — e.g., automation bias (over-reliance on AI recommendations), dataset shift (when deployed population differs from training data), and "black-box" behaviour (lack of interpretability). For example, a narrative review emphasises that many AI-medical education studies still lack rigorous evaluation of how learners engage with these risks (Sun et al., 2023).

Interpretability (or at least explainability) is increasingly demanded by regulatory and safety frameworks; physicians should know how to ask: What was the training data? What confidence/uncertainty metrics are provided? How does the system handle rare/unseen cases?

Integration into clinical work and human-in-the-loop oversight: Beyond knowing what the AI does, physicians need competence in using it as part of a workflow: when to trust it, when to override it, when to question it. They should understand workflow implications (alert fatigue, triage bottlenecks), documentation and medico-legal implications (who accounts for what), and ongoing monitoring (is the model still performing as expected?). For instance, a mixed-methods study from Pakistan found that although students and faculty had positive attitudes toward AI in curricula, knowledge/practice scores were modest — highlighting the gap between awareness and actionable competence (Liaqat et al., 2023a; Naseer et al., 2025).

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Ethical, legal, and professional implications: Physicians must understand implications around data privacy, algorithmic fairness (performance across sub-populations), transparency to patients, and professional identity (when part of the decision-making is shifted to AI). Curricula increasingly emphasise these aspects as core competencies (Hopson et al., 2025).

In summary, the role of physicians is shifting to that of AI-enabled clinician-advisor rather than simply knowledge-provider. This requires new literacies—technical, interpretive, ethical—and lifelong learning, given the pace of AI change.

Review of current training/education frameworks for physicians & medical students

There is increasing but still nascent integration of AI training into medical education. Key findings from recent literature:

Curriculum frameworks

A 2024 scoping review identified 21 relevant papers on AI curricula in medical education (19 describing specific programs, 2 describing frameworks). The authors concluded that while many programs exist, true pedagogical frameworks were lacking and specialties beyond radiology were underrepresented (Tolentino et al., 2024).

An arXiv preprint (July 2024) proposes a refined AI-literacy framework with four dimensions (Foundational, Practical, Experimental, Ethical) and aligns these to preclinical, clinical and research phases of medical education (Ma et al., 2024).

A recent Canadian study (2024) used the Delphi method to design an undergraduate medical AI curriculum, indicating a move toward more structured, expert-grounded frameworks (Singla et al., 2024).

Educational programs and evidence

Programs such as a one-credit, 18-hour "AI literacy" course for medical students show early feasibility.

An extracurricular "AI in Medicine" (AIM) program for pre-medical students at BYU reported significant improvements in AI-knowledge and pathology-related understanding (Cohen's d ranged 1.8–4.7) in a quasi-experimental design (Hopson et al., 2025; Karuppan Perumal et al., 2025).

However, a systematic review of AI-powered educational interventions in health professions (published October 2024) found that measurable educational outcomes are still limited: most studies focus on knowledge or skill (Kirkpatrick Level 2), few address behavioural change or workplace impact (Level 3/4) (Feigerlova et al., 2025).

Barriers and gaps

Many studies identified that instructors lacked AI expertise, curricula lacked theory/pedagogy, and institutional barriers (time, faculty buy-in, resources) hindered deployment.

Global disparities exist: medical schools in lower-resource settings may face technological/institutional constraints (Hopson et al., 2025).

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There is a lack of standardised assessment of AI competencies; reporting standards for AI-education interventions are weak (Feigerlova et al., 2025).

Recommendations for training design

Key recommendations emerging from the literature include:

Embed AI training as part of the medical curriculum (not as an add-on) and align it longitudinally across pre-clinical, clinical and postgraduate phases (Table 2).

Adopt an interdisciplinary approach: collaboration between computer science, data science, medical education, ethics/social science.

Include experiential/practical components (e.g., case-based use of AI tools, simulation, hands-on data exploration) alongside didactic content.

Ensure ethical and equity dimensions are woven throughout—not just as a standalone module.

Develop faculty development and infrastructure to support AI training.

Establish evaluation frameworks beyond knowledge gain (behaviour change, patient outcomes) for AI-education interventions.

Table 2. Evolving Competencies and Educational Frameworks for Physicians in the AI Era

Competency Domain	Core Learning Objectives	Illustrative Educational Approaches / Programs	Relevance to Physician Role
Foundational AI Literacy	Understand basic ML/AI concepts, data types, model training, evaluation metrics	Short courses, online modules, foundational lectures (e.g., 18-hour "AI literacy" course for medical students)	Enables physicians to interpret AI capabilities & limits
Practical / Applied Skills	Use AI tools in simulated clinical contexts; interpret model outputs & uncertainty	Simulation labs, case-based exercises, workflow integration scenarios	Prepares for "human-in-the-loop" supervision and safe adoption
Experimental / Research Literacy	Understand validation, generalizability, and bias; contribute to AI research	Research electives, interdisciplinary capstones with data science	Positions physicians as co-developers and evaluators of AI tools
Ethical & Legal Awareness	Analyze accountability, fairness,	Integrated ethics modules, policy simulations, regulatory	Supports disclosure, equitable

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	transparency, and patient consent	briefings	practice, and patient trust
Data Governance & Bias Mitigation	Recognize and address bias, privacy risks, data-quality issues	Workshops on bias auditing, dataset evaluation, equity performance dashboards	Reinforces fairness and professional responsibility
Lifelong Learning & Adaptation	Continuously update skills with evolving AI technologies	CME, micro-credentials, AI governance committee participation	Sustains competency and confidence in adaptive AI environments

Ethical, Legal, and Professional Issues

Responsibility and accountability when AI is involved

When AI systems inform diagnosis or treatment, accountability becomes multi-actor: clinicians (users), health-care organizations (deployers), and manufacturers (providers) each bear duties across the system's life cycle.

Clinician accountability (use-level). Physicians remain responsible for integrating AI outputs with clinical context and for documenting the rationale to accept or override algorithmic suggestions. Contemporary medico-legal analysis notes that AI does not "replace" but **reconfigures** the standard of care—courts will likely ask whether a reasonable clinician used the tool appropriately given its known strengths/limits and local policies (Terranova et al., 2023).

Institutional accountability (deployment-level). Hospitals have duties to select fit-for-purpose tools, train users, monitor real-world performance, and report safety signals (post-market). Draft and final U.S. FDA guidances for AI-enabled device software functions emphasize **lifecycle management**, usability risk controls, and pre-specified change plans for adaptive models (PCCP) to support safe iteration.

Manufacturer accountability (design-level). In the EU, the **AI Act** (together with the medical-device rules) assigns high-risk obligations to providers (risk management, data quality, transparency) and to deployers (use policies, human oversight, logging). New MDCG guidance details how MDR/IVDR interact with the AI Act, including specific human-oversight expectations (Busch et al., 2024).

Global guidance. WHO's 2025 LMM guidance calls for explicit governance: disclosure to patients when LMMs are used, role clarity, data-protection safeguards, bias assessment, and continuous monitoring.

Implication for practice. Expect a **shared-accountability** model: clinicians for appropriate, documented use; organizations for safe deployment and monitoring; and manufacturers for design transparency, updates, and evidence. Negligence claims will

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likely hinge on (i) tool selection policies, (ii) training and oversight, and (iii) whether clinicians reasonably interpreted AI outputs in context (Sonicki, 2024).

Bias, equity, and transparency of AI systems

Bias can arise from proxies, sampling, and deployment context—and can systematically disadvantage subgroups (Figure 2).

Well-documented case. A widely used U.S. risk-prediction algorithm systematically offered **less care to Black patients** because it used health-care cost as a proxy for need. Correcting the target reduced the disparity substantially. This remains the canonical empirical demonstration of proxy-induced bias in clinical algorithms (Obermeyer et al., 2019).

Regulatory & governance responses. The EU AI Act obliges providers of high-risk medical AI to implement risk management, data-governance measures, and transparency documentation that enable human oversight; deployers must ensure users receive this information and apply the model within its intended scope (Busch et al., 2024).

Global guidance on transparency. WHO's 2025 guidance on LMMs recommends disclosure, data-lineage documentation, bias audits, and reporting of subgroup performance, particularly where models may generalize poorly across populations (Sonicki, 2024).

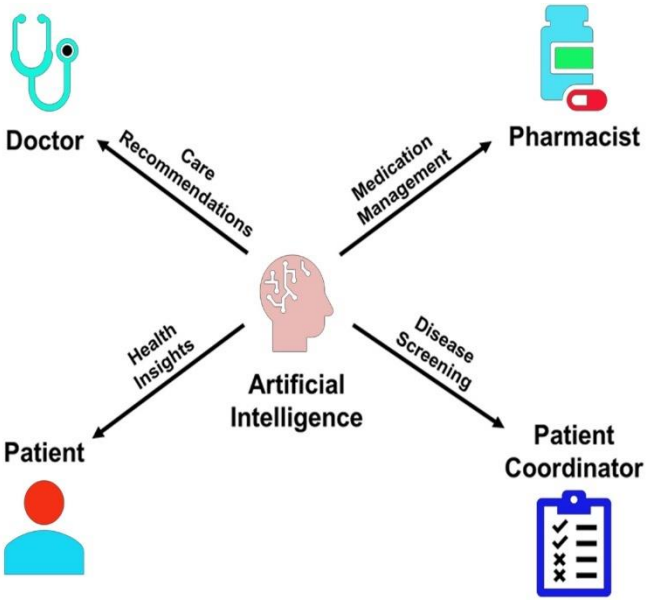

Figure 2. AI-Enabled Care Coordination in Healthcare. AI-driven care coordination linking doctors, pharmacists, coordinators, and patients with recommendations, medication management, screening, and personalized health insights

Impact on the physician–patient relationship

AI can both support and strain the clinical relationship.

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Potential benefits. "Ambient AI scribes" that draft notes from the encounter have been associated with **lower burnout and documentation burden** and with clinicians reporting **greater engagement with patients**, which plausibly strengthens rapport (Figure 1). Recent multi-site studies on quality-improvement reports show reduced burnout and after-hours documentation when ambient tools are adopted (Olson et al., 2025).

Risks to trust and agency. Experimental and survey research finds that some patients **lower their trust** when AI is involved—especially if systems are opaque or highly autonomous—and many expect **disclosure** about AI use. Ethical analyses caution that AI complicates informed consent unless clinicians can explain the role, limits, and uncertainties of the tool (Zondag et al., 2024).

Professional guidance. Medical-association statements increasingly support **transparent disclosure** calibrated to clinical risk and patient agency (e.g., AMA policy discussions on "augmented intelligence" and disclosure frameworks) (Perlis, 2025).

Practice point. Pair adoption of AI with **relational safeguards**: obtain patient permission for ambient recording; disclose when AI substantively informs decisions; invite questions; and document the clinician's rationale, especially when accepting or rejecting AI recommendations (Olson et al., 2025).

Challenges and Barriers

Technical limitations of AI

Despite rapid advances, AI in medicine faces several persistent technical limitations (Figure 3):

Data quantity, quality and representativeness. Many clinical AI systems are trained on relatively small, homogeneous datasets which limit generalisability. They may not adequately handle confounders like age, gender or ethnicity, raising risk of under-performance in real-world settings (Ahmed et al., 2023).

Lack of human-like reasoning, multimodal integration and robustness. AI tools often struggle with unexpected cases, rare events, or combining modalities (EHR + imaging + free text). For example, a recent review notes the difficulty of scaling these systems and achieving general-purpose reasoning in clinical contexts (Mehraeen et al., 2025).

Workflow and deployment mismatch ("last-mile" problem). Even well-performing algorithms often fail when exposed to real-world workflow issues: unstructured data, missing inputs, interruptions, alert fatigue, interoperability issues (Kelly et al., 2019).

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Model drift and lifecycle maintenance. AI models degrade over time if inputs change (distribution shift), yet many systems lack robust monitoring or retraining plans (Petersen et al., 2022).

Explainability and trust. Physicians and institutions often balk at "black-box" models whose decision path is opaque, reducing acceptance and raising safety concerns (Scipion et al., 2025).
In sum, technical limitations create a credibility-gap: AI may show strong retrospective performance, but moving to safe, scalable, real-world deployment remains challenging.

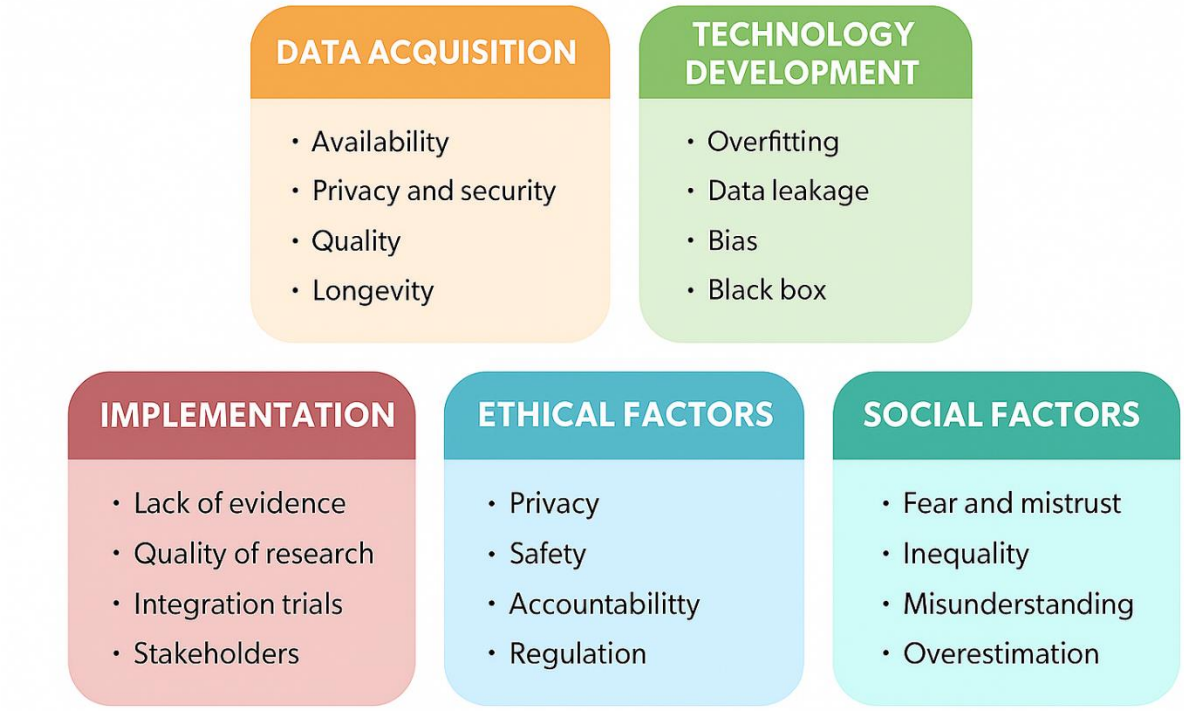

Figure 3. Key Challenges in Artificial Intelligence Implementation. Overview of critical factors influencing AI adoption, including data, technology, ethics, implementation, and social considerations

Workflow integration & acceptance by physicians
Integrating AI into clinical practice is not simply a technical problem, it requires human/factor, organisational, regulatory and cultural change.

Workflow alignment and usability. Studies show that AI tools must align with clinical workflows to avoid creating additional friction. If the tool disrupts rather than helps the clinician, adoption stalls (Nasef et al., 2025).

Clinician acceptance, trust & cognitive burden. A recent systematic exploration found barriers such as lack of familiarity, fear of loss of autonomy, distrust of AI decisions, and concerns about medico-legal liability. Even if an AI tool works well,

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clinicians may choose to ignore or override it ("negotiation" of AI output) due to these factors (Sivaraman et al., 2023).

Change management, leadership & organisational readiness. Implementation studies emphasise key levers like leadership buy-in, training, continuous monitoring, and incentivisation. Barriers frequently appear at "planning" and "sustainment" phases rather than purely technical (Nair et al., 2024).

Interoperability and data integration. Poor integration with existing electronic health record (EHR) systems, legacy infrastructure, and lack of standards (DICOM, HL7, FHIR) hamper deployment.
Therefore, for physicians, the barrier is not only trusting the AI's accuracy, but trusting that the tool will integrate smoothly, respect their workflow, and support rather than hinder care.

Resource and equity issues (especially in low- and middle-income settings)
Resource constraints and equity gaps pose major challenges for AI deployment globally and particularly in low- and middle-income countries (LMICs).

Infrastructure, data and workforce limitations. LMIC settings often lack large, well-labelled datasets, robust computing infrastructure, stable internet/electricity, and trained personnel to deploy/monitor AI systems. A recent study emphasises the risk of AI exacerbating inequities if these structural barriers are not addressed (Adhikari et al., 2025).

Bias & equity risks amplified. AI models developed in high-income settings may perform poorly in other geographies or among under-represented groups. If such models are used unchecked elsewhere, they may worsen disparities (Botha et al., 2024).

Cost, sustainability and scaling. The cost of deployment (hardware, software, training) and ongoing maintenance may be prohibitive. LMICs risk being 'last adopters' or being offered sub-optimal tools (Botha et al., 2024).

Cultural, regulatory and governance barriers. Policies, data-sharing laws, national AI strategies may be underdeveloped in many LMICs, reducing oversight, local adaptation and safe deployment (Adhikari et al., 2025).

Future Directions and Recommendations
What physicians, institutions, and policymakers should do to adapt
Physicians
Build AI literacy and "model sense." Understand intended use, data provenance, calibration/uncertainty, limits under distribution shift; use reporting checklists (e.g., TRIPOD-AI/TRIPOD+AI for prediction models; DECIDE-AI for early live evaluations; CONSORT-AI/SPIRIT-AI for trials) to judge evidence quality (Collins et al., 2024).

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Practice accountable human-in-the-loop use. Document why you accepted/overrode an AI recommendation; disclose meaningful AI use to patients and discuss uncertainty (Sonicki, 2024).

Monitor performance where you work. Champion basic post-deployment checks (alert burden, turnaround time, subgroup performance, drift flags) and escalate concerns to governance committees (Han et al., 2024).

Health-care institutions

Adopt formal AI governance. Create a multidisciplinary committee to evaluate tools with standardized evidence frameworks (e.g., NICE ESF for digital health, aligned to regulation), set disclosure policies, and define metrics for safety, equity, and ROI (Unsworth et al., 2021).

Operationalize lifecycle oversight. Require vendors to provide change-management plans and facilitate monitoring (e.g., predetermined change-control plans for adaptive models), with incident reporting pathways (Zinchenko et al., 2022).

Invest in implementation science. Budget for integration (EHR interoperability), training, and sustained evaluation, RCTs show promise but adoption remains nascent; the "last mile" needs resourcing (Han et al., 2024).

Policymakers and regulators

Harmonize evidence and risk frameworks. Encourage use of TRIPOD+AI/PROBAST+AI for prediction models; require transparent documentation and human-oversight provisions (Moons et al., 2025).

Implement AI-Act-style obligations and guidance. For high-risk medical AI, require risk-management, high-quality data, user information, logging, and human oversight; clarify deployer duties (Aboy et al., 2024).

Support real-world evidence (RWE). Fund pragmatic trials and post-market registries linked to outcomes and equity reporting, not just accuracy metrics (Han et al., 2024).

Research gaps

Long-term, patient-centered outcomes. Most AI trials are short-term and specialty-clustered; we need multicenter pragmatic RCTs/RWE showing durable benefit (mortality, QOL, harms), not just sensitivity/throughput (Han et al., 2024).

Adoption and impact at scale. Insurance-claims analyses show clinical use is still concentrated in a few devices; understand barriers, net value, and diffusion dynamics (Wu et al., 2024).

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Equity & generalizability. Routine reporting of subgroup performance and external validation across sites—including LMIC settings—remains rare; methods and incentives are needed to avoid widening disparities (Sonicki, 2024).

Lifecycle safety for adaptive models. Establish best practices and audit tooling for drift detection, safe updating (e.g., PCCPs), rollback, and user-facing transparency (Zinchenko et al., 2022).

Human factors & communication. Study how explanations, uncertainty displays, and disclosure practices affect clinician calibration and patient trust in routine care (Sonicki, 2024).

Economic evaluation. Standardize cost-effectiveness and budget-impact methods for AI interventions, aligned to evidence frameworks (El Arab & Al Moosa, 2025).

Conclusion

Artificial intelligence has emerged not as a replacement for physicians but as a force redefining medical professionalism itself. The physician's role is shifting from being the primary diagnostician to becoming an interpreter, overseer, and integrator of algorithmic insight within a broader human-AI partnership. This evolution demands technical fluency, ethical reflexivity, and renewed focus on communication and trust. While evidence demonstrates that AI can augment diagnostic accuracy, efficiency, and personalization of care, successful adoption depends on aligning these technologies with human values and clinical realities. Physicians must remain accountable for ensuring that AI tools are used appropriately, that their recommendations are contextualized, and that patients are informed and empowered in shared decision-making. Institutions should establish governance frameworks that monitor model performance, mitigate bias, and enforce transparency across the AI lifecycle. Policymakers must harmonize regulatory pathways, evidence standards, and equity mandates to safeguard both innovation and patient safety. Future progress depends on addressing three frontiers: (1) **long-term evaluation** of AI-augmented care on health outcomes and system costs; (2) **capacity building** through medical education that embeds AI literacy and critical reasoning; and (3) **ethical stewardship** to ensure that automation enhances, human compassion and professional integrity. Physicians who embrace these challenges will not be displaced by algorithms; they will define the standards by which intelligent medicine earns public trust.

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