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Contemporary challenges in european and national health care systems

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Integrating artificial intelligence into healthcare practice

Overview

AI can be responsibly integrated into healthcare practice, covering:

- Core concepts and types of AI used in health
- Clinical and operational applications
- Workflow integration and human–AI collaboration
- Data quality, validation, and safety monitoring
- Ethical, legal, and regulatory considerations
- Patient-centred use of AI tools and symptom checkers

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Why AI in Healthcare?

Main drivers for AI adoption include:

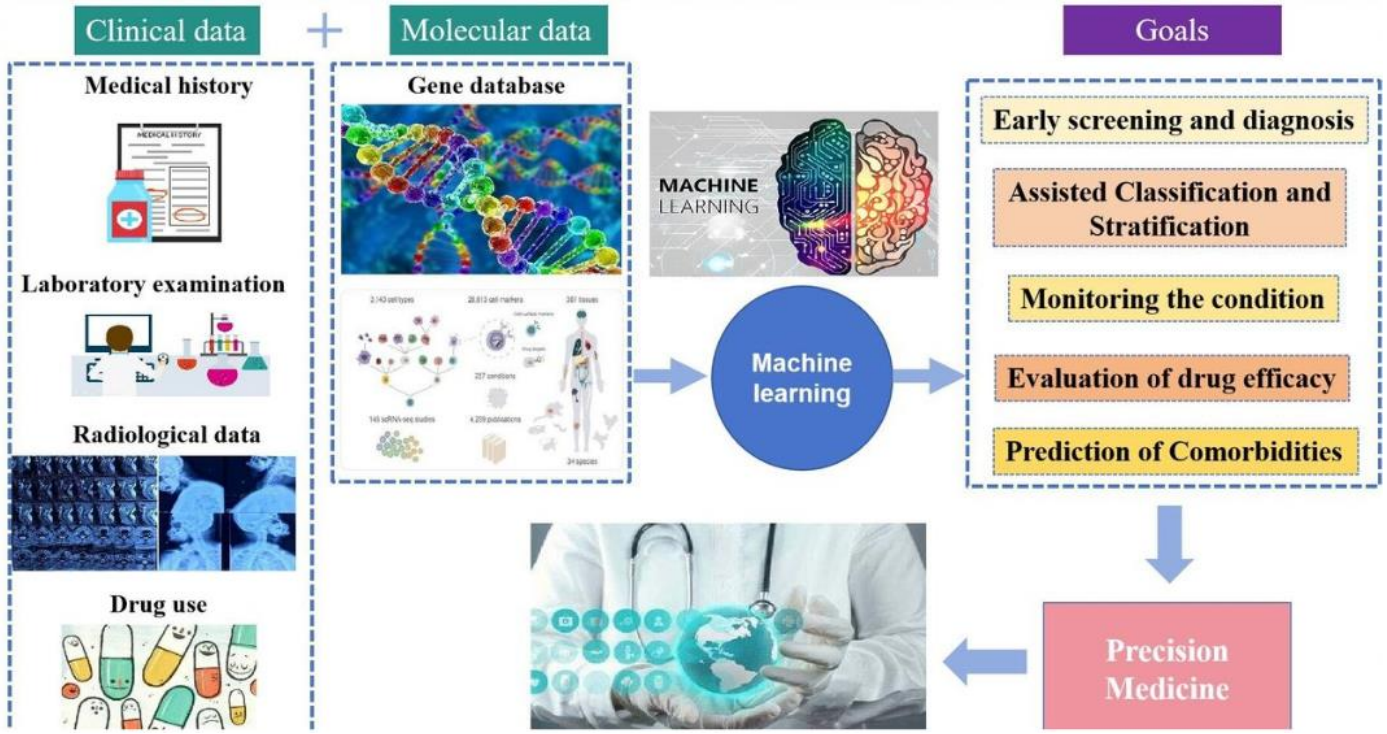
- Rising demand, ageing populations, and workforce shortages
- Growth of digital data from EHRs, imaging, wearables, and sensors
- Need to improve diagnostic accuracy and reduce adverse events
- Pressure to increase efficiency and reduce costs
- Opportunities for personalized and predictive care

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Key Concepts: AI, ML, Deep Learning, LLMs

- **Artificial Intelligence (AI):** Computer systems performing tasks that normally require human intelligence.
- **Machine Learning (ML):** Algorithms that learn patterns from data to make predictions or classifications.
- **Deep Learning (DL):** Multi-layer neural networks used for complex tasks (e.g., imaging, speech).
- **Large Language Models (LLMs):** Models trained on large text corpora that generate human-like language and can support knowledge retrieval and reasoning.

Main Domains of AI Application in Healthcare



- Diagnostics and imaging analysis
- Risk prediction and clinical decision support
- Treatment optimisation and prescribing
- Operational management and resource allocation
- Remote monitoring and telehealth
- Patient-facing tools: symptom checkers, chatbots, self-management apps

Chen, Y.; Liu, H.; Yu, Q.; Qu, X.; Sun, T. Entry Point of Machine Learning in Axial Spondyloarthritis. *Spondyloarthritis* **2024,** *10*(1), e003832. https://rmdopen.bmj.com/content/10/1/e003832

AI in Diagnostics and Imaging

Typical uses:

- Automated detection of abnormalities in radiology, pathology, dermatology, ophthalmology
- Quantitative measurements (e.g., lesion size, cardiac function)
- Triage of urgent cases based on image analysis
- Support for second-opinion reading

AI tools complement specialist expertise but do not replace clinical judgment.

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AI for Risk Prediction and Clinical Decision Support

- Prediction of disease onset, deterioration, or readmission risk
- Identification of high-risk subgroups for targeted interventions
- Decision support for guidelines-based care and risk scores
- Real-time alerts for critical lab results or vital sign changes
  High-performance models must be transparent enough to be trusted and usable in practice.

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AI in Therapeutics and Prescribing

- Drug–drug interaction screening and optimisation of medication regimens
- Dose adjustment based on renal function, weight, or pharmacogenomics
- Support for antimicrobial stewardship and narrow-spectrum choices
- Prioritisation of patients for advanced therapies or clinical trials
  Clinical teams remain responsible for benefit–risk assessment and shared decision-making.

Examples of AI Tools in Healthcare and Their Uses

Imaging & Diagnostics

Aidoc – AI support for detecting acute findings on CT scans (e.g., intracranial hemorrhage, pulmonary embolism) to prioritise radiology workflows.

HeartFlow – AI-based analysis of coronary CT to estimate fractional flow reserve and support decisions in coronary artery disease.

Clinical Decision Support & Risk Prediction

Epic Sepsis Model (EHR-embedded AI) – real-time prediction of sepsis risk to prompt early evaluation and treatment.

Google's AI for Diabetic Retinopathy – automated grading of retinal images to support screening programmes.

Patient-Facing Symptom Checkers and Triage Tools

Isabel Symptom Checker – supports patients in exploring possible causes for symptoms and whether to seek care.

Buoy Health – conversational AI triage assistant that directs patients to self-care, primary care, or emergency services as appropriate.

Ada Health – app that guides users through symptom questions and suggests likely conditions and care options.

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Examples of AI Tools in Healthcare and Their Uses

Medscape AI Search / Medscape AI — AI-driven clinical reference tool that delivers fast, evidence-based medical answers tailored to clinicians, synthesising Medscape's proprietary content and peer-reviewed literature in real time

Operational & Workflow Optimisation

Qventus – AI platform for predicting patient flow, optimising bed management, and reducing length of stay.
Hospital IQ – supports staffing and scheduling decisions using predictive analytics on demand and capacity.

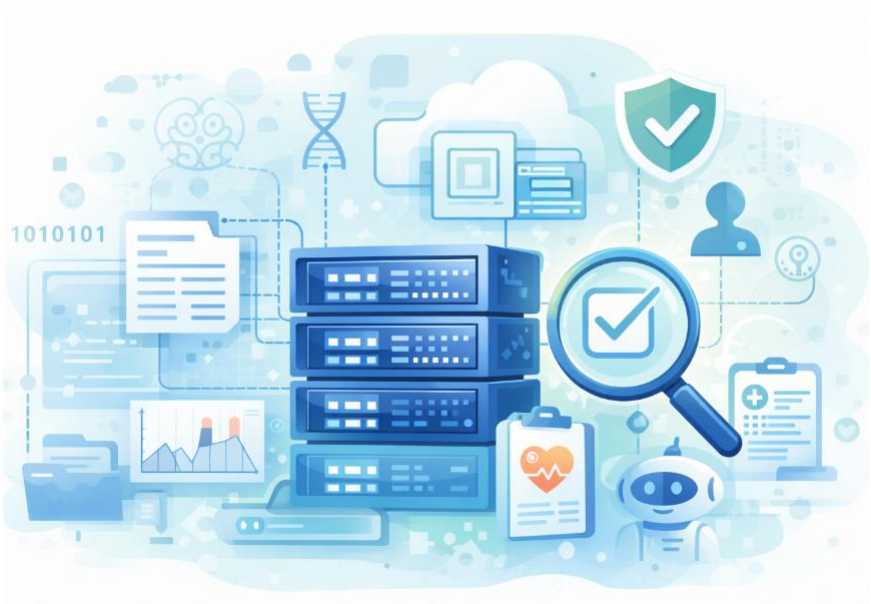
Virtual Assistants and Documentation

Nuance Dragon Medical One – speech recognition and AI-assisted clinical documentation integrated into EHRs.
EHR-integrated **virtual assistants** (e.g., voice-based order entry, information retrieval) – reduce administrative burden and help clinicians access data quickly.

AI in Operations and Workflow Management

- Forecasting demand for beds, operating rooms, or staffing
- Optimising scheduling of appointments and procedures
- Predicting patient flow through emergency departments or wards
- Automating routine documentation or coding tasks

  Well-designed AI systems can reduce administrative burden and free time for direct patient care.



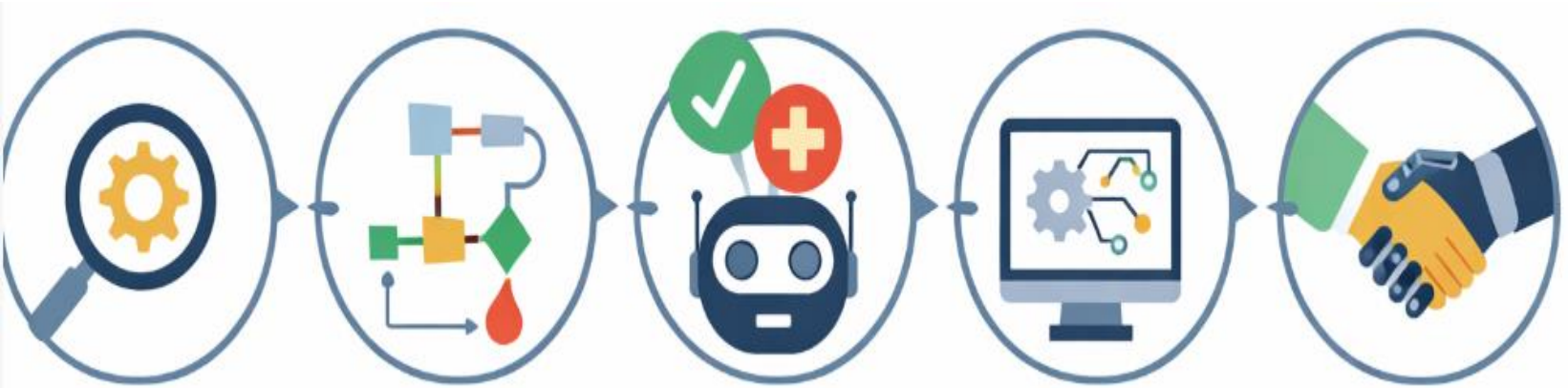
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Principles of Workflow Integration

Successful AI integration requires:

- Clear definition of the clinical problem being addressed
- Mapping of the current workflow and decision points
- Identification of where AI adds value (triage, prioritisation, recommendation)
- Minimal disruption of existing systems and interfaces
- Clear allocation of responsibilities between humans and AI tools



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Human–AI Collaboration in Practice

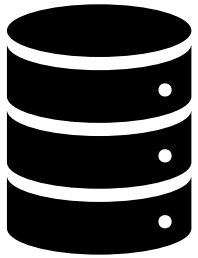
- Key aspects of human–AI teaming:
- AI as *decision support*, not autonomous decision-maker in most clinical contexts
- Clinicians interpreting outputs in light of patient context and preferences
- Mechanisms to override or question AI recommendations
- Documentation of how AI output influenced clinical reasoning
- Shared accountability across clinical, IT, and governance structures

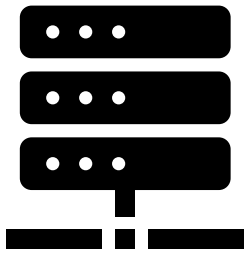
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Data Foundations for AI

- Robust AI systems depend on:
- High-quality, complete, and well-labelled datasets
- Representative data covering diverse populations
- Standardised coding and interoperability (e.g., SNOMED CT, ICD, FHIR)
- Attention to missing data, noise, and measurement error

  Poor data quality leads directly to unreliable and potentially harmful outputs.





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Model Development, Validation, and Generalisability

- Before deployment, AI models should undergo:
- Internal validation (e.g., cross-validation, test sets)
- External validation on data from different settings or populations
- Assessment of calibration, discrimination, and clinical usefulness
- Evaluation of performance drift over time after deployment

Generalisability is critical when models are used beyond the original development environment.

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Safety, Reliability, and Monitoring

- Definition of acceptable performance thresholds and error rates
- Prospective monitoring of performance and incident reporting
- Procedures for model updates, retraining, or withdrawal
- Guardrails to prevent unsafe recommendations (e.g., hard stops)
- Integration of AI-related safety into existing risk management systems

Ethical, Regulatory, and and Policy Landscape

- Respect for autonomy: informed use and explanation where appropriate
- Non-maleficence and beneficence: maximising benefit and minimising harm
- Fairness and equity: avoiding bias against specific groups
- Transparency and explainability at the appropriate level
- Accountability and clear lines of responsibility for AI-enabled decisions
- High-risk AI applications are increasingly subject to specific regulatory requirements (e.g., risk management, documentation, oversight)
- Institutions must align AI use with data protection, privacy, and cybersecurity laws
- Professional bodies and guidelines contribute to standards of good practice



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Patient-Facing AI Tools and Symptom Checkers

Common types:

- Symptom checker websites and apps
- General-purpose chatbots providing health information
- Condition-specific tools (e.g., dermatology, mental health, pregnancy)

Potential uses:

- Support for health information seeking
- Preliminary triage guidance
- Facilitation of patient–provider discussions

Use in practice requires awareness of limitations, disclaimers, and local guidance.

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Evaluating Patient-Facing AI Tools

Clinicians and organisations can assess such tools by considering:

- Clarity and readability of information for lay users
- Medical accuracy and alignment with current guidelines
- Handling of red flags and emergency symptoms
- Transparency about data use, sponsorship, and commercial interests
- Presence of appropriate disclaimers and advice to seek professional care

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AI from the Patient Perspective

Important aspects for patients:

- Perceived trustworthiness and credibility of the tool
- Ease of use and accessibility (language, literacy, digital skills)
- Emotional impact of risk information or differential diagnoses
- Influence on help-seeking behaviour and adherence
- Potential for confusion, anxiety, or false reassurance if information is poor

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Communication with Patients About AI

Examples of good practice include:

- Explaining when and how AI is used in their care (where relevant)
- Emphasising that AI supports, not replaces, professional judgment
- Discussing uncertainties and limitations of predictions or suggestions
- Encouraging questions and joint interpretation of AI outputs
- Being prepared to address misinformation from online AI tools

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Practical Steps for Implementing an AI Tool

Typical implementation pathway:

- Identify clinical need and select candidate AI solution
- Conduct local evaluation (technical, clinical, usability)
- Involve multidisciplinary stakeholders (clinicians, IT, data protection, patients)
- Pilot in a controlled setting with monitoring and feedback
- Scale-up with training, governance, and continuous improvement processes

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Interprofessional Collaboration for AI Integration

AI implementation is a team effort involving:

- Clinicians defining clinical requirements and evaluating usefulness
- Data scientists and informaticians building and refining models
- IT teams ensuring integration, performance, and security
- Managers and policymakers addressing resources and priorities
- Patients and the public contributing perspectives on acceptability and trust

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Training and Upskilling the Healthcare Workforce

Key competencies for AI-enabled practice:

- Basic understanding of AI concepts and limitations
- Skills in interpreting and critically appraising AI outputs
- Digital literacy and familiarity with clinical information systems
- Knowledge of ethical and legal aspects of AI use
- Ability to communicate about AI with patients and colleagues

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Barriers and facilitators

Barriers:

- Limited trust or understanding of AI among clinicians and patients
- Workflow misalignment and poor usability
- Data quality issues and technical integration challenges
- Regulatory and liability concerns

Facilitators:

- Strong governance and leadership support
- Transparent performance data and good user experience
- Ongoing training, feedback, and co-design with end users



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Conclusion

- AI can support diagnostics, risk prediction, treatment decisions, and system efficiency.
- Safe integration depends on data quality, robust validation, and continuous monitoring.
- Human–AI collaboration, not replacement, is central to responsible use.
- Ethics, governance, and regulatory compliance are integral, not optional extras.
- Patient-centred approaches, clear communication, and workforce training are essential for sustainable adoption.

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