

# AI IN DIGITAL HEALTHCARE TRANSFORMATION: ANALYSING THE IMPACT OF AI TECHNOLOGIES ON HEALTHCARE SERVICE DELIVERY AND OPERATIONAL EFFICIENCY

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## Abstract

As health systems continue to deal with the ever-growing demands, workforce challenges, diagnostic lag and high operational expenses, Artificial Intelligence (AI) has emerged as a force of change in the world of digital healthcare. In this article, we look at the benefits of AI technologies to healthcare service delivery and operational efficiency, as well as examining the ethical, technical and organizational concerns of implementing AI. The narrative literature review approach is used, and is informed by academic literature, healthcare reports, policy documents and real-life examples from 2020 to 2023. The article focuses on two areas of great importance: (1) AI can enhance service management through diagnostic support, clinical decision support, digital triage, remote monitoring and personalized care and patient communication; and (2) AI can enhance the efficiency of administrative workflows through documentation, demand forecasting, capacity planning and resource optimization. AI technologies, when applied safely within clinical systems, can improve the performance of systems and processes in terms of speed, accuracy, access and workflow. This does not, however, guarantee benefits. AI, however, brings up issues of data privacy, data bias, explainability, explainability of responsibility, preparedness of staff and inequity of digital access. Therefore, AI must be used in conjunction and not in place of health care providers.

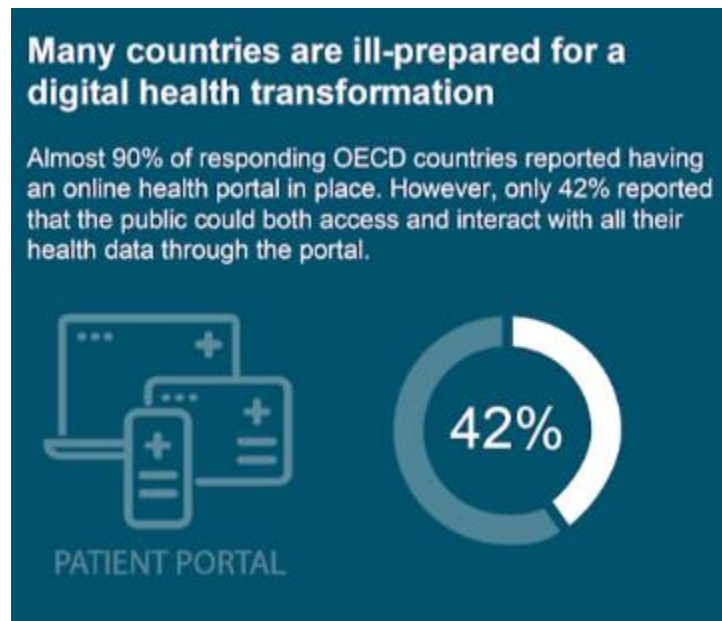
## INTRODUCTION

Healthcare systems are experiencing challenges due to a lack of staff, high costs and an increasing demand for services. The World Health Organisation (2019) has stated that digital health is key in enhancing health systems (WHO, 2019), and the OECD (2023) found health expenditure across OECD countries increased to 9.2% of GDP in 2022, up from 8.8% in 2019 prior to the pandemic (OECD, 2023). These forces are indication that traditional healthcare delivery models are ineffective. In healthcare, digital

transformation involves incorporating digital technologies, data infrastructure, and interconnected systems into clinical and administrative workflows (Barbieri et al., 2023). These include EHRs, telemedicine, remote monitoring, and digital diagnostics and automated decision support systems. Artificial Intelligence (AI) has been a vital part of this metamorphosis, handling the analysis of enormous amounts of medical data, uncovering patterns, foreseeing future events and automating repetitive tasks in the healthcare industry. The use of AI in healthcare includes using machine learning and

deep learning, natural language processing and predictive analytics, in clinical and operational decision making, patient management, and operations (Kodali, 2023). The main points highlighted in this article are Healthcare systems need to improve their service delivery as well as their operational efficiencies. There are a number of needs that need to be addressed for patients to have faster access, more accurate diagnosis, less

harm, better communications, and for health systems to reduce delays, manage scarce resources, and manage costs. Some solutions that AI can offer include diagnostic assistance, triage, personalisation, workflow automation and demand forecasting. It is used but there are concerns regarding bias, privacy, explainability and accountability along with staff readiness for its use.



**Figure 1: Digital health readiness gap in OECD countries**

Source: (OECD, 2023)

These pressures show that traditional healthcare delivery models are no longer sufficient, and healthcare systems need stronger digital infrastructure to support access, efficiency and patient-centred care.

This article seeks to critically examine the role of AI technologies in driving digital transformation in healthcare, in the areas of healthcare service delivery and operational efficiency, as well as consider the risks, barriers and ethical issues associated with the use of AI. This paper begins with a review of literature related to the topic, followed by the analysis of how AI affects service delivery and service efficiency, and a critical discussion of the challenges in implementing AI.

## Literature Review

### The concept of Digital Healthcare Transformation

Digital healthcare transformation is defined in the literature as the systematic use of digital technologies to transform the delivery, management and experience of healthcare. Digital health must be used to make health systems more resilient and better able to withstand shocks and stresses, while adding more tools to their arsenal, by bringing together technological, organizational, human and financial resources, as proposed by World Bank Group (2023). It represents a paradigm shift from the traditional paper-based and reactive care models to data-driven healthcare, facilitated by real-time information to support clinical and operational decisions. OECD (2023)

stresses the role of electronic health records, telemedicine, and population health data and digital tools, as they are increasingly influencing digital health (OECD, 2023). In this context, EHRs facilitate better data availability, telemedicine increases access, remote monitoring allows for continuous care, digital diagnostics

enhance detection, and AI allows for prediction and automation. Digital transformation is thus not just a technological shift, but also a transformation of workflows, professional decisions, patient interaction and experience in healthcare. There is a growing demand for the application of AI in healthcare.

### Global Artificial Intelligence in Healthcare Market

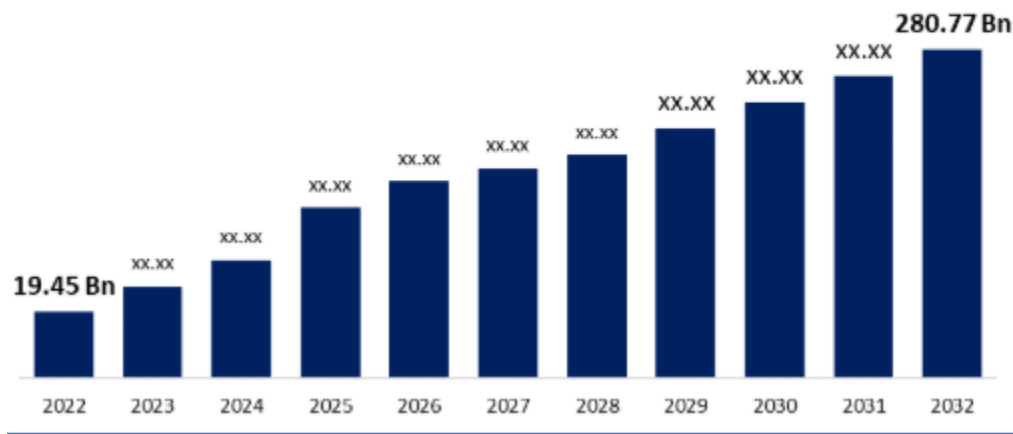


Figure 2: Global Artificial Intelligence in Healthcare Market

Source: (Spherical Insights, 2022)

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#### Artificial Intelligence in Healthcare

In the medical field, artificial intelligence is said to be the utilization of computational systems for the implementation of functions that typically require human intelligence, including pattern recognition (Nasim et al., 2023), prediction, language processing, decision support, etc. While using AI responsibly and ethically, Reddy, Fox and Purohit (2019) suggest that AI can contribute to health systems to enhance diagnosis, treatment decisions, public health surveillance, and health-service management. Machine learning is relevant to many clinical settings, such as disease risk identification and outcome prediction from clinical data, while deep learning plays a critical role in medical imaging, where it can learn complex visual patterns from X-ray, CT scan, MRI, and retinal images. Natural language processing can be used for analysis of unstructured clinical text, including patient notes, discharge summaries

and referral letters. Predictive analytics relies on historical and real-time data to help predict deterioration, readmission, admissions need and resource requirements. It has also recently come across the use of generative AI in generating summaries, documentation, and enhancing information retrieval, but with a risk of accuracy and hallucination (Yu et al., 2023). This literature review indicates that overall, AI helps with diagnosis, risk prediction, decision-making and automation.

#### AI and Healthcare Service Delivery

It has been established in the literature that AI can enhance the delivery of health services by making them faster, more accessible, and more intelligent in the patient journey. In diagnostic services, AI has been extensively researched across various medical fields, such as radiology, ophthalmology and pathology, where the technology can aid

quicker detection of abnormalities and minimize delays in diagnostics (Mun et al., 2021). AI can also play a role in clinical decision-making by examining patient records, test results and risk factors, and alerting the clinician to patient deterioration, or the risk of patient readmission or possible treatment options. AI-powered symptom checkers and decision-support systems can streamline the triage process, ensuring that patients receive the right level of care, thereby alleviating unnecessary strain on primary and emergency care systems. AI's contribution to chronic disease management and early intervention using wearable and home monitoring data is also noted in remote monitoring literature (Jeddi and Bohr, 2020). AI can also help with personalised care by discovering high-risk patients and anticipated treatment reactions. It is also important to note in the literature, however, that these benefits are contingent upon clinical validation, the reliability of the data obtained, and the integration of workflow and staff acceptance.

## AI and Operational Efficiency

Existing studies indicate that AI has the potential to enhance operational efficiency by streamlining repetitive tasks and optimizing the utilization of healthcare resources. AI-powered automation can streamline and minimize back-office obligations with regard to appointment scheduling, coding, billing, claims processing, and documentation, thus freeing up more time for staff to dedicate to patient care (Talukdar, Singh and Barman, 2023). Another benefit of predictive analytics for the application of bed and capacity planning is that it can forecast the number of patients in the ED, medicines needed and a pattern of discharge, which can then predict the pressure on beds. This helps staffing and resource allocation to be more effective, particularly when there is a high demand. According to Patil and Shankar (2023), AI can provide value in the healthcare industry by streamlining clinical workflows, minimizing delays, and facilitating better and faster decision-making. However, it is also found that improvements in efficiency are not always ensured in literature. The high implementation costs, lack of interoperability between digital systems, and the

lack of data quality and staff training can diminish the practical benefits that businesses can derive from adopting AI in Healthcare.

## Review Approach

The current article takes an investigative and narrative literature review strategy to explore how artificial intelligence can be used to digitally transform health care. Due to the broad nature of the topic and its fast rate of evolution, the narrative review approach is appropriate which entails synthesizing academic evidence, discussion of policy, and presentation of examples from the healthcare context (Fadlallah et al., 2019). The goal is not to follow a predetermined search strategy like a systematic review, but instead to gather critically all the evidence on the impact of AI on healthcare service provision and efficiency. The review is based on academic literature, healthcare reports, policy documents and selected real-world examples of AI from 2020 to 2023. The sources include key digital health guidance documents from WHO, reports and publications from the OECD on healthcare and digital transformation, policy documents from the NHS, peer-reviewed journal articles and healthcare technology case studies. These sources were chosen due to their ability to offer reliable information regarding the opportunities and risks associated with the use of AI in healthcare. The selection was centered around the four following thematic areas: AI in healthcare service delivery, AI and operational efficiency, digital healthcare transformation and ethical or implementation barriers (Joshi et al., 2022). Evidence for service delivery was assessed against the following areas: diagnosis, triage, remote monitoring, personalised care and patient communication. Operational evidence was evaluated with respect to workflow automation, documentation, demand forecasting, bed planning, staff planning and cost control. The article thus examines the advantages and drawbacks of AI, not just as a technology that is entirely good.

## Analysis: Impact of AI on Healthcare Service Delivery AI-Enabled Diagnosis and Clinical Decision Support

The most obvious areas where AI is making a difference in healthcare service delivery are image-based diagnosis, particularly in radiology, pathology, dermatology and ophthalmology. With the power of deep learning systems, X-rays, CT scans, retinal images and skin-lesion images can be analysed to uncover patterns which might be hard or time-consuming for clinicians to spot manually. In the imaging domain, the deep learning

technique demonstrated high diagnostic performance in the systematic review of 2021, with AUC values ranging from 0.933 to 1.000 in ophthalmology, 0.864 to 0.937 in respiratory imaging and 0.868 to 0.909 in breast imaging, highlighting robust potential for early disease detection and diagnostic support (Aggarwal et al., 2021). But the same review cautioned that many studies had methodological flaws and were highly heterogeneous, and they were not validated externally, so accuracy reported in the study could be exaggerated.

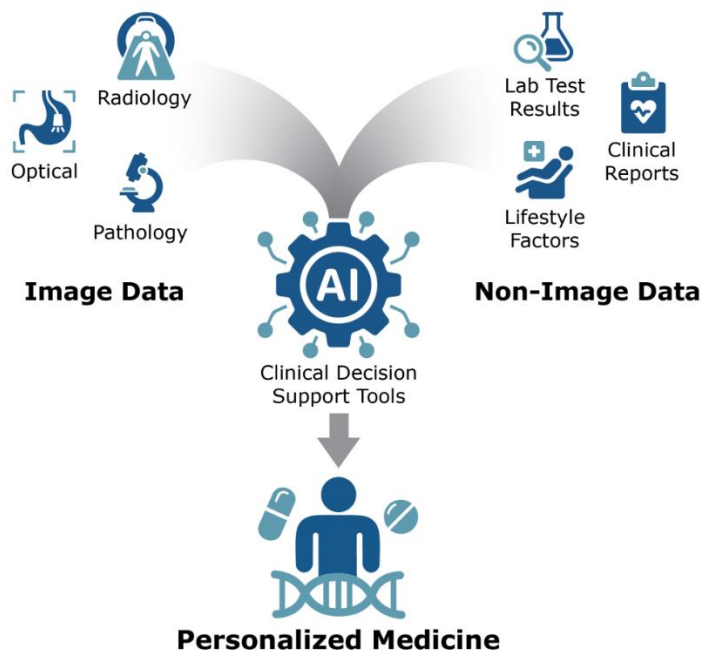


Figure 3: Role of AI in integrating image and non-image data for clinical decision support and personalised medicine

Source: (Nih.gov, 2023)

AI is currently already leveraged to alleviate the burden on diagnosis. The UK government spent £21 million in 2023 on 64 NHS trusts to install AI applications for analysing X-rays and CT scans, including to accelerate lung cancer diagnosis (GOV.UK, 2023). It is estimated that a million X-rays are taken in England every month (News Editor, 2023) and faster image interpretation can help to alleviate diagnostic backlog. Most importantly, AI should assist with prioritisation and clinical decision making, not dictate it, and

the decision-making process and final judgement should be left to clinicians.

### AI in Patient Access, Triage and Care Navigation

Before patient contact, AI can aid in early symptom evaluation, digital triage and care navigation, enhancing patient access. NHS 111 online offers a digital assessment in England, and directs users to right care at the right place and time, in line with the broader NHS move towards

“right person, right place, right time” access (Turnbull et al., 2023).

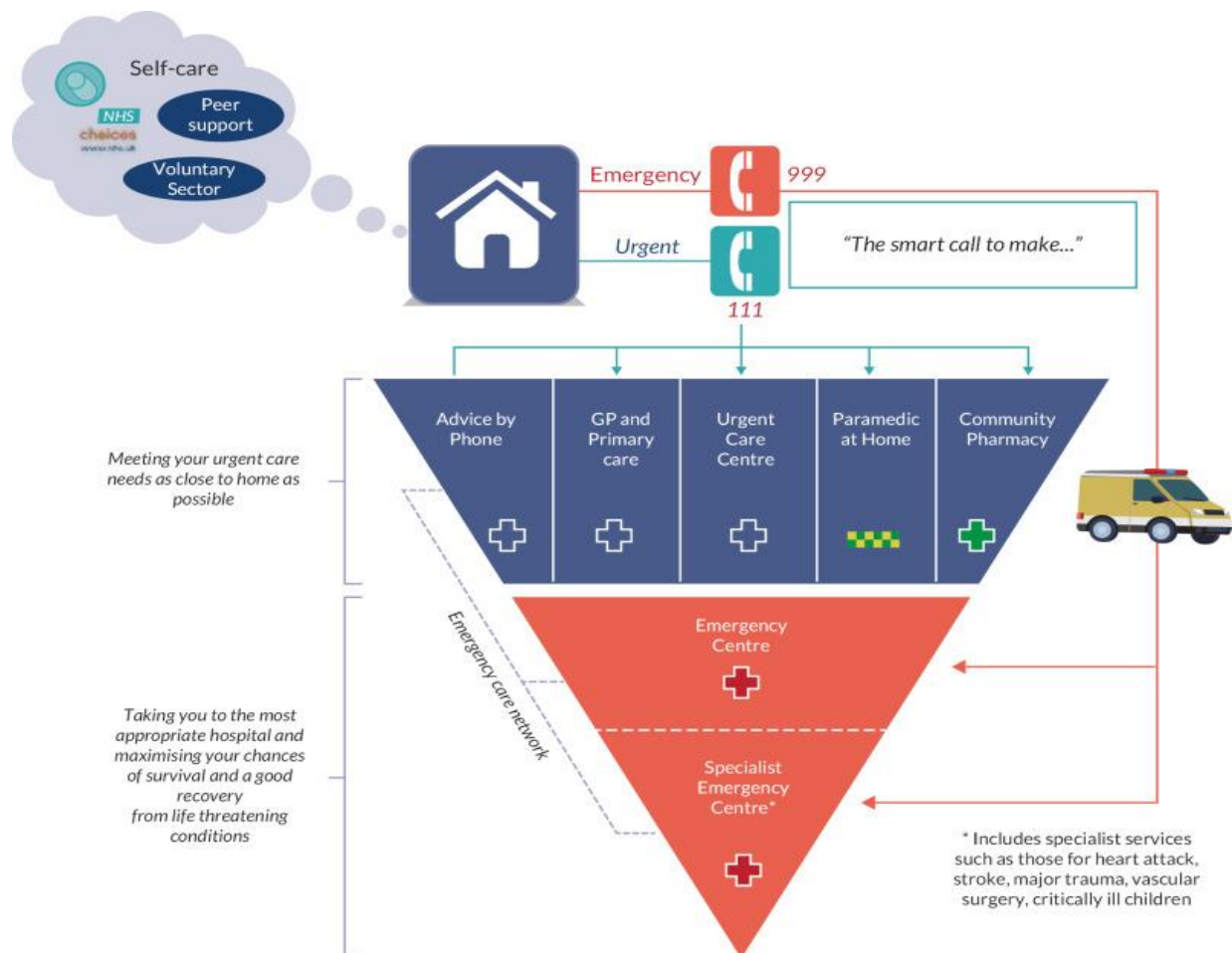


Figure 4:NHS urgent and emergency care navigation pathway

Source: (Turnbull et al., 2023)

NHS England also found that digitally enabled total triage grew during COVID-19, with the number of patient requests being triaged remotely before being passed on to telephone, video, face to face, urgent care or self-care pathways. But data indicate that AI symptom checking has mixed clinical results. A 2022 systematic review revealed that the use of digital symptom checkers might increase convenience and access to health services, but the accuracy of diagnosis and triage was inconsistent between tools, with calls for safety concerns (Wallace et al., 2022). Likewise, Fraser and colleagues determined that 14% of the symptom-checker triage recommendations were deemed unsafe by two or more physicians (2022).

Thus, AI triage will not only help lower appointments but also help the patient to get information faster, but it may also delay the patient's urgent treatment if the AI doesn't provide safe advice. There is a need for clinical monitoring of humans.

**AI-Driven Personalised, Predictive and Remote Care**

AI-powered personalised, predictive and remote care. Personalised, predictive and remote care using AI. By understanding the patient data, AI enables a transition from reactive treatment to personalised, predictive and remote care. In oncology, AI is able to integrate imaging,

pathological and clinical data to offer more personalised treatment planning, although there is stronger evidence of AI for decision support rather than fully automated treatment decisions. Predictive models are also being applied to help identify patients that are likely to deteriorate or

require readmission. In general, AI-based models were found to be performing well in predicting in-hospital clinical deterioration, which could be helpful to initiate interventions and escalate care early, as reported by Veldhuis et al (2022).

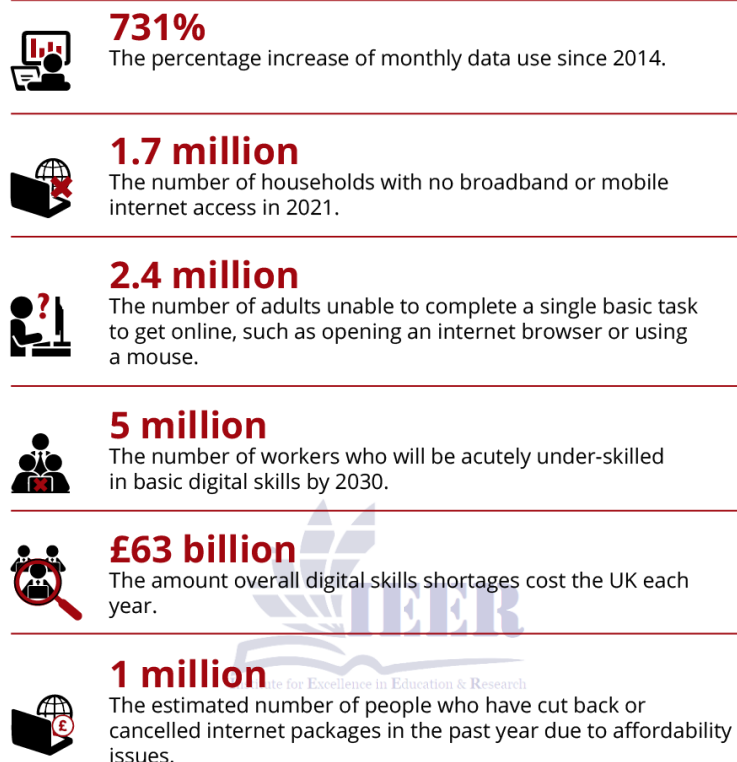


Figure 5: Scale of digital exclusion and limited internet access affecting healthcare participation  
Source: (Parliament.uk, 2023)

This is a benefit that can be enjoyed beyond hospitals by remote monitoring. The researchers found that home-based data collection for follow-up is becoming more commonplace in primary care as a tool for chronic disease management, with the use of health remote monitoring systems. (Peyroteo et al., 2021) This model, however, requires reliable devices, representative datasets and patients' access to digital devices. Digital exclusion still poses a significant challenge: according to a report by the House of Lords in the UK in 2023, there were 1.7 million households without mobile or broadband internet at home and 2.4 million people unable to do a simple online task (Milmo, 2023).

**Analysis: Impact of AI on Operational Efficiency AI-Enabled Administrative Automation and Documentation Efficiency**

Automation reduces repetitive, administrative and documentation intensive tasks including appointment scheduling, patient registration, billing, coding and claims processing, which are made easier and more efficient by AI. NHS England's 2022 guidance outlines how RPA can be utilised to copy, verify and move information between digital systems and eliminate manual tasks from high volume administrative processes (NHS England, 2023). From an operational perspective, it is essential as healthcare personnel may be spending time on repetitive data entry

rather than patient care. Another important efficiency aspect is clinical documentation. J Moy and M Schwartz (2020) reported strong associations between eHR and documentation burden and clinician burnout, providing a rationale for the need for automation. NLP and generative AI can summarize notes, write discharge letters, and generate clinical notes. AWS HealthScribe, for instance, was launched in 2023 to provide clinical notes from patient-clinician interactions, without compromising HIPAA eligibility (Koencke et al., 2020). But the output of the AI must be reviewed by a clinician as mistakes with summaries, coding or unsupported text can pose a risk to patients, billing and legal matters.

### **AI for Workforce, Capacity and Demand Planning**

AI can help with workforce and capacity planning by predicting patient needs, bed pressure, and the use of the Intensive Care Unit (ICU) and the Emergency Department (ED). This is crucial as the NHS England urgent and emergency care recovery plan was launched against the backdrop of record pressure on the system as "more A&E attendances than ever" this winter, alongside an increase in serious ambulance calls and millions of calls to NHS 111. An anticipated expansion of 5,000 more sustainable hospital beds and 800 new ambulances were part of the plan, illustrating the magnitude of the capacity pressure that forecasting attempts to address (NHS England, 2023). Predictive analytics can help with admittance forecasting, managing staff schedules, planning for winter and bed allocation by analyzing previous admissions, seasonal illness trends, and local demand. AI and Discrete Event Simulation were used in a 2023 study to demonstrate the potential of modelling to assist with ICU bed capacity management during COVID-19 (Ortiz-Barrios et al., 2023). AI predictions are only beneficial when the data are accurate and up to date, though. Historical trends may be unreliable in the event of sudden changes, like pandemic outbreaks, strikes or outbreaks in the local community.

### **AI-Driven Cost Control, Resource Optimisation and Quality Improvement**

AI can help with cost control by cutting down on waste, duplicate work, unnecessary delays and idle capacity. The size of the lost operation is revealed by missed appointments: NHS England (2023) said it is essential to improve "did not attend" as this harms capacity, delays treatment for long waiting patients and undermines the recovery of elective services. The use of AI-powered reminders, risk scoring, and scheduling capabilities can then help free up or reallocate slots sooner, while helping to identify patients who may be at risk of being unable to attend. The principles of resources optimisation also apply to medicines and stock control. The example used in NHS Scotland's 2023 AI strategy is a system used for pharmacies, which analyses data to forecast when medication levels are getting low and which medicines are in need of re-ordering, before the pharmacist does the final safety checks (Wright, 2024). AI dashboards also can pinpoint patient-flow bottlenecks and help with evidence-based quality improvement. However, the savings are not immediate as the implementation of AI takes time and investment, staff training, data integration, and continuous monitoring.

### **Discussion: Critical Evaluation of AI in Healthcare Transformation**

AI holds significant promise for revolutionizing healthcare, yet it requires a strategic implementation. The UK government recently committed £21 million to 64 NHS trusts to implement AI-powered radiology systems for X-rays and CT scans in 2023, and the UK is doing more than 600,000 chest X-rays every month. This indicates that AI can help speed up reporting, early diagnosis and diagnostic load reduction. But there is also evidence that the technical promise needs to be demonstrated in real-world clinical experiences, and not just in controlled studies. A recent study based on NHS data, published in 2023, found AI could be used to analyse chest X-rays with a mean time of 7.1 seconds, with 20% of the examinations being identified as high confidence normal, but still needed radiologist audit to ensure safety (GOV.UK, 2023b).

The problem is: AI accuracy doesn't necessarily translate to healthcare value. There is a strong chance that a system can be technically robust but not enhance safety, access or workload if the system is not well integrated into the clinical workflow. The EPIC Sepsis Model is a powerful warning model. A 2021 external validation study of 38,455 hospitalizations reported an AUC of just 0.63, well below the levels of 0.71 and 0.84 the developers claimed (Wong et al., 2021). This means there is concern that this model may not be adopted widely without sufficient local validation. Thus, leverage AI as a tool to enhance, not replace. WHO's 2021 ethics guidance reinforces the ethical principles of safety, transparency, accountability and fairness, and reminds humans to stay in control of healthcare decisions (WHO, 2021). This is significant because hospitals could leverage AI to save costs and man-hours, but at no expense to patient safety or equity. AI has the potential to exacerbate inequality as well. According to OECD's 2023 digital health analysis, digital transformation is not equally distributed among countries and relies heavily on a robust data infrastructure and patient access, as well as system readiness (OECD, 2023). If the hospitals are not adequately resourced, they could be less suited if they lack interoperable records, trained staff or funding. Thus, while accuracy is a critical factor in the success of an algorithm, it should not be the only measure for AI's performance, but its ability to improve patient treatment, reduce unnecessary burden and provide access to the patient in an equitable way, while functioning in the healthcare environment.

## **Challenges, Ethical Issues and Implementation Barriers**

### **Data Governance, Privacy, Bias and Trust**

But AI in healthcare requires huge patient-specific information like electronic health records, medical images, lab reports, prescriptions and telemetry information. It creates great privacy and Cyber security concerns as patient information is sensitive. WHO (2021) has highlighted the importance of privacy, autonomy, transparency and safety in the use of AI in health care, especially when it comes to the handling of data by different

stakeholders like healthcare providers, researchers and technology developers. Without data governance, there may be risks for patients related to data security, improper use of patient information, or poor informed consent for patients when using AI.

Bias is also a massive moral issue, and it's one that's hard to resolve. Recommendations based on AI systems are based on previous data, and this could mean that it is not as accurate for under-represented groups if there is insufficient or unrepresentative data. This can further widen health disparities in situations where AI technologies are more effective for ethnic groups that are more identifiable than ethnic minorities, older adults, and those who are lower income or less likely to have access to health care. Level of trust is also affected by the level of explainability. Often your AI systems can be called "black boxes", because it is difficult to understand how decisions are being taken and how they are being taken.

### **Regulation, Safety, Infrastructure and Workforce Readiness**

Safety and accountability issues are also prevalent with AI. There may be a Blurred Line between clinicians, hospitals and developers/regulators when the AI system gives unsafe recommendations. This need makes it imperative to clinically validate AI tools, perform local testing and continuous auditing following implementation. Kyriakou and Otterbacher (2023) emphasizes the importance of human involvement in every aspect of safety, ethics and professional judgement when making health care decisions.

In addition, a few barriers exist with regard to implementation. Financial costs are related to the implementation of AI, such as investments in the digital infrastructure, interoperability of records, cyber security, training and ongoing technical support. However, the benefits of AI might be hard to come by for healthcare institutions without robust digital systems, further widening the chasm between the best and worst hospitals. AI's benefits could exacerbate the divide between high-tech hospital systems and those with less resources, if hospitals with less sophisticated

digital infrastructure have difficulties achieving the benefits. Therefore, the ability to have effective governance, employee engagement and strong safety controls is critical to implementing AI.

## Conclusion and Recommendations

The role of AI in digital healthcare transformation is undeniable because it empowers efficient and quicker healthcare delivery and access, which is crucial for a data-driven environment. It enhances service delivery by helping with diagnoses, triage, home monitoring and communication with patients. It also enhances operational efficiency by automating administrative tasks, forecasting demand, providing documentation support, planning resources and optimising workflow. Yet, AI has also posted significant threats, such as privacy concerns, bias in algorithms, poor explainability, safety concerns, and inequities in access to digitally advanced and under-resourced services. AI is thus not intended to substitute healthcare professionals, but rather as a tool to aid in clinical judgement, patient safety, and evidence-based decision-making.

It is important for healthcare organisations to not use AI as a clinical decision-making body, but rather as a decision support tool. Prior to a broad deployment of an AI system, it is crucial to pre-test in the environment where it will be used before deployment to ensure performance is repeatable hospital to hospital, cohort to cohort and workflow to workflow. Comprehensive data governance, cybersecurity and privacy safeguards are critical for ensuring the security of patient information. Practical training of staff to develop understanding of outputs, limitations and risks of AI. AI tools should also be regularly tested in the real world to check for bias, inaccuracy, safety and impact. Finally, patient and clinical involvement in the adoption and application of AI will help to build trust, usability, accountability, and safe practice of AI in the healthcare sector.

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