SvedbergOpen
DISSEMINATION OF KNOWLEDGE
International Journal of Artificial Intelligence and Machine Learning
Publisher's Home Page: https://www.svedbergopen.com/
Research Paper Open Access

UPMC's MyUPMC and Digital Patient Portal: Digital Transformation, Architecture, and Institutional Impact in Healthcare

Rajesh Kumar Balusu[1*]

[1*]AGAP Technologies Inc., USA

Abstract

The healthcare industry is experiencing a major revolution due to digitization. In this piece, we will examine how digital healthcare and translational sciences can be combined to solve issues such as fragmented EHRs, inefficient administrative processes, and lack of accessibility to medical services. The development of centralized platforms, using interoperable standards with cloud-based and microservices architecture, guarantees seamless data flow and regulatory compliance. The process of workflow automation, predictive analytics, and mobile-first design ensures reduced operational costs and enables patients to engage in health care management. Software transformation is among the reasons for all this. Currently, there exist telemedicine software, appointment scheduling software, revenue cycle management software, decision-support software, and analytic software in a single piece of software. The move from multiple documents to applications makes integration easy, more effective, and secure. The reasons for software transformation are many; among them include patient-centricity, efficiency, accessibility, decision-making, and regulatory compliance. The outcome of such programs could also go beyond purely technological improvements. Greater patient involvement, optimized processes, and preventive medicine offer illustrations of how digital technologies play a role in the field of medicine. Technological developments result in improved cooperation, decreased burdens, and greater dependability for organizations. Feedback from users highlights the practical nature of using software applications. Patient portals are among the most advanced digital technologies used to engage patients in their care process. In summary, digital transformation is not only a technical

Keywords: Digital Health, Healthcare Innovation, Interoperability, Patient Engagement, Software Transformation.

Introduction

There have been many changes made to innovation in healthcare that impact the lives and welfare of patients. Efforts have been made to ensure that healthcare is more efficient, cost-effective, and customized, with digital health solutions forming a core part of such processes. The application of translational sciences along with digital technology has led to product innovations as well as investments in biotechnology in order to make sure that the focus on transformative healthcare is achieved. The importance of collaboration is highlighted through peer-to-peer recognition, which reached new heights last year, emphasizing the significance of collaboration in the process of innovation. Nowadays, digital health technology such as patient portals can be defined as systems that facilitate patient-centered care and improve the interaction between patients and physicians as well as increase transparency within the entire process of healthcare services. Mobile-first solutions allow for empowering patients to become active participants in managing their healthcare issues while supporting health professionals in providing timely and efficient care [1].

A significant problem facing the healthcare delivery system is the issue of fragmented electronic medical records. Often, more than one system is present in the same network, resulting in duplicated patient history and inefficient data access. Centralized on HL7 and FHIR platforms, these solutions facilitate secure data access and sharing between clinical, laboratory, and billing systems. Thus, the integration not only increases efficiency but also allows for making informed clinical decisions. Finally, using distributed ledger technology helps to ensure secure tamper-proof data management [14].

Scalability and high availability become key for systems that have to be operational 24/7. Modern cloud-based infrastructure allows millions of simultaneous users with the help of load-balancing and redundant databases [5]. Automation and failover solutions allow minimal downtime, whereas IoT-based hospitals' infrastructure allows merging clinical information systems with monitoring equipment [13]. These architectural basics allow achieving reliability and flexibility for platforms to withstand increasing loads. Ensuring security and meeting regulatory requirements becomes crucial for digital healthcare systems. Using such approaches as end-to-end encryption, multi-factor authentication, and role-based access control provides reliable protection for sensitive patient information [5]. Log tracking and monitoring contribute to HIPAA compliance as well as usage of distributed ledger technologies (blockchain) for record management [14]. The role of automation here includes reducing cognitive and administrative overload among healthcare workers. For instance, appointment reminders, prescription refills, and lab notifications, among others, help ease up workflows. At the same time, predictive analytics will help to uncover gaps and take corrective action proactively [4]. Continuous integration pipeline and self-healing capabilities help keep things reliable without compromising access during any updates or maintenance [7].

Digital patient engagement constitutes another important outcome of such digital transformations. With mobile-first design, digital patient portals can be used seamlessly from any device, and dashboards can provide relevant insights. In terms of entrepreneurial activities within the digital health space, one can single out innovation in telemedicine and predictive analytics as key drivers of sustainability [10]. Users provide feedback on convenience, openness, and usability time and again. The availability of real-time test results, secure communication channels, and telehealth services improve the patient experience, especially when the patients require many clinical encounters [9]. A mobile-first user interface increases engagement, and automation lowers administrative burdens. Moving forward, initiatives will be directed toward the use of telehealth for marginalized communities, improved AI-based predictive models, and increased inclusiveness of technology.

Table 1. Digital Health Challenges and Solutions [1, 2, 14]

Challenge	Description	Digital Solution
Fragmented Records	Multiple systems create duplication and inefficiency	Unified EHRs with HL7/FHIR protocols for secure, real-time data exchange
Administrative Burden	Staff overwhelmed with manual tasks	Automation of reminders, refills, and notifications to streamline workflows
Security Concerns	Sensitive patient data vulnerable to breaches	End-to-end encryption, MFA, RBAC, and blockchain-based record management
Limited Patient Engagement	Patients passive in care decisions	Mobile-first portals with dashboards and secure messaging for active participation

Digital Design and Solutions

Healthcare delivery increasingly depends on digital platforms that unify records, streamline workflows, and enhance patient engagement. Between 2017 and 2019, a major transformation was achieved by consolidating multiple electronic health record (EHR) systems into a single unified instance. This transition reduced fragmentation, improved interoperability, and strengthened the digital patient portal that serves as the primary entry point for patient interaction [2]. Switching from nine different EHR systems to one common system provided a platform for smooth integration of data and improved usability. The portal was developed with the aim of providing anytime access to care such as online consultations and booking, which was done keeping in mind the user who is mobile-first [8]. Scrum, Agile, and Kanban were some of the development methodologies used to make sure that the feedback provided by the users led to improvement [7]. Hardware and software upgrades at an enterprise level in 2016 to 2018 allowed for the system to become operational for millions of patients [5]

.

Day-to-day activities showcase the magnitude of this evolution. An average of 43 million ADT transactions are executed daily to link patients' records in an effort to ensure the continuity of care in different clinical settings [13]. This degree of interoperability proves that the portal architecture is robust enough to support organizational needs. The introduction of digital programs has increased accessibility, where 93% of patients admitted for maternity services are now digitally involved [9]. The portal design has been implemented with cloud support and microservices, ensuring availability, redundancy, scalability, and enterprise-class security [5]. IAM, MFA, and RBAC ensure that HIPAA, HITECH, and regional data privacy regulations are fully complied with [14]. The security and confidentiality of data are provided by using end-to-end encryption, token authentication, and the API gateway architecture, thus fostering trust in the digital healthcare systems [1].

The use of interoperability tools such as HL7 and FHIR APIs facilitates the transfer of information in real time and makes it easy for patients and health care providers to communicate [2]. Messaging protocols play a key role in ensuring that patient-provider communication is seamless and clear. Cloud-based architecture makes the system scalable and easy to operate in all circumstances [5]. Machine-learning algorithms and predictive models are included in the platform to encourage prevention and compliance with drug therapy. Personalized patient recommendations are made through data-based personalization, while predictions of any potential negative outcomes will be provided to prevent them [1]. Cross-platform compatibility will ensure that the patient can reach out no matter if he or she uses a smartphone, tablet, or computer [8].

Technology & Solutions Architecture

Integration & Interoperability

Consolidation of data from several clinical systems such as EHR, laboratory information system, and billing system ensures that all data are consolidated and accessed in real time [2]. Use of APIs and HL7/FHIR protocols makes it easy to share information securely, thus avoiding duplication and inaccuracies.

Scalability & High Availability

Use of cloud architecture allows for millions of users to use the platform simultaneously due to load balancing, redundant databases, and failover capabilities, which ensure high availability [5].

Security & Compliance

Patient data is encrypted end-to-end, making it difficult for unauthorized persons to access patient data [14]. Additionally, there are multi-factor and identity-based security measures to prevent breaches. This helps in building trust between patient and provider [1].

Automation & Smart Operations

Appointment reminders, prescriptions, and laboratory test reminders can be automated. The use of predictive analytics helps uncover any gaps in patient care, allowing for proactive measures to be taken to increase patient well-being. Automating processes decreases the amount of paperwork, making the process more efficient and improving patient satisfaction [7].

Outcomes of Digital Design

With the help of digital design, the impact of technology becomes apparent. First, increased patient involvement can be traced by improved use of online tools and greater adherence to treatment plans [8]. Second, operational efficiency is gained through decreasing administrative burden and increasing speed in scheduling and executing clinical tasks [7]. Third, data-driven care becomes possible because of access to real-time health data, allowing for evidence-based decision-making [1]. In the end, sustainability and resilience can be achieved owing to the lesser amount of energy being used, low costs incurred from operations, and low downtimes resulting from the use of cloud and automation technologies [5]. This shows the importance of using digital design for the sake of delivering patient-centered care.

Table 2. Technology & Solutions Architecture [5, 7, 13]

Component	Key Features	Impact on Healthcare Delivery
Integration	APIs and HL7/FHIR protocols unify clinical, lab, and billing systems	Eliminates duplication, improves accuracy, supports informed decision-making
Scalability	Cloud-native, load-balanced servers, redundant databases	Supports millions of users, ensures resilience and high availability
Security	Encryption, IAM, MFA, RBAC, audit logging	Builds trust, ensures compliance with HIPAA/HITECH
Automation	Predictive analytics, appointment reminders, lab notifications	Reduces workload, improves patient adherence, enhances proactive interventions

Software Transformation

Modern healthcare organizations are turning towards more complex and sophisticated software environments, which incorporate various services, including telehealth services, appointment scheduling engines, RCM software, CDS technology, and analytics systems. All these elements are part of one integrated environment that can be used to ensure the proper functioning of all processes in the healthcare industry related to both patient engagement and operational effectiveness [1]. Real-time telemetry, analytics, and incident identification capabilities can be achieved with the help of logging and monitoring solutions [5].

The application of CI/CD pipelines, automated testing, IaC, and containerization helps organizations innovate continuously without compromising stability and compliance [7]. The shift from the Cerner to Epic inpatient management software is one major achievement that demonstrates the realization of such a change. With the implementation of Epic, this figure will fall by at least fifty percent, resulting in reduced operating expenses, less employee exhaustion, and increased cybersecurity [13]. The collection of patient data into one location improves data accessibility, thus facilitating rapid releases whenever requested. Prior issues associated with accessing multiple systems have been a problem in the past; this solution resolves such problems [14].

Key Drivers of Software Transformation

Patient-Centric Care

One of the key factors driving the evolution of software is the trend toward patient-centric care. Through integration of records into one common interface, patients get easy access to appointments, medication, and virtual consultation [8]. With a mobile-first philosophy, users will be able to interact with healthcare service providers from any device they own, promoting accessibility and usability. Custom dashboards help users analyze vital health data, thus ensuring patient compliance with treatment procedures [9]. Effective messaging provides an opportunity to communicate with providers directly, ensuring timely delivery of care.

Operational Efficiency

Efficiency is ensured through automation of processes, which involves reducing unnecessary human involvement and eliminating inefficiencies among healthcare professionals [4]. The use of scheduling engines makes it easier to handle appointments; similarly, the automation of bills and integration with health insurance companies makes work less hectic for healthcare professionals. By bringing all processes together on one platform, duplication is avoided, and more time is left for performing more important clinical procedures. The decline in the number of messages about admissions, discharges, and transfers, from 27 million per day to less than half, shows how this is possible [13].

High Availability & Reliability

Reliability is crucial for health care, as systems need to be available all the time. Thanks to contemporary software architectures, availability is guaranteed at the level of 99.99%, thanks to such measures as having multiple server capacities, failover, and monitoring [5]. Containerization, along with the usage of microservices architecture, provides for updatability with no disruption for the patients [7]. Self-healing systems can restore functionality after detecting faults automatically. Reliability does not only provide for effective health care system operation but also contributes to patient trust building.

Data-Driven Decision Making

The ability to leverage real-time analytics and prediction is integrated into the platform for clinical decision-making and supporting healthcare provision [1]. Information from electronic health records, lab reports, and wearable health technology devices is aggregated into dashboard solutions, helping doctors make decisions based on data-driven evidence. Predictive models for identifying future adverse events enable prompt action to guarantee better patient results. Clinical decision support systems assist healthcare professionals in preventing mistakes by providing evidence-based decision support [11]. This model makes the health care delivery process proactive rather than reactive, ensuring that prevention takes precedence in health care delivery.

Compliance & Security

Compliance and security are always a vital part of software changeover processes. HIPAA compliance, secure data handling, and effective access control methods form an important part of any modern-day design [14]. Encryption protects data in the resting phase as well as in transit, while MFA makes the identification process more robust. Role-based access ensures that only authorized individuals are allowed access to sensitive data. Access auditing capabilities enable the creation of transparency related to access activities. This will ensure that higher adoption rates are maintained in the digital space.

Table 3. Key Drivers of Software Transformation [1,4,5,7]

Driver	Description	Contribution to Transformation
Patient-Centric Care	Unified access to appointments, records, and consultations	Empowers patients, improves satisfaction, and improves adherence
Operational Efficiency	Automation of workflows, integration with billing and insurance	Reduces duplication, lowers costs, minimizes burnout
High Availability	99.99% uptime, failover, containerization, self-healing systems	Ensures continuity of care, builds patient trust
Data-Driven Decisions	Real-time analytics, predictive models, CDS tools	Enables proactive care, improves clinical accuracy
Compliance & Security	HIPAA compliance, encryption, MFA, role-based access	Safeguards privacy, ensures regulatory adherence

Software Transformation Components

Cloud-Enabled Architecture

Moving from the conventional on-premises architecture to a hybrid or cloud-based system improves scalability and disaster recovery [5]. Workloads within containers and microservices layers increase resilience and support for updating each layer individually. Elasticity in cloud computing guarantees that millions of users can be simultaneously served without any disruption [13].

Modern Application Design

The microservices approach allows modular maintenance and fast feature rollout. EHR compatibility, lab tests, billing, and insurance integration ensure compatibility with different medical software applications [2]. An API-first strategy ensures the security of data transfer, preventing duplicates and enhancing accuracy [14].

Automation & Smart Operations

Automation is implemented for appointment reminders, scheduling, and prescriptions, making the process more efficient in terms of communication [4]. Self-recovery is achieved using automation where any failure can be detected and recovered automatically with minimal downtime. CI/CD makes it possible to deploy updates easily without compromising the availability of patients and is continuously improving [7].

Enhanced User Experience (UX)

With its mobile-first approach, it is ensured that smartphones and websites are made accessible [8].

Data Analytics & AI Integration

Real-time predictive analytics ensure more accuracy to detect treatment gaps and risks, allowing for proactive measures. Clinical decision support systems improve clinical outcomes through evidence-based guidelines [11].

Benefits of Transformation Process

It should be noted that both the consolidation of EHRs and software upgrades lead to certain results. Patient involvement increases because of more usage of Internet services and care plan adherence [8]. The process of achieving greater efficiency takes place due to decreased administrative work, fast scheduling, and workflow optimization [4]. It is also possible to talk about data-based care delivery due to the availability of relevant health information at all times [1]. Sustainability and resilience become apparent thanks to the application of cloud infrastructure and automation technologies. They provide lower downtime rates, decreased expenses, and minimal ecological footprint [5]. The drop of ADT messages from 27 million to almost half shows how such consolidation contributes to greater efficiency and cybersecurity [13]. The benefits of transformation are associated with decreased operational costs and employee burnout, faster record access, and enhanced coordination [12]. Conclusions on this matter should be considered within a broader context, and that is why the significance of such transformations can be viewed outside their organization. Centralized patient records ensure access to timely information by all involved parties.

Business Growth and Results

User feedback focuses on ease of use, transparency, and usability. Immediate availability of test results, secure communication channels, and telemedicine have improved patient experiences, especially for those who require frequent clinical contact [9]. Mobile-first interfaces play a critical role in user retention, while automation simplifies clinical processes. In the future, more telemedicine offerings for marginalized communities, predictive analysis with the use of AI, and increased digital inclusion to minimize the digital divide will be essential [1]. Digital engagement can be observed for a wide range of patients. For instance, up to 93% of the maternity patients can currently be reached via digital communication channels, demonstrating that the portal enables the provision of highly personalized services [9]. Digital health education has additionally been integrated into the strategy; therefore, a rise of 60% in the number of patient engagements has been achieved [10]. Quantitative improvements in usage metrics demonstrate the operational benefits of digital transformation. Portal logins increased by 27%, patient-initiated secure messaging grew by 16%, mobile application downloads rose by 38% within a 90-day period, and call center volume decreased by 15% [7].

This leads to less paperwork and a more responsive environment. Decreasing the volume of calls received just from call centers can already produce great efficiency. Financial results further demonstrate why it is so crucial for the success of the company to pursue its digitalization. With annualized cost savings equal to $3.2 million, which were possible due to fewer administrative tasks, reduced costs associated with mailing, better attendance at appointments, lower numbers of patients who failed to arrive [12], and marketing that requires 42% fewer funds than before [11].

Furthermore, the trend in revenue generation from 2016 through 2019 can serve as additional proof of the influence of the digital transformation. Indeed, operating revenue increased from around $13 billion in 2016 to $15.6-$16 billion in 2017, almost $19 billion in 2018, and $20.6 billion in 2019 [12]. Thus, the overall increase is

more than 50% during the four years considered, with the rate of yearly growth being about 10% and up to 20%. The mentioned dynamics show that the digital platforms help to build an effective value-based model of health care delivery [10]. The combination of data on patient engagement and financial performance is an example of demonstrating the significance of the digital transformation in terms of increasing resilience in the sphere. First, secure and mobile-friendly interfaces lower administrative costs, streamline communication, and promote constant engagement with patients. In addition, evident financial benefits prove the ability to scale up such activities and make them sustainable [7].

Apart from financial benefits, other effects of digitization can be seen in patient satisfaction and improved quality of care. Improved communication using encrypted messages helps strengthen relations between patients and providers, whereas mobility allows for managing healthcare regardless of the location [8]. Patient contact through digital means is demonstrated by reaching 93% of maternity patients [9]. Education tools serve not only to engage patients but also provide information that enables them to make informed decisions [10].

This sustainability is enhanced by the relationship between operational efficiency and achieving patient-oriented outcomes. For instance, the decline in call centers and costs incurred on mailings shows how digitization has simplified administrative processes. On the other hand, the increase in logins and secure messaging depicts how there is an inclination towards utilizing digital channels [7]. Such efficiency results in saving costs, hence providing room for innovation [12]. In summary, the statistics collected between 2016 and 2019 clearly show that digitization is not only about technology. It is more about the shift that produces tangible benefits. Consistent revenue growth alongside reduced administration and increased interactions with patients indicates that digital platforms are an essential part of health care going forward [11].

Table 4. Business Growth and Operational Outcomes [7, 9, 11, 12]

Outcome	Description	Organizational Impact
Patient Engagement	Increased portal adoption, secure messaging, telehealth integration	Strengthens patient-provider relationships, improves satisfaction
Operational Efficiency	Reduced call center volume, streamlined scheduling, automated workflows	Lowers administrative costs, improves responsiveness
Financial Performance	Sustained revenue growth, cost savings from reduced overhead	Demonstrates scalability and sustainability of digital transformation
Clinical Communication	Enhanced messaging, real-time access to results	Improves coordination, reduces delays, supports evidence-based care

Feedback & Conclusion

Positive reactions have been registered for the digital patient portal, which has gained a lot of traction in terms of its use and clinical effectiveness. The users appreciate the ease and transparency offered by the portal, in particular its capabilities like test results availability in real time, messaging with the doctor, appointment booking online, and telemedicine [1]. The mobile-first approach and user-friendly interface made the platform very popular, especially among patients with chronic illnesses requiring frequent consultations [8]. According to users, the interface is easy to use, convenient for monitoring health data, and effective for communicating with medical professionals. The quick access to lab test results in multiple departments has increased patients' engagement, allowing people to take decisions regarding their health care [2]. Messaging services have been identified as one of the key factors facilitating patient engagement, especially when it comes to addressing after-hour questions or organizing follow-up appointments [9]. However, some people may find it difficult to use this product since learning the system and its navigation can be challenging for them, although patient satisfaction rates are very high [7]. Therefore, it is vital to address any problems regarding the usability of the application in order to make

it more widely used. The program will be constantly upgraded with the aim to simplify its usage, streamline the work process, and enhance accessibility [4].

Perspectives on Patient Portals from the Industry as a Whole support their importance. Survey results show that 82% of healthcare executives consider patient portals to be among the top three engagement tools [10]. Mobile apps in general and tools like Apple Health in particular rank much lower according to the survey results. Hence, patient portals are the most widely spread tool among healthcare institutions for patient engagement [11]. Not only that, but the advantages of using the portal can be seen not only through the usability aspect but also through other tangible benefits. The processes become automated, proactive, and highly available, which increases reliability and uptime, decreases complexity, and reduces management overheads [5]. These changes positively impacted patients' satisfaction and led to cost savings, proving the value of the portal in both the clinical and operational spheres [12].

Technologically, the portal represents contemporary software engineering due to its cloud-based architecture, microservices, automation, and built-in data analysis capabilities [13]. Such characteristics make it possible to offer smooth access to health care facilities to patients. On the other hand, security is a key issue that should be taken into account, with the end-to-end encryption of sensitive data, multi-factor authentication, and role-based access control systems [14]. Operational effects include the minimization of bureaucratic procedures and improvement of clinical processes. Appointment reminders, drug prescriptions, and laboratory notifications help automate routine operations, and predictive analytics assist in detecting health care gaps and addressing them before complications occur [4]. A high-availability approach guarantees almost zero downtime in operations and provides continuity of treatment, contributing to patient trust in information technology solutions [5].

Table 5. Feedback and Strategic Priorities [1, 8, 9, 14]

Feedback Theme	Patient Perspective	Strategic Priority
Usability	The portal is easy to navigate and convenient for tracking health metrics	Continuous UX improvements, accessibility compliance
Transparency	Real-time results and secure messaging valued	Expand secure communication channels and enhance patient trust
Engagement	High adoption among chronic care and maternity patients	Extend telehealth and predictive analytics for underserved populations
Challenges	Some users face navigation difficulties	Simplify workflows, reduce learning curve, improve inclusivity
Future Directions	Desire for proactive, personalized care	Invest in AI-driven insights, expand digital inclusivity, strengthen security

The business growth witnessed during the period of 2016-2019 further proves the strategic significance of the platform. In just four years, operating revenue grew from about $13 billion to $20.6 billion, showing an increase exceeding 50%. An increase in insurance membership and financial investment prove the contribution of the platform to developing a value-based model of health care [11, 12]. Social impacts are equally important. The portal promotes patient engagement, accessibility of health care services, and community health projects. Security and confidentiality considerations will make sure that the process of digitalization adheres to the ethical framework and regulations [14]. The example where 93% of the maternity patients were reachable via digital communication shows the effectiveness of a more focused approach [9]. Another issue to be improved includes constant enhancement of predictive analysis as a source of information for patient management [1]. Telemedicine should be provided to disadvantaged populations for equal opportunities [8]. More focus on accessibility can help solve the issue of user experience [7].

Overall, the portal can be regarded as a comprehensive enterprise-level digital solution for the provision of digital health care. With its help, clinical practice, effective operations, and business growth have been integrated through

cloud-based technology solutions, security standards, interoperability, and analytics to create a digital front door that brings both business benefits and better patient experience. The combination of all these factors, including technological, operational, business-related, and societally beneficial impacts, proves that digital transformation in health care is no longer just an opportunity to improve technology but an essential strategic shift [12].

References

1. Oluwatosin Ogundare, Tolu Owadokun, et al., "Integrated artificial intelligence in healthcare and the patient's experience of care," Scientific Reports, vol. 15, Article 21879, Jul. 2025. https://www.nature.com/articles/s41598-025-07581-7?utm_source=copilot.com
2. Zubia Rashid, et al., "Practices Supporting Electronic Health Record Transitions: Lessons from Four US Healthcare Systems," Journal of General Internal Medicine, vol. 38, pp. 1015–1022, Oct. 2023.
3. https://link.springer.com/article/10.1007/s00521-025-11081-0?utm_source=copilot.com
4. James Griffin, "Epic vs Cerner EMR Integration Comparison: Technical Architecture Guide for Healthcare CTOs," Invene, Aug. 15, 2025. https://www.invene.com/blog/cerner-emr-vs-epic?utm_source=copilot.com
5. Mus'ab Muhammad Kakale, "Of digital transformation in the healthcare (systematic review of the current state of the literature)," Health and Technology, vol. 14, pp. 35–50, Dec. 2023. https://link.springer.com/article/10.1007/s12553-023-00803-w?utm_source=copilot.com
6. Marian Ileana, Pavel Petrov, et al., "AI-Enabled Secure and Scalable Distributed Web Architecture for Medical Informatics," Applied Sciences, vol. 15, no. 19, Article 10710, Oct. 2025. https://www.mdpi.com/2076-3417/15/19/10710?utm_source=copilot.com
7. Gaganpreet Singh Hundal, Donna Rhodes, Chad Laux, "Digital Transformation of Healthcare Enterprises in the Era of Disruptions—A Structured Literature Review," Sustainability, vol. 17, no. 13, Article 5690, Jun. 2025. https://www.mdpi.com/2071-1050/17/13/5690?utm_source=copilot.com
8. Ghaliah H. Alfurayh, Abdullah T. Alanazi, and Hanin S. Aldalham, "Feasibility of Using Patient Portal to Enhance Patient Engagement and Patient-Generated Data in Tertiary Hospital," Healthcare, vol. 13, no. 5, Article 518, Feb. 2025. https://www.mdpi.com/2227-9032/13/5/518
9. Florian Wurster, et al., "Roger's diffusion of innovations theory and the adoption of a patient portal's digital anamnesis collection tool: study protocol for the MAiBest project," Implementation Science Communications, vol. 5, Article 74, Jul. 2024. https://link.springer.com/article/10.1186/s43058-024-00614-8
10. Sascha Noel Weimar, Rahel Sophie Martjan, Orestis Terzidis, "Conceptualizing the landscape of digital health entrepreneurship: a systematic review and research agenda," Management Review Quarterly, vol. 75, pp. 1619–1667, Apr. 2024. https://link.springer.com/article/10.1007/s11301-024-00417-0
11. Estelle Pfitzer, et al., "Success Factors of Growth-Stage Digital Health Companies: Systematic Literature Review," Journal of Medical Internet Research, vol. 26, Dec. 2024. https://www.jmir.org/2024/1/e60473
12. Subhajit Hazra, Kundan Singh Bora, "Capitalization of digital healthcare: The cornerstone of emerging medical practices," Intelligent Pharmacy, vol. 3, no. 5, pp. 309–322, Oct. 2025.
13. https://www.sciencedirect.com/science/article/pii/S2949866X24001229
14. Fatemeh Yadegari, Abbas Asosheh, "A unified IoT architectural model for smart hospitals: enhancing interoperability, security, and efficiency through clinical information systems (CIS)," Journal of Big Data, vol. 12, Article 149, Jun. 2025. https://link.springer.com/article/10.1186/s40537-025-01197-4
15. João Carlos Ferreira, et al., "Enhancing EHR Interoperability and Security through Distributed Ledger Technology: A Review," Healthcare, vol. 12, no. 19, Article 1967, Oct. 2024. https://www.mdpi.com/2227-9032/12/19/1967