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Review

Transforming healthcare delivery: A comprehensive review of digital integration, challenges, and best practices in integrated care systems

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ABSTRACT

Digital transformation in healthcare, particularly within Integrated Care Systems (ICS), offers significant potential to improve the quality, accessibility, and efficiency of care. This narrative review examines the best practices, challenges, and outcomes of digital healthcare transformation within ICS, with a focus on the integration of key technologies such as electronic health records (EHRs), telemedicine, and artificial intelligence (AI). The review highlights the critical role of leadership, stakeholder engagement, and staff training in overcoming barriers to successful digital adoption, including resistance to change, interoperability issues, and financial constraints. It further explores the impact of digital tools on patient outcomes, operational efficiency, and patient engagement. Despite the promise of digital transformation, several challenges persist, including technological barriers, regulatory complexities, and the need for significant investment in infrastructure. To maximize the benefits of digital healthcare tools, the review recommends fostering collaboration among healthcare providers, prioritizing staff involvement and leadership support, implementing digital solutions in phases, and addressing financial and regulatory challenges early in the planning process. By addressing these challenges and implementing recommended strategies, ICS can enhance care coordination, optimize resource utilization, and ultimately improve patient outcomes, paving the way for a more sustainable healthcare system.

1. Introduction

The healthcare sector is undergoing an unprecedented transformation, fuelled by rapid technological advancements, shifting patient expectations, and evolving policy frameworks [1–3]. The digitization of healthcare processes has emerged as a central driver in reshaping the landscape of care delivery, with an emphasis on improving the efficiency, accessibility, and quality of services [4,5]. As part of this transformation, Integrated Care Systems (ICS) have gained prominence as a strategic approach to address the fragmentation within healthcare systems, promoting seamless coordination across various providers and ensuring that patients receive comprehensive care tailored to their individual needs [6,7]. This shift towards digital health technologies

within ICS aims to optimize the delivery of care, streamline workflows, and improve patient outcomes by ensuring timely, accurate, and personalized interventions.

Integrated Care Systems represent a fundamental shift from traditional healthcare delivery models towards a more coordinated, patient-centred approach. The concept of integrated care is defined as the coordination of services across the continuum of care, multiple service providers, settings, and levels of care to achieve improved patient outcomes, enhanced patient experience, and optimised resource utilisation [8,9]. ICS are underpinned by several core principles including patient-centredness, where care is designed around the individual's needs and preferences; population health focus, addressing the health needs of entire communities; collaborative governance involving

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multiple stakeholders in decision-making; and value-based care that emphasises outcomes rather than volume of services [10,11]. These systems typically encompass primary care, secondary care, mental health services, social care, and public health functions, creating a unified framework for service delivery. The conceptual foundation of ICS rests on the understanding that healthcare challenges are complex and multifaceted, requiring coordinated responses that transcend traditional organisational boundaries. By bringing together diverse healthcare providers, local authorities, voluntary sector organisations, and communities, ICS aim to create a more responsive and efficient healthcare ecosystem that can address both immediate care needs and broader determinants of health [7,8].

Digital healthcare transformation is not merely about adopting new technologies; it is about leveraging the power of these tools to fundamentally change the way care is delivered and experienced [12,13]. Technologies such as Electronic Health Records (EHRs), telemedicine platforms, wearable health devices, and Artificial Intelligence (AI)-driven analytics have proven to be game-changers in addressing long-standing challenges in healthcare [14–16]. EHRs, for instance, enable clinicians to access and update patient information in real-time, eliminating the inefficiencies and errors associated with paper records [17]. Telemedicine extends the reach of healthcare services, especially in rural and underserved areas, by allowing patients to consult with medical professionals remotely [18,19]. Meanwhile, AI has the potential to revolutionize diagnostics, treatment planning, and decision-making by analysing vast amounts of medical data to identify patterns and predict outcomes [20,21].

Despite the promise of these technologies, their successful implementation within ICS is not without significant challenges [22,23]. One of the foremost hurdles is the integration of these digital systems across disparate healthcare organizations and services [24,25]. Achieving interoperability, the ability of different digital platforms to communicate and share data is crucial for the success of any digital transformation initiative [26,27]. However, many ICS face obstacles in aligning various technological infrastructures, which can hinder the smooth flow of information between different care providers, slowing down care delivery and reducing efficiency [28,29]. Additionally, the implementation of digital systems often requires substantial financial investments in both technology and training, placing a strain on already stretched healthcare budgets [30,31].

Moreover, digital transformation demands substantial organizational and cultural change [32,33]. The introduction of new technologies often necessitates a shift in organizational workflows, roles, and responsibilities, which can cause resistance from staff members who may feel overwhelmed by the disruption to their familiar practices [34, 35]. The acceptance of digital technologies by healthcare professionals is critical for the success of these initiatives [36]. Research has shown that user acceptance is often influenced by factors such as the perceived usefulness of the technology, its ease of use, and the extent to which staff members feel supported during the transition process [37,38]. Without proper training, leadership support, and a commitment to addressing concerns regarding technological adoption, healthcare organizations may struggle to realize the full potential of digital healthcare solutions [39,40].

In addition to staff acceptance, leadership and change management play pivotal roles in guiding the digital transformation journey [40,41]. Effective leadership is essential for setting a clear vision, securing the necessary resources, and fostering an organizational culture that embraces innovation and continuous improvement [42,43]. Change management strategies, such as those outlined in established models like Kotter's 8-Step Change Model, Lewin's Change Model, and the ADKAR framework, provide structured approaches to navigating the complexities of digital transformation [44,45]. By focusing on clear communication, stakeholder engagement, and iterative implementation, healthcare organizations can mitigate resistance and build momentum towards widespread adoption.

The impact of digital healthcare transformation goes beyond efficiency gains and cost reductions [46,47]. When properly implemented, digital technologies have the potential to improve patient care by providing clinicians with more accurate, timely, and comprehensive information about their patients' health [48,49]. For example, the use of AI and machine learning in predictive analytics can help identify at-risk patients, enabling early interventions that prevent hospitalizations and reduce adverse health outcomes [50,51]. Additionally, digital platforms facilitate better communication between healthcare providers, ensuring that patients receive consistent and coordinated care throughout their journey across different stages of treatment [52,53]. As a result, the integration of digital technologies into ICS has the potential to create a more patient-centred, efficient, and effective healthcare system.

However, the path to successful digital healthcare transformation is complex, requiring careful planning, strategic investment, and the alignment of multiple stakeholders within the healthcare ecosystem [54]. This review aims to explore the various facets of this transformation, examining best practices, the challenges faced by ICS, and the factors influencing the acceptance of digital tools by healthcare professionals. In doing so, the review will identify strategies for overcoming barriers to implementation, highlight key success factors, and propose actionable recommendations for enhancing the effectiveness of digital healthcare initiatives in integrated care settings. By synthesizing the current evidence and lessons learned from various healthcare settings, this paper provides valuable insights for policymakers, healthcare providers, and technology developers working to advance the digital transformation of healthcare systems.

The integration of digital technologies within Integrated Care Systems (ICS) holds significant promise for transforming healthcare delivery by improving efficiency, coordination, and patient outcomes [55, 56]. However, challenges such as interoperability between systems, financial constraints, resistance to organizational change, and insufficient staff training continue to hinder the successful implementation of these technologies [57,58]. Furthermore, healthcare professionals' acceptance of digital tools is often influenced by factors such as ease of use, perceived usefulness, and the support provided during the transition [59]. This narrative review is justified by the need to address the gaps in existing literature, offering a comprehensive examination of best practices, challenges, and factors that affect the adoption of digital healthcare within ICS. The aim of this review is to synthesize current evidence on the digital transformation of healthcare in ICS, with a particular focus on implementation strategies, barriers to success, and the factors influencing staff acceptance. The objectives are to evaluate best practices for digital healthcare implementation, analyse challenges, explore staff acceptance factors, assess the role of leadership and change management, and provide actionable recommendations for improving the effectiveness of digital healthcare initiatives in ICS.

2. Method

This narrative review employs an integrative approach, synthesizing diverse sources of evidence to explore the best practices, challenges, and outcomes associated with the digital transformation of healthcare within Integrated Care Systems (ICS). The integrative approach is appropriate for this review as it allows for the inclusion of both qualitative and quantitative studies, thus offering a comprehensive understanding of the multi-faceted nature of digital healthcare transformation. The review specifically focuses on examining the integration of digital technologies such as electronic health records (EHRs), telemedicine, and artificial intelligence (AI), alongside factors influencing their adoption, including organizational culture, leadership, and staff acceptance. The review also addresses key challenges in the implementation process, such as interoperability, financial constraints, and resistance to change, which may hinder the success of digital transformation efforts within ICS.

A systematic search strategy was developed to identify relevant

literature published between 2005 and 2025. A combination of databases, including PubMed, Scopus, Google Scholar, and the Cochrane Library, were used to locate peer-reviewed articles. Key search terms included "digital healthcare," "Integrated Care Systems," "digital transformation," "telemedicine adoption," "electronic health records," "AI in healthcare," and "staff acceptance of digital tools." Boolean operators (AND/OR) were applied to refine the search, ensuring a broad range of articles were included. In addition to peer-reviewed journal articles, grey literature, including government reports, white papers, and industry publications, were also reviewed to capture a broader perspective on the topic. Reference lists of selected studies were cross-checked to ensure that relevant literatures were not overlooked.

The inclusion and exclusion criteria were clearly defined to ensure the review focused on studies that were most pertinent to the objectives. Only studies examining the implementation of digital healthcare technologies within ICS or similar healthcare settings were included. Additionally, studies that provided empirical data on outcomes, challenges, or best practices related to digital transformation and staff acceptance were prioritized. Exclusion criteria involved studies that were not related to healthcare, those that focused on a single technology without considering its broader integration, and those without sufficient empirical evidence. Studies in languages other than English were excluded to maintain consistency in the synthesis process.

Data extraction was performed by reviewing the full text of selected articles, with key themes such as implementation strategies, challenges, staff acceptance, and organizational change being extracted. Thematic analysis was employed to categorize the findings, and studies were assessed for quality using tools like the Critical Appraisal Skills Programme (CASP) for qualitative research and the Cochrane risk of bias tool for quantitative studies. The data were then synthesized into key themes, providing a comprehensive understanding of the current landscape of digital transformation within ICS. Finally, the review identifies gaps in the existing literature and offers practical recommendations for overcoming barriers to successful digital healthcare adoption.

3. Digital transformation in healthcare

Digital transformation in healthcare encompasses the integration of advanced technologies into all facets of healthcare systems, aiming to enhance patient care, streamline operations, and improve clinical outcomes [47]. Digital tools empower patients to actively manage their health, leading to more personalized and efficient care. For instance, wearable devices enable continuous monitoring of vital signs, allowing for timely interventions and fostering a proactive approach to health management [60].

The automation and digitization of administrative and clinical tasks reduce costs and streamline processes [61]. Technologies like electronic health records (EHRs) facilitate seamless information exchange among healthcare providers, minimizing errors and enhancing workflow efficiency [62]. Also, Artificial intelligence (AI) and machine learning technologies offer real-time clinical insights, improving decision-making and patient outcomes [63]. AI algorithms can analyse vast amounts of medical data to identify patterns, aiding in early diagnosis and personalized treatment plans [64].

Furthermore, Electronic Health Records (EHRs) are fundamental in digitizing patient data, providing healthcare professionals with comprehensive and up-to-date patient information, thereby enhancing the quality of care [61,62]. Telemedicine facilitates remote consultations, reducing healthcare access barriers and enabling patients to receive care from the comfort of their homes. This technology has been particularly beneficial in managing chronic conditions and during public health emergencies [63,64]. Wearable technologies, such as smartwatches and fitness trackers, enable continuous monitoring and real-time data sharing, allowing for proactive health management and early detection of potential health issues [65,66]. Artificial Intelligence (AI) and Machine Learning assist in predictive analytics, diagnostics,

and treatment recommendations, enhancing the accuracy and efficiency of healthcare delivery. For example, AI algorithms can analyse medical imaging to detect anomalies, aiding in early diagnosis [67]. The ongoing digital transformation in healthcare is reshaping the landscape of medical practice, emphasizing the need for continuous adaptation and integration of emerging technologies to meet evolving patient needs and improve overall healthcare delivery. The integration of digital technologies into healthcare systems can be conceptualized as an interconnected ecosystem, where tools such as EHRs, telemedicine, wearable devices, and AI collectively enhance patient care and operational efficiency. The evolution of healthcare digitalization can be traced through several key technological milestones, illustrating how the sector has progressively embraced innovation to enhance care delivery and system efficiency (Fig. 1).

A schematic timeline depicting major milestones in the digitalization of healthcare, from the early adoption of Electronic Health Records (EHRs) in the 1990s, through the rise of mobile health apps and wearable devices in the 2010s, the acceleration of telemedicine during the COVID-19 pandemic, and the current integration of AI and predictive analytics.

4. Integrated care systems (ICS) and their role in healthcare transformation

Integrated Care Systems (ICS) represent a collaborative approach to healthcare delivery, aiming to provide coordinated, patient-centred care across various levels of the healthcare system [8–10]. By fostering collaboration among healthcare providers, social services, and community organizations, ICS strive to reduce fragmentation and enhance the quality of care [11]. The role of ICS in digital healthcare transformation is multifaceted, encompassing system integration, resource optimization, and improved patient outcomes [65].

4.1. System integration

ICS play a pivotal role in facilitating seamless information exchange across different care settings, thereby reducing fragmentation [66]. By implementing interoperable digital systems, ICS enable healthcare providers to access and share patient information efficiently, leading to more coordinated care [67]. For instance, the integration of electronic health records (EHRs) across multiple providers allows for real-time updates and comprehensive patient histories, enhancing clinical decision-making and patient safety [68]. However, achieving true interoperability remains a significant challenge, as many healthcare systems still operate on siloed platforms that hinder effective data sharing.

4.2. Resource optimization

Through better scheduling, coordination, and data analytics, ICS can maximize the use of available resources, including healthcare personnel. Digital tools enable the analysis of patient flow, staff availability, and resource utilization, leading to more efficient operations. For example, predictive analytics can forecast patient admission rates, allowing for
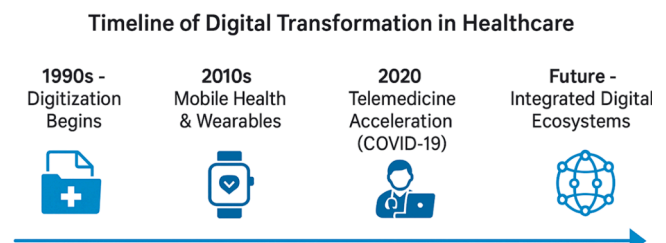
Timeline of Digital Transformation in Healthcare

Fig. 1. Timeline of digital transformation in healthcare.

proactive staffing adjustments and reducing bottlenecks in care delivery [69]. Despite these advantages, financial constraints pose a significant barrier to implementing such technologies, as substantial investments are required for both technology acquisition and staff training [70,71].

4.3. Patient outcomes

Improving continuity of care through better communication and shared decision-making is a core objective of ICS [72,73]. Digital platforms facilitate real-time communication among care teams, ensuring that all providers are informed of a patient's status and treatment plan [74,75]. This collaborative approach leads to more personalized care and better patient outcomes. However, the success of these initiatives depends on the acceptance and effective use of digital tools by healthcare professionals [76]. Resistance to change and inadequate training can impede the adoption of digital technologies, highlighting the need for comprehensive change management strategies [77,78].

4.4. Challenges in digital transformation within ICS

Despite the potential benefits, the digital transformation within ICS faces several challenges. Interoperability remains a significant hurdle, as ensuring that digital systems across various healthcare providers can communicate and share data effectively is often hindered by the lack of standardized protocols and diverse technological infrastructures, leading to inefficiencies and data silos [79,80]. Data privacy and security are also critical concerns, as protecting patient information in an increasingly connected digital environment is paramount. Breaches in data security can undermine patient trust and lead to legal and financial repercussions, making the implementation of robust cybersecurity measures and adherence to data protection regulations essential to mitigate these risks [81–83].

Additionally, financial constraints pose a major challenge, as implementing digital systems requires substantial investment in both technology and training. Many ICS operate under tight budgets, making it difficult to allocate funds for comprehensive digital transformation initiatives, necessitating efforts to secure funding and demonstrate the return on investment of digital technologies [84,85]. Addressing these challenges requires a strategic approach that includes stakeholder engagement, investment in infrastructure, and a commitment to continuous improvement [86,87]. By leveraging digital technologies effectively, ICS can enhance care coordination, optimize resource utilization, and ultimately improve patient outcomes.

The structure and impact of Integrated Care Systems (ICS) on healthcare transformation are illustrated in Fig. 2, highlighting the interconnected nature of system integration, resource optimization, and patient outcomes, as well as the challenges that need to be addressed for successful implementation. This flowchart illustrates the key components of ICS, including system integration, resource optimization, and patient outcomes, as well as the challenges faced in digital transformation within healthcare systems.

5. Best practices for digital healthcare transformation

Implementing digital transformation within Integrated Care Systems (ICS) requires a strategic approach to overcome inherent challenges and achieve desired outcomes. The following best practices have been identified to guide this process:

5.1. Leadership and vision

Strong leadership is essential in setting a clear vision for digital transformation, aligning all stakeholders, and securing necessary resources [88,89]. Leaders must articulate a compelling vision that emphasizes the benefits of digital technologies in enhancing patient care and operational efficiency. For example, the NHSX initiative in the UK
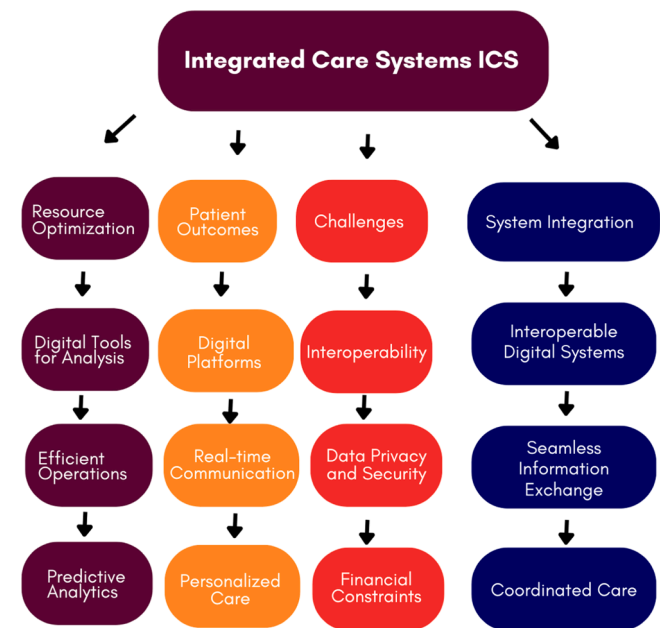

Fig. 2. Integrated Care Systems (ICS) and their role in healthcare transformation.

exemplifies a strategic approach to digitizing services, connecting systems, and transforming care delivery across the NHS and social care sector [90].

5.2. Stakeholder engagement

Involving healthcare professionals, patients, and policymakers ensures that digital solutions meet their needs and are widely accepted [91, 92]. Engagement fosters a sense of ownership and encourages the adoption of new technologies. Recent findings highlight the importance of involving healthcare providers in the digital transformation process to ensure that technological solutions align with clinical workflows and improve patient outcomes [93,94].

5.3. Phased implementation

Gradual implementation of digital solutions, starting with pilot programs, can help identify issues early and allow for necessary adjustments [79]. This approach mitigates risks associated with large-scale rollouts and provides valuable insights into the practical challenges of digital integration. The Global Digital Exemplar (GDE) programme in the UK serves as an example, where selected NHS trusts received funding to implement digital projects, with the expectation of sharing knowledge gained during the implementation of IT systems [80].

5.4. Training and support

Ensuring that staff are adequately trained and supported in using digital tools increases their likelihood of successful adoption. Ongoing training programs and accessible support resources are vital to build confidence and competence among healthcare providers [81]. A comprehensive guide on digital transformation in healthcare highlights the necessity of training and support to facilitate the effective use of digital technologies [82].

5.5. User-centred design

Designing digital tools with input from end-users ensures that technologies are intuitive and meet their specific needs [83]. User-centred

design principles lead to higher satisfaction and better utilization of digital solutions [84,85]. The World Health Organization's SMART guidelines framework exemplifies this approach by translating traditional health guidelines into formats suitable for digital health systems, ensuring that the tools are adaptable and user-friendly [86,87].

By adhering to these best practices, ICS can navigate the complexities of digital transformation, leading to improved patient care, enhanced operational efficiency, and a more sustainable healthcare system. These best practices can be visualized as a stepwise roadmap for digital healthcare transformation, highlighting key strategies and real-world examples that facilitate successful implementation (Fig. 3).

6. Change systems and approaches in digital healthcare

Implementing digital transformation within Integrated Care Systems (ICS) necessitates a structured approach to change management [95]. Several models have been identified as crucial in guiding this transformation:

6.1. Kotter's 8-step change model

John Kotter's 8-Step Change Model emphasizes the need for creating urgency, building a guiding coalition, and consolidating gains for long-term change. This model is particularly relevant in healthcare settings, where establishing a sense of urgency can drive the adoption of digital technologies. For instance, a study on change management in hospitals highlighted the importance of creating a sense of urgency to overcome resistance and facilitate the adoption of digital innovations [96,97].

6.2. ADKAR model

The ADKAR Model focuses on individual change and the importance of awareness, desire, knowledge, ability, and reinforcement in the adoption process. In healthcare, this model can be applied to ensure that staff are not only aware of the digital changes but also motivated and equipped to implement them effectively. Best practices for change management in healthcare IT emphasize the need for clear communication and training to address each component of the ADKAR model [98, 99].

Fig. 3. Schematic roadmap of best practices for digital healthcare transformation in Integrated Care Systems (ICS). The figure illustrates five essential steps. Leadership & Vision, Stakeholder Engagement, Phased Implementation, Training & Support, and User-Centred Design. This roadmap emphasizes the sequential and interconnected nature of strategies that underpin effective digital transformation within ICS.

6.3. Lewin's change model

Kurt Lewin's Change Model involves unfreezing current practices, implementing the change, and refreezing the new practices to establish them as the norm. This approach is applicable in healthcare environments where existing workflows need to be adjusted to accommodate new digital tools. A comprehensive change management strategy in healthcare IT includes phases that align with Lewin's model, such as preparing for change, managing change, and reinforcing change [100, 101].

6.4. Systems theory

Systems Theory views the organization as a dynamic system, where changes in one area affect the entire system. This approach stresses the importance of alignment between different components of ICS during digital transformation [102,103]. In healthcare, adopting a systems perspective ensures that digital initiatives are integrated across various departments, leading to cohesive and efficient care delivery. A study on change management in healthcare IT highlights the need for a holistic approach that considers the interdependencies within healthcare organizations [104,105].

Beyond these conceptual models, technological drivers play an equally critical role in accelerating digital transformation within healthcare systems [106,107]. Machine learning algorithms serve as foundational technologies that enable predictive analytics, automated pattern recognition, and decision support systems, fundamentally transforming how clinical decisions are made and patient care is delivered [108,109]. The Internet of Things (IoT) ecosystem creates interconnected networks of medical devices, sensors, and monitoring equipment that enable real-time data collection and seamless information flow across care settings, facilitating continuous patient monitoring and timely interventions [110]. Digital twins technology creates virtual replicas of patients, medical devices, or entire healthcare systems, allowing for simulation-based planning, personalised treatment modelling, and predictive maintenance of medical equipment [111]. Cloud computing platforms provide the scalable infrastructure necessary for storing and processing vast amounts of healthcare data while enabling secure access and collaboration across distributed care teams [112]. Blockchain technology offers solutions for secure, immutable health records and enables trusted data sharing between organisations whilst maintaining patient privacy and data integrity [113]. These technological drivers work synergistically with change management models to create comprehensive transformation frameworks that address both human and technical aspects of digital healthcare implementation [114].

By applying these change management models alongside these technological drivers, healthcare organizations can navigate the complexities of digital transformation, leading to improved patient care and operational efficiency. The primary change management models and technological drivers guiding digital transformation in healthcare are outlined in Fig. 4, including Kotter's 8-Step Model, ADKAR Model, Lewin's Change Model, and Systems Theory.

7. Staff acceptance of digital technologies

The successful integration of digital technologies into healthcare systems hinges significantly on the acceptance and engagement of healthcare professionals. Understanding the factors that influence this acceptance is crucial for effective implementation and utilization of digital tools. Table 1 presents a comprehensive analysis of factors influencing staff acceptance of digital technologies in healthcare settings, categorising these factors by their level of influence and the corresponding implementation strategies that organisations can employ to enhance acceptance rates. By addressing these factors, healthcare organisations can enhance staff acceptance of digital technologies, leading
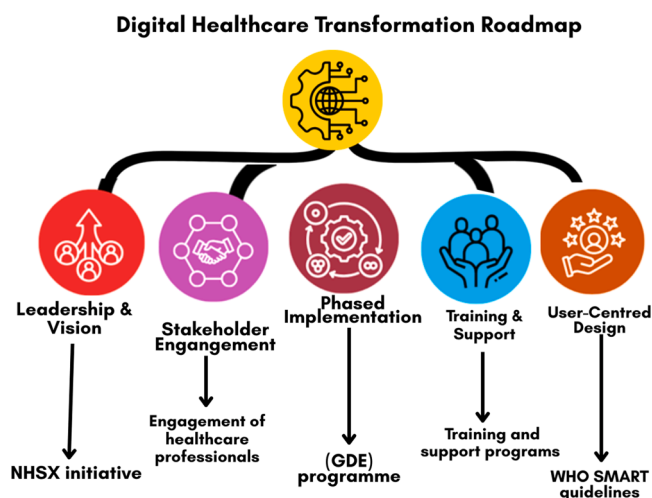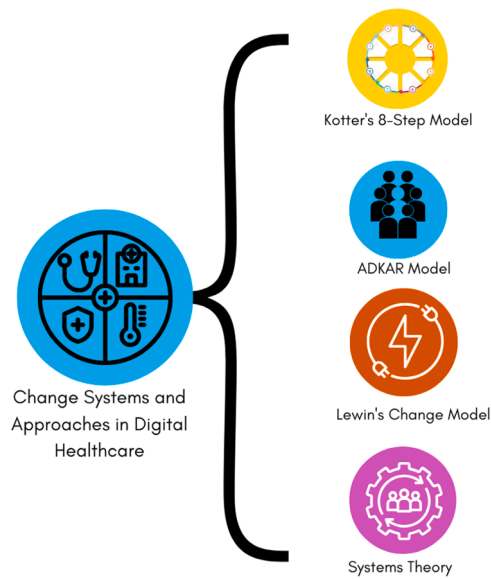
Fig. 4. Simplified change systems and approaches in digital healthcare. This flowchart highlights the key change management models used in digital transformation within Integrated Care Systems (ICS).

to improved patient care and operational efficiency.

7.1. Perceived ease of use

Healthcare professionals are more likely to embrace digital tools that are intuitive and seamlessly integrate into their existing workflows [118, 121]. Complex or cumbersome systems can lead to resistance and decreased utilization. Recent studies have emphasized that the compatibility of health information systems with existing processes is a critical factor influencing their adoption [120,122].

7.2. Perceived usefulness

Digital solutions that demonstrably enhance patient care or reduce workload are more readily accepted. For instance, tools that streamline administrative tasks or provide real-time clinical insights can improve efficiency and patient outcomes. Research indicates that performance expectancy, which reflects the perceived usefulness of technology, significantly impacts healthcare professionals' intention to use health information systems [123].

7.3. Organizational culture

A culture that promotes innovation, flexibility, and continuous learning facilitates the adoption of new technologies [124]. Organizations that encourage open communication and support experimentation are more likely to experience successful digital transformations. The

Technology Acceptance Model (TAM) suggests that organizational support and culture can influence healthcare professionals' attitudes toward new technologies [125].

7.4. Training and involvement

Ensuring that staff are adequately trained and involved in the decision-making process fosters a sense of ownership and readiness for change [126]. Comprehensive training programs and active involvement in the selection and implementation phases can mitigate resistance and enhance competence in using digital tools [127,128]. Findings from previous research on healthcare information technology acceptance highlights that facilitating conditions, including training and support, are significant determinants of technology adoption [129,130].

7.5. Leadership support

Support from leadership ensures that digital transformation is a strategic priority and that resources are allocated for successful implementation [131]. Leaders who champion digital initiatives and allocate necessary resources can inspire confidence and commitment among staff. Studies have shown that leadership support is a critical factor in the successful adoption of healthcare information technologies [132].

8. Challenges in digital healthcare transformation

While digital transformation in Integrated Care Systems (ICS) holds significant promise for enhancing healthcare delivery, several barriers impede its progress. Addressing these challenges is crucial for the successful integration of digital technologies into healthcare practices [133]. Table 2 provides a detailed breakdown of the primary challenges encountered during digital healthcare transformation, their impact levels on implementation success, and evidence-based mitigation strategies that organisations can employ to overcome these barriers. Addressing these challenges requires a comprehensive approach that includes stakeholder engagement, investment in infrastructure, and a commitment to continuous improvement. By overcoming these barriers, ICS can enhance care coordination, optimise resource utilisation, and ultimately improve patient outcomes.

8.1. Resistance to change

Healthcare professionals may resist digital tools if they perceive them as unnecessary or cumbersome [140]. This resistance can stem from concerns about increased workload, disruption of established routines, and scepticism regarding the efficacy of new technologies [115]. A study highlights those psychological barriers, including resistance to change, are significant obstacles to the adoption of digital health technologies by healthcare providers [141].

Table 1
Factors influencing staff acceptance of digital technologies and implementation strategies.

Factor Category	High Influence Factors	Medium Influence Factors	Low Influence Factors	Key Implementation Strategies
Individual Factors [115]	Perceived usefulness, Digital literacy, Previous technology experience	Age, Professional role, educational background	Gender, Years of experience	Personalised training programs, Mentorship systems, Competency assessments
Technological Factors [116,117]	System usability, Integration with workflows, Reliability	User interface design, Response time, Security features	Brand reputation, Cost visibility	User-centred design, Pilot testing, Continuous system optimisation
Organisational Factors [118]	Leadership support, Training availability, Change management approach	Organisational culture, Resource allocation, Communication quality	Organisation size, Geographic location	Strong leadership commitment, Comprehensive training, Clear communication strategies
Environmental Factors [119,120]	Regulatory requirements, Patient safety concerns, Peer influence	Professional standards, Industry trends, Competitive pressure	Economic conditions, Technology vendors	Compliance integration, Safety protocols, Professional development programs

Table 2
Challenges in digital healthcare transformation and mitigation strategies.

Challenge Category	Specific Challenges	Impact Level	Affected Stakeholders	Mitigation Strategies	Success Indicators
Technical Challenges [134,135]	Legacy system integration, Interoperability issues, Data security	High	IT departments, Clinical staff, Patients	Phased migration, API development, Cybersecurity frameworks	System integration rates, Data sharing metrics, Security incident reduction
Financial Challenges [136]	High implementation costs, Ongoing maintenance, ROI uncertainty	High	Healthcare executives, Finance departments, Policymakers	Business case development, Phased investment, Grant applications	Cost-benefit ratios, Budget adherence, Financial sustainability metrics
Human Resource Challenges [137]	Staff resistance, Training requirements, Digital skill gaps	Medium-High	Healthcare professionals, Training departments, HR	Change management programs, Comprehensive training, Skill development	Adoption rates, Training completion, Staff satisfaction scores
Regulatory Challenges [138]	Data privacy compliance, Clinical governance, Quality standards	Medium	Compliance officers, Clinical governance, Legal teams	Regulatory alignment, Policy development, Compliance monitoring	Audit results, Regulatory compliance rates, Quality metrics
Organizational Challenges [139]	Cultural resistance, Workflow disruption, Communication gaps	Medium	All staff levels, Management, Patients	Cultural change initiatives, Communication strategies, Stakeholder engagement	Culture assessment scores, Workflow efficiency, Communication effectiveness

8.2. Technological barriers

The integration of disparate systems limited technical infrastructure, and issues with data privacy can slow down progress [142]. Outdated legacy systems and isolated data hinder the seamless exchange of information, leading to inefficiencies and potential errors. For instance, the *National Programme for IT in the NHS* faced criticism for inadequate attention to data security and patient privacy, raising concerns about the safety of medical data [143].

8.3. Financial constraints

The high costs associated with acquiring, implementing, and maintaining digital systems can be a significant barrier, especially in resource-limited settings [144]. Investments in technology infrastructure, training, and ongoing support require substantial financial resources. A report by the *Health and Social Care Committee* notes that a shortage of skilled digital professionals in the NHS has been a barrier to digital transformation, as digital specialists often command higher wages or better conditions in the private sector [145].

8.4. Regulatory challenges

Navigating the complex regulatory landscape for data privacy and security is critical to the successful adoption of digital health solutions [146]. Stringent regulations are necessary to protect patient information but can also create barriers to the swift implementation of new technologies. A report by the *Innovation Ecosystem Programme* commissioned by NHS England highlights those regulatory challenges and disjointed policies are hindering health innovation in the UK, preventing NHS staff from accessing potentially life-changing advancements [147].

9. Outcomes of digital healthcare transformation

The successful integration of digital technologies into healthcare systems has the potential to significantly enhance patient care, operational efficiency, and patient engagement. Recent advancements and studies underscore the transformative impact of digital healthcare. The outcomes of digital healthcare transformation can be broadly categorized into improved patient outcomes, operational efficiency, and increased patient engagement (Fig. 5).

9.1. Improved patient outcomes

Digital transformation enables more accurate diagnoses, personalized treatments, and better coordination of care [47,148]. Artificial intelligence (AI) and machine learning algorithms analyse vast datasets to
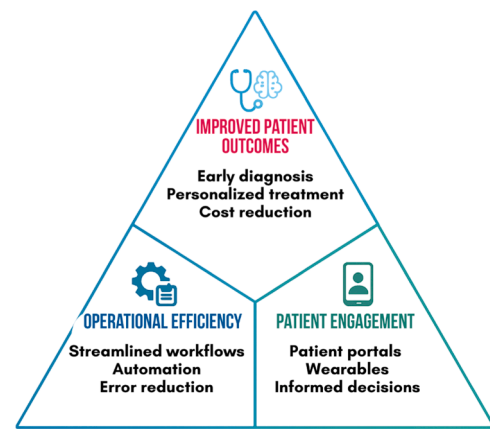
Fig. 5. *Key outcomes of digital healthcare transformation.* A schematic illustration highlighting three primary benefits of digital transformation in healthcare: improved patient outcomes through personalized and data-driven care, enhanced operational efficiency via automation and workflow optimization, and increased patient engagement supported by digital tools and platforms. Together, these components contribute to a more sustainable, patient-centred healthcare system.

identify patterns, facilitating early detection of diseases and tailored treatment plans. For instance, AI applications in healthcare are projected to result in net savings of up to $360 billion in healthcare spending, highlighting their potential to improve patient outcomes and reduce costs [149].

9.2. Operational efficiency

The adoption of digital tools streamlines administrative tasks, reduces medical errors, and optimizes resource allocation [47]. Automated systems handle routine processes, allowing healthcare professionals to focus more on patient care [150]. A comprehensive digital transformation in healthcare is enhancing the quality of treatment delivered, reducing costs, and improving patient outcomes [47].

9.3. Increased patient engagement

Digital platforms empower patients to take an active role in managing their health. Patient portals, wearable devices, and telemedicine services provide individuals with access to their health information, enabling informed decision-making and fostering a proactive approach to health management [13,151]. Technological innovation has become an integral aspect of daily life, contributing to a patient-centric culture

and offering patients a broader range of healthcare choices [152]. Overall, digital healthcare transformation leads to improved patient outcomes, enhanced operational efficiency, and increased patient engagement, collectively contributing to a more effective and sustainable healthcare system [153,154].

10. Conclusion and recommendations

Digital transformation within Integrated Care Systems (ICS) holds significant promise for enhancing the quality, accessibility, and efficiency of healthcare services. However, realizing these benefits necessitates overcoming challenges such as staff resistance, interoperability issues, and financial constraints. By implementing best practices in change management, actively involving staff in the transformation process, and fostering a culture of continuous learning, organizations can maximize the advantages of digital healthcare tools.

Recommendations:

I. **Encourage Collaboration and Knowledge Sharing Across Healthcare Providers to Improve System Integration**: Facilitating collaboration among healthcare providers is essential for effective system integration. Sharing knowledge and best practices can lead to more cohesive and interoperable digital solutions. A study published in *Frontiers in Health Services* emphasizes that collaboration among healthcare professionals is a key facilitator in adopting digital health technologies [155].

II. **Prioritize Staff Training and Ensure Leadership Support to Foster Acceptance of Digital Tools:** Investing in comprehensive training programs and securing strong leadership support are critical for fostering staff acceptance of digital tools. Training enhances competence and confidence, while leadership support ensures that digital transformation is a strategic priority. Research indicates that training and leadership support are significant facilitators in the adoption of digital health technologies by healthcare professionals [156,157].

III. **Implement Digital Solutions in Phases to Allow for Necessary Adjustments and Improvements:** Adopting a phased implementation approach enables organizations to identify and address issues early in the process, allowing for necessary adjustments and improvements. This strategy can mitigate risks associated with large-scale rollouts and ensure a smoother transition. A report by the NHS Confederation highlights that phased implementation can help in managing the complexities of digital transformation in healthcare settings [158].

IV. **Address Financial and Regulatory Challenges Early in the Planning Process to Minimize Barriers to Implementation:** Proactively addressing financial and regulatory challenges during the planning phase can minimize barriers to implementation. Securing funding and navigating the regulatory landscape early on ensures that digital transformation initiatives are not hindered by unforeseen financial or compliance issues. A study published in *Nature Medicine* discusses how early identification and mitigation of barriers can facilitate the adoption of digital health technologies [159].

By adopting these recommendations, healthcare organizations can navigate the complexities of digital transformation, leading to improved patient care, enhanced operational efficiency, and a more sustainable healthcare system.

11. Future directions and limitations of the study

Digital transformation within Integrated Care Systems (ICS) is an evolving field with significant potential to enhance healthcare delivery. Future research and practice should focus on several key areas to address existing challenges and capitalize on emerging opportunities.

11.1. Future directions

I. **Advancement of Artificial Intelligence (AI) and Machine Learning (ML):** Integrating AI and ML into healthcare can lead to more accurate diagnostics, personalized treatment plans, and predictive analytics for patient outcomes. For instance, AI applications in healthcare are projected to result in net savings of up to $360 billion in healthcare spending, highlighting their potential to improve patient outcomes and reduce costs [160].

II. **Development and Integration of Large Language Models (LLMs) in Healthcare:** The emergence of Large Language Models represents a transformative opportunity for healthcare systems, offering unprecedented capabilities in clinical decision support, medical documentation, and patient communication [161]. LLMs can potentially revolutionise healthcare delivery by providing intelligent clinical documentation assistance, reducing administrative burden on healthcare professionals whilst improving accuracy and completeness of medical records [162]. These models can serve as sophisticated clinical decision support tools, offering evidence-based recommendations and assisting in differential diagnosis by processing vast amounts of medical literature and patient data [163]. Furthermore, LLMs can enhance patient communication through intelligent chatbots and virtual health assistants that provide personalised health information, medication reminders, and preliminary symptom assessment [164]. Future research should focus on developing healthcare-specific LLMs that are trained on medical literature and clinical data whilst ensuring patient privacy and safety. Key research priorities include establishing robust validation frameworks for LLM-generated clinical recommendations, developing standardised evaluation metrics for healthcare LLM applications, investigating the integration of LLMs with existing electronic health record systems, and addressing ethical considerations including bias mitigation, transparency, and accountability in AI-driven healthcare decisions. Additionally, research is needed to understand the impact of LLMs on healthcare workforce dynamics, training requirements for healthcare professionals to effectively utilise these tools, and the development of regulatory frameworks that ensure safe and effective deployment of LLM technology in clinical settings.

III. **Expansion of Telemedicine and Remote Monitoring:** The COVID-19 pandemic accelerated the adoption of telemedicine. Future efforts should focus on expanding these services, particularly in rural and underserved areas, to improve access to care. A systematic review on digital health technology integration in primary healthcare services for rural populations emphasizes the importance of telemedicine in enhancing healthcare access [165].

IV. **Enhancement of Data Interoperability:** Developing standardized protocols and platforms that allow seamless data exchange between different healthcare systems is crucial. This will enable comprehensive patient records and improve care coordination. The *National Programme for IT in the NHS* faced criticism for inadequate attention to data security and patient privacy, underscoring the need for robust data management frameworks [166].

V. **Integration of Wearable Technologies:** Encouraging the use of wearable devices can empower patients to monitor their health proactively [167]. However, challenges such as data security, device interoperability, and patient engagement need to be addressed [168]. Emerging wearable technologies, including smartwatches and fitness trackers, have the potential to revolutionize how patients monitor their health outside of medical settings [169,170].

12. Limitations of the review

I. **Rapid Technological Advancements:** The fast-paced evolution of digital technologies can outdate research findings quickly, making it challenging to provide long-term recommendations. For example, the integration of AI and ML in healthcare is advancing rapidly, and studies may not capture the latest developments.

II. **Variability in Healthcare Settings:** Differences in healthcare infrastructure, resources, and cultural contexts can affect the applicability of findings across various settings. A study on the integration of eHealth technologies in public hospitals in South Africa highlights challenges such as fragmentation and lack of standardization, which may not be generalizable to other regions.

III. **Limited Longitudinal Data:** There is a scarcity of long-term studies assessing the sustained impact of digital transformation on patient outcomes and system efficiency. The *National Programme for IT in the NHS* was criticized for failing to deliver clinical benefits, indicating the need for more comprehensive evaluations.

IV. **Potential Bias in Published Studies:** Many studies may have publication bias, favouring positive outcomes over negative or inconclusive results, which can skew the understanding of digital transformation's effectiveness.

Addressing these future directions and limitations is essential for advancing digital healthcare transformation and ensuring its successful integration into ICS.

CRediT authorship contribution statement

Titus Oloruntoba Ebo: Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation, Conceptualization. **Aanuoluwapo Clement David-Olawade:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation. **Dolapo Mary Ebo:** Writing – review & editing, Writing – original draft, Methodology, Investigation. **Eghosasere Egbon:** Writing – review & editing, Writing – original draft, Visualization, Investigation. **David B. Olawade:** Writing – original draft, Writing – review & editing, Methodology, Investigation, Project administration, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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