UDC 004.8:614.2:005.6
DOI: https://doi.org/10.37734/2409-6873-2026-3-16

AI-DRIVEN INFORMATION SYSTEMS FOR RESOURCE MANAGEMENT IN HEALTHCARE ECOSYSTEMS UNDER CONDITIONS OF UNCERTAINTY

Ihor REKUNENKO
Doctor of Economics, Professor, Head of the Oleg Balatskyi Department of Management,
Sumy State University
ORCID: https://orcid.org/0000-0002-1558-629X

Yuliia MATVIEIEVA
PhD, Associate Professor,
Senior Lecturer at the Oleg Balatskyi Department of Management,
Education and Research Institute of Business, Economics and Management
Sumy State University
ORCID: https://orcid.org/0000-0002-3082-5551

Dmytro CHEREDNICHENKO
PhD student;
ORCID: https://orcid.org/0009-0006-7285-4402

Ye MAO
PhD student,
Sumy State University
ORCID: https://orcid.org/0009-0007-3979-1021

Annotation. *The rapid development of AI is transforming healthcare management, while the use of AI-driven information systems for resource management under uncertainty remains insufficiently systematized.* ***Purpose.*** *To identify and systematize AI-driven information systems for resource management in healthcare ecosystems, analyze international practices, and develop a conceptual model for adaptive resource management under uncertainty.* ***Methodology.*** *Bibliometric and comparative analyses, systematization, conceptual modeling, and international case studies were applied.* ***Results.*** *AI-driven information systems were classified by managed resources, AI technologies, and managerial functions. Their role in resource optimization, risk management, and decision support was determined. A conceptual model integrating predictive analytics, risk assessment, decision support, resource allocation, monitoring, and feedback was developed.* ***Practical implications.*** *The proposed model improves resource management and strengthens healthcare ecosystem resilience under uncertainty.*

Keywords: *artificial intelligence; AI-driven information systems; healthcare ecosystem; resource management; uncertainty; predictive analytics; decision support.*

General statement of the problem and its connection with the most important scientific or practical tasks. Modern healthcare systems operate under conditions of increasing uncertainty driven by pandemics, military conflicts, population ageing, shortages of healthcare personnel, disruptions in supply chains, financial constraints, and cybersecurity threats. These factors substantially complicate the planning, allocation, and utilization of healthcare resources, increasing the need for adaptive management systems capable of responding promptly to changes in the external environment. At the same time, healthcare organizations face a growing spectrum of risks associated with uneven workloads among medical staff, shortages of hospital beds, medical equipment, and pharmaceuticals, disruptions in logistics, fluctuations in demand for healthcare services, delays in diagnosis, the spread of infectious diseases, financial losses, and information security threats. Managing these risks requires intelligent tools capable of continuous monitoring, forecasting future developments, evaluating alternative scenarios, and supporting managerial decision-making in real time.

The traditional management model, which treats an individual healthcare institution as an autonomous organizational unit, is increasingly unable to ensure efficient resource utilization within a complex and rapidly changing environment. Consequently, both academic research and international practice have gradually shifted toward conceptualizing healthcare as a multi-level ecosystem that integrates hospitals, primary healthcare providers, laboratories, pharmacy networks, insurance organizations, research institutions, IT companies, public authorities, and patients into a unified network of collaboration, resource integration, and value co-creation.

Within such an ecosystem, resource management should be performed not only at the level of individual healthcare organizations but also across the entire network of interconnected stakeholders. Key resources include healthcare professionals, hospital bed capacity, medical equipment, pharmaceuticals, financial resources, healthcare data, knowledge, and telemedicine services. However, the integration of numerous stakeholders generates rapidly increasing volumes of data, expanding information flows, and growing managerial complexity, thereby limiting the effectiveness of traditional approaches to information analysis, risk forecasting, and resource coordination.

Under these circumstances, AI-driven information systems have become an essential component of healthcare ecosystems. These systems enable the integration of heterogeneous data sources, prediction of resource demand, managerial decision support, optimization of patient flows, forecasting of hospital capacity utilization, inventory management, digital monitoring of resource availability, and real-time coordination among ecosystem participants. Furthermore, artificial intelligence enables the early identification of workforce, resource, operational, financial, and cybersecurity risks, supports the simulation of alternative scenarios, and facilitates the development of adaptive managerial decisions based on the current state of the healthcare ecosystem. Therefore, artificial intelligence should be viewed not merely as an individual digital technology but as an enabling infrastructure that supports data integration, stakeholder coordination, adaptive resource management, and the resilience of healthcare ecosystems under conditions of uncertainty.

Despite the rapid advancement of research on digital healthcare transformation, telemedicine, and artificial intelligence, the integration of AI-driven information systems into resource management mechanisms at the level of the healthcare ecosystem remains insufficiently explored. Most existing studies focus on individual technological solutions, clinical AI applications, or the activities of single healthcare organizations. In contrast, the practical challenges facing modern healthcare systems require coordinated resource management across multiple ecosystem participants, comprehensive risk forecasting, and adaptive decision-making under conditions of high uncertainty.

Addressing this research gap is of considerable scientific and practical importance, as it may contribute to improving the efficiency of healthcare resource utilization, strengthening healthcare system resilience, advancing telemedicine, enhancing the digital integration of healthcare data, improving interorganizational collaboration, and supporting managerial decision-making at both regional and national levels. These challenges determine the relevance of the present study and its close connection with the priority tasks of developing a digital, adaptive, and resilient healthcare system.

Analysis of recent research and publications. Scientific interest in artificial intelligence (AI) in healthcare has increased substantially in recent years. To assess the scale and dynamics of this research and identify insufficiently explored areas, a bibliometric analysis of publications indexed in Scopus was conducted. The search using the query TITLE-ABS-KEY (“artificial intelligence” AND “healthcare”) identified more than 31,000 publications by 2025. Research activity remained relatively limited until 2018 but increased sharply thereafter, reaching 390 publications in 2019, 677 in 2020, 1,312 in 2021, 2,036 in 2022, 3,764 in 2023, 7,617 in 2024, and 15,430 in 2025. This rapid growth reflects the accelerating digital transformation of healthcare, further intensified by the COVID-19 pandemic and advances in machine learning, generative AI, telemedicine, and big data analytics.

The literature demonstrates several interconnected research directions. A substantial body of Ukrainian research examines the application of digital technologies, information systems, and AI to improve healthcare management and efficiency. Relevant contributions include the studies of Vysotskyi A.A., Surikov O.O., Vasyliuk-Zaitseva S.V. [1], Horkunenko A.B. [2], Shostakovych-Koretska L.R. [3], Volkov O.S. [4], Oleshko O.M. [5], Brodkevych V. and Liudvichenko V. [6], Khaitovych M.V. and Turchak D.V. [7], and Svintsitskyi A.V., Klymova V.V., and Sendetskyi S.S. [8]. Collectively, these studies demonstrate the growing role of digital and intelligent technologies in healthcare management, while also indicating the need for their further integration into broader management systems.

Another important research direction concerns the development of healthcare ecosystems and digital platforms. Viswanadham [9] proposed a digital healthcare ecosystem model integrating healthcare providers, government institutions, IT companies, and patients within a common digital environment. Constantinides [10] further developed the ecosystem perspective by emphasizing ecosystem orchestration, interorganizational collaboration, and resource coordination. These ideas are complemented by Torab-Miandoab et al. [11] and Koumpis et al. [12], who associate healthcare ecosystem development with open innovation, interoperability, AI, digital platforms, and the Quadruple Helix approach. Thus, contemporary ecosystem research increasingly emphasizes coordination among multiple actors and the integration of heterogeneous information and resources.

A parallel research stream focuses directly on AI applications in healthcare. Bajwa et al. [13] identify AI as an important driver of transformation in medical practice through clinical decision support, automation, and personalized medicine. Olawade et al. [14] highlight predictive analytics, automation of healthcare processes, and robotic technologies, while drawing attention to data integration, model interpretability, and information security. Akila et al. [15] similarly demonstrate the potential of AI to optimize clinical workflows, support decision-making, automate electronic health records, and improve resource management. The JAMA Summit report by Angus et al. [16] extends this perspective by considering AI as an element of healthcare infrastructure capable of supporting not only clinical applications but also organizational and managerial processes.

Recent Scopus-indexed studies further demonstrate the expansion of AI toward integrated and intelligent healthcare information environments. Joshi et al., with the participation of Tanwar S., examined Explainable AI (XAI) for dementia classification within the Healthcare 4.0 paradigm [20], while Gor et al., also involving Tanwar S., applied explainable machine learning to secure robotic telesurgery and protected communication in healthcare information systems [21]. Singh B. and Kaunert C. [22; 23] investigated the integration of Cloud Computing, the Internet of Medical Things (IoMT), and AI for early diagnosis, digital healthcare transformation, and intelligent healthcare data management. Bielick C.G., Celi L.A., et al. [24] emphasized the need to evaluate AI beyond individual algorithms, focusing on clinical validity, safety, transparency, and effectiveness in real-world healthcare settings.

Overall, the reviewed studies demonstrate considerable progress in AI applications, healthcare information systems, digital platforms, and ecosystem-based healthcare management. However, these research streams remain largely fragmented. Existing studies predominantly address clinical applications of AI, digital transformation, individual information technologies, or the organizational development of healthcare ecosystems. Comparatively less attention has been devoted to AI-driven information systems as an integrated mechanism for adaptive resource management at the healthcare ecosystem level, particularly under conditions of uncertainty. The coordination of heterogeneous resources, information flows, stakeholders, risk-related information, and managerial decisions within such an environment therefore remains insufficiently systematized. This gap substantiates the relevance of further research into AI-driven information systems for resource management in healthcare ecosystems under conditions of uncertainty.

Formation of the objectives of the article (task statement). The purpose of this study is to identify and systematize contemporary AI-driven information systems employed for resource management in healthcare ecosystems, to examine international implementation practices, and to develop a conceptual model for the application of artificial intelligence to support adaptive resource management under conditions of uncertainty.

Presentation of the main research material with full justification of the scientific results obtained. The rapid growth of scientific interest in the application of artificial intelligence in healthcare has been accompanied by an equally rapid expansion in the practical implementation of AI-driven information systems across leading healthcare organizations worldwide. According to Grand View Research, the global artificial intelligence market in healthcare, valued at approximately USD 36.7 billion in 2025, is projected to exceed USD 505 billion by 2033, with a compound annual growth rate (CAGR) of approximately 39% [25]. This growth is driven not only by advances in clinical AI applications but, more importantly, by the increasing scarcity of healthcare resources. According to the updated estimates of the World Health Organization (WHO), the global shortage of healthcare workers is expected to reach approximately 10 million by 2030 [26]. Combined with the growing prevalence of chronic diseases, population ageing, and limited hospital bed capacity and diagnostic infrastructure, these challenges have created a sustained demand for adaptive resource management solutions.

An analysis of the implementation of AI-driven information systems in leading healthcare organizations worldwide (Table 1) makes it possible to classify these systems according to two interrelated dimensions: 1) the type of healthcare resource managed by the system and 2) the type of artificial intelligence technology on which it is based.

The systematization of international experience in the application of AI-driven information systems demonstrates that modern artificial intelligence-based information systems have evolved beyond supporting individual clinical processes and are increasingly employed as strategic tools for resource management within healthcare ecosystems. The analysis of the examined cases enabled the classification of AI-driven information systems according to the type of managed resource and their primary managerial functions.

Based on the type of managed resource, four major categories of AI-driven information systems can be distinguished:

– hospital bed capacity and patient flow management systems (Mayo Clinic);

– healthcare workforce, operational process, and clinical documentation management systems (Cleveland Clinic);

– diagnostic resource management and clinical decision support systems (NHS England);

– population health, telemedicine, and healthcare accessibility management systems (Kaiser Permanente; Apollo Hospitals).

At the same time, the analysis demonstrates that the functionality of AI-driven information systems extends

Table 1

International Experience in the Application of AI-driven Information Systems for Resource Management in Healthcare Ecosystems under Conditions of Uncertainty

Health-care organization	AI technology	AI-driven information system	Managed resource(s)	Managerial function	Risks mitigated	Benefits for the healthcare ecosystem
Mayo Clinic, [27]	Predictive AI	Hospital Command Center	Hospital bed capacity, patient flow	Demand forecasting, resource allocation	Hospital overcrowding, bed shortages, delays in patient admission	Improved system capacity and adaptability
Cleveland Clinic, [28]	Generative AI	Virtual Command Center; AI Documentation Assistant	Healthcare workforce, operating rooms, clinical documentation	Coordination of clinical operations, managerial decision support	Staff overload, information delays, process fragmentation	Enhanced interdepartmental coordination and management efficiency
NHS England, [29]	AI Imaging	Radiology Information System	Diagnostic resources	Automated diagnostics, patient routing	Diagnostic delays, shortage of radiologists, patient backlogs	Reduced waiting times and more efficient utilization of diagnostic resources
Kaiser Perma-nente, [30]	Predictive Analytics	Population Health Platform	Patients, health data	Risk prediction, chronic disease management	Chronic disease complications, hospital readmissions, uneven workload distribution	Improved preventive care and population health management
Apollo Hospitals, [31]	AI + Tele-medicine	Telehealth Platform	Healthcare services, remote consultations	Remote healthcare delivery, coordination of consultations	Limited access to healthcare, workforce shortages, logistical constraints	Improved accessibility of healthcare services and stronger ecosystem integration

Source: Developed by the authors based on the analysis of sources [27–31]

far beyond resource optimization. Nearly all of the examined systems perform a set of interconnected managerial functions, including resource demand forecasting, decision support, monitoring of resource availability, coordination of interactions among healthcare ecosystem participants, automation of routine processes, and rapid response to changes in the external environment.

The classification of AI-driven information systems according to the underlying artificial intelligence technologies reveals a gradual evolution of AI applications in healthcare. Early solutions primarily relied on predictive analytics to forecast resource demand (Mayo Clinic, Kaiser Permanente), whereas contemporary systems increasingly incorporate generative artificial intelligence to automate clinical documentation and support managerial decision-making (Cleveland Clinic), computer vision technologies for medical image analysis (NHS England), and AI-enabled telemedicine platforms that facilitate the remote delivery of healthcare services (Apollo Hospitals). This trend is consistent with the findings of Bielick, Celi, and co-authors [24], who emphasize the need to move beyond the evaluation of individual AI algorithms toward comprehensive assessments of their effectiveness under real-world healthcare conditions.

Another important pattern emerging from the analysis deserves particular attention. Regardless of the specific AI technology employed, all of the examined information systems are designed not only to optimize resource utilization but also to reduce uncertainty and mitigate the risks associated with the operation of healthcare ecosystems. Specifically, predictive AI models are applied to forecast hospital bed occupancy and demand for healthcare services; generative AI is used to reduce the risks of clinical documentation errors and information overload among healthcare professionals; computer vision systems help minimize diagnostic risks; and AI-enabled telemedicine platforms address the risks associated with limited access to healthcare services. Consequently, AI-driven information systems are gradually evolving from tools for automating individual processes into integrated mechanisms for adaptive resource and risk management across the entire healthcare ecosystem.

Most of the reviewed solutions are designed to optimize specific types of resources or perform localized managerial functions, such as hospital bed management, workforce management, diagnostic support, and healthcare accessibility. However, none of the analyzed studies presents an integrated mechanism capable of providing comprehensive management of all resource categories, coordinating interactions among healthcare ecosystem participants, and simultaneously addressing risks and uncertainty.

The literature review further indicates that, despite the demonstrated managerial benefits, the practical implementation of AI-driven information systems is accompanied by several persistent challenges.

First, data interoperability remains a critical issue, requiring the integration of heterogeneous data sources – including electronic health records (EHRs), Internet of Medical Things (IoMT) devices, and administrative information systems – into a unified information environment. Olawade et al. identify data integration, model interpretability, and information security as key barriers limiting the large-scale implementation of AI solutions [14].

Second, the trust of clinicians and healthcare managers in AI-generated recommendations represents another major challenge, particularly in the context of generative AI-based decision support systems, such as those implemented at the Cleveland Clinic. Addressing this issue requires the adoption of transparent and explainable AI (XAI) mechanisms capable of providing understandable justifications for AI-generated recommendations [20; 21].

Third, there is a growing need for comprehensive evaluation of AI-driven solutions under real-world healthcare conditions, rather than assessing only the performance of individual algorithms during the validation stage. Bielick, Celi, and co-authors emphasize that AI systems should be evaluated in terms of their clinical validity, safety, practical effectiveness, and overall impact on healthcare delivery [24].

Finally, organizational and regulatory alignment remains an essential prerequisite for successful implementation. This includes the harmonization of technological, organizational, ethical, and regulatory mechanisms required to coordinate the activities of all participants within the healthcare ecosystem, as emphasized by Koumpis and co-authors [12].

The systematization of international experience also demonstrated that existing AI-driven information systems perform individual managerial functions, including data integration, forecasting, decision support, monitoring, and resource coordination; however, they predominantly operate as independent information solutions. In most cases, they lack a unified adaptive management cycle that integrates data aggregation, predictive analytics, risk assessment, managerial decision-making, implementation of decisions, performance monitoring, and continuous learning of the information system based on accumulated operational experience. This identified research gap provided the basis for developing the authors' conceptual model of adaptive resource management in healthcare ecosystems based on AI-driven information systems, presented in Fig. 1.

The proposed model implements a complete resource management cycle, which comprises the following interconnected stages:

1. Data Integration – consolidation of heterogeneous data sources (electronic health records (EHRs), Internet of Medical Things (IoMT) devices, healthcare registries, workforce data, and logistics systems)

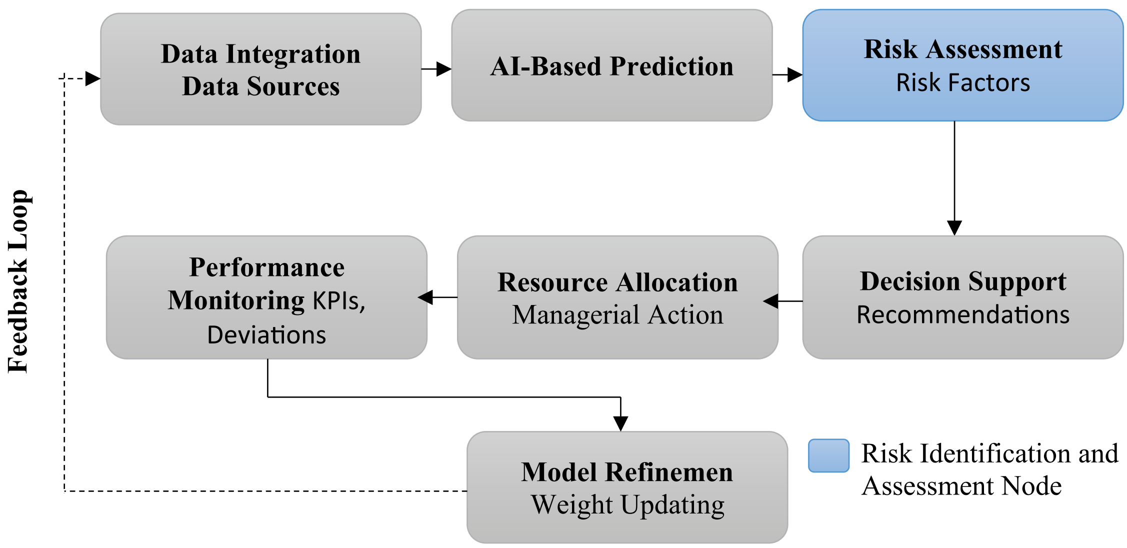

Figure 1. Conceptual model of adaptive resource management in healthcare ecosystems under uncertainty based on AI-driven information systems

Source: developed by the authors

into a unified healthcare ecosystem information space, thereby eliminating the fragmentation inherent in the traditional management model focused on individual healthcare institutions.

2. AI-Based Prediction – application of predictive analytics to forecast future resource demand, including patient flows, staff workload, and equipment requirements, following approaches implemented by the Mayo Clinic and Kaiser Permanente.

3. Risk Identification and Assessment – a dedicated module that directly addresses the problem formulated in the Introduction by enabling the timely identification of workforce, resource, operational, financial, and cybersecurity risks. This component distinguishes the proposed model from conventional predictive systems by transforming forecasts into quantified risks assessed according to their probability and potential impact on the resource capacity of the healthcare ecosystem.

4. Decision Support – generation of managerial recommendations based on the assessed risks (analogous to the Clinical Decision Support approach implemented at the Cleveland Clinic), while preserving the final decision-making authority of healthcare managers and clinicians rather than fully automating the decision process.

5. Resource Allocation – implementation of managerial decisions through the redistribution of healthcare personnel, hospital beds, medical equipment, and healthcare services among ecosystem participants.

6. Performance Monitoring – continuous monitoring of actual performance indicators (KPIs) following resource allocation and comparison of observed outcomes with predicted values.

7. Model Updating – adjustment of model weights and decision thresholds based on identified deviations, enabling continuous learning from operational experience and closing the adaptive feedback loop.

Unlike most existing AI-driven information systems, where predictive analytics represents the core functionality, the proposed conceptual model shifts the focus toward risk-oriented resource management. Risk assessment serves as the integrating mechanism linking predictive analytics with managerial decision-making, thereby ensuring the adaptive functioning of the healthcare ecosystem under conditions of uncertainty.

Current international practice primarily addresses localized managerial challenges; however, none of the analyzed cases integrates prediction, risk identification, decision support, resource allocation, and performance monitoring into a unified adaptive resource management framework for the healthcare ecosystem. Moreover, the persistent challenge of insufficient systematic risk assessment and management, consistently highlighted in the literature [14; 24], provides a strong rationale for introducing a dedicated risk-oriented module within the proposed conceptual model.

Conclusions from these problems and prospects for further research in this area. The findings confirm that the ongoing transformation of healthcare systems is accompanied by a rapidly increasing role of artificial intelligence and AI-driven information systems as instruments for resource management under conditions of uncertainty. A bibliometric analysis of Scopus-indexed publications revealed an exponential increase in scientific interest in this field after 2020, indicating its emergence as one of the fastest-growing interdisciplinary research domains. The review of contemporary studies and international practices demonstrated that AI-driven information systems are already employed for resource demand forecasting, patient flow management, workforce coordination, clinical decision support, documentation automation, population health management, and telemedicine services. However, the analysis also showed that most existing solutions remain focused on optimizing individual resources or isolated management processes, whereas integrated resource management mechanisms at the healthcare ecosystem level are still largely absent.

The scientific novelty of this study lies in the development of a conceptual model for adaptive resource management in healthcare ecosystems based on AI-driven information systems. The proposed model integrates data collection and consolidation, predictive analytics, risk assessment, decision support, resource allocation, performance monitoring, and continuous model improvement through a feedback mechanism. Unlike existing approaches, it conceptualizes artificial intelligence not merely as a digital technology but as an infrastructural mechanism for coordinating resources, information flows, and interactions among healthcare ecosystem stakeholders under uncertainty.

The practical significance of the study lies in the potential application of the proposed model as a conceptual framework for developing next-generation AI-driven information systems aimed at the integrated management of human, material, financial, informational, and medical resources across regional and national healthcare systems. Future research should focus on designing the architecture of an AI-driven information system for healthcare ecosystems, developing a system of performance evaluation indicators, constructing models for risk assessment and adaptive resource allocation, and validating the proposed conceptual model using real-world clinical and managerial data from healthcare organizations.

REFERENCES

1. Vysotskyi A. A., Surikov O. O. & Vasyliuk-Zaitseva S. V. (2023). Rozvytok shtuchnoho intelektu v suchasnii medytsyni [The development of artificial intelligence in modern medicine]. *Ukr. Med. Chasopys – Ukrainian Medical Journal,* No. 2(154). DOI: https://doi.org/10.32471/umj.1680-3051.154.241221 [in Ukrainian].

2. Horkunenko A. B. (2025). Shtuchnyi intelekt u medytsyni: masshtaby rynku ta napriamy rozvytku [Artificial intelligence in medicine: Market scale and development directions]. *Visnyk sotsialnoi hihiieny ta orhanizatsii okhorony zdorovia Ukrainy – Bulletin of Social Hygiene and Health Care Organization of Ukraine,* No. 1, pp. 35–41. DOI: https://doi.org/10.11603/1681-2786.2025.1.15340 [in Ukrainian].

3. Shostakovych-Koretska L. R. (2025). Application of artificial intelligence in clinical medicine, scientific research and education in the conditions of martial state. *Infectious Diseases – Infektsiyni Khvoroby,* No. 2, pp. 71–77. DOI: https://doi.org/10.11603/1681-2727.2025.2.15302

4. Volkov O. S. (2025). Shtuchnyi intelekt u medytsyni: perspektyvy diahnostyky ta likuvannia do 2035 roku [Artificial intelligence in medicine: Prospects for diagnosis and treatment up to 2035]. In: *Proceedings from ITSS '25: Informatsiini tekhnolohii v suchasnomu sviti – International Scientific and Practical Conference of Higher Education Students and Young Scientists "Information Technologies in the Modern World"*, April 29, 2025, p. 75. Kharkiv: DBTU. [in Ukrainian].

5. Hlushchenko V., Ivakhniuk T., Oleshko T., Berladir K., Smiyanov V. & Oleshko O. (2023). Modern approaches and possibilities of application of 3D modeling for tissue engineering and bone regeneration. Literature review. *East Ukr Med J,* Vol. 11, No. 4, pp. 337–351.

6. Brodkevych V. & Liudvichenko V. (2022). Shtuchnyi intelekt i mashynne navchannia v haluzi okhorony zdorovia: vyklyky i perspektyvy [Artificial intelligence and machine learning in healthcare: Challenges and prospects]. *Informatsiini tekhnolohii ta suspilstvo – Information Technologies and Society,* Vol. 2, No. 4, pp. 20–28. DOI: https://doi.org/10.32689/maup.it.2022.2.3 [in Ukrainian].

7. Khaitovych M. V. & Turchak D. V. (2025). Zastosuvannia shtuchnoho intelektu v klinichnii farmakolohii [The use of artificial intelligence in clinical pharmacology]. *Medychna nauka Ukrainy – Medical Science of Ukraine,* Vol. 21, No. 2, pp. 142–153. DOI: https://doi.org/10.32345/2664-4738.2.2025.15 [in Ukrainian].

8. Svintsitskyi A. V., Klymova V. V. & Sendetskyi S. S. (2024). Vykorystannia shtuchnoho intelektu v medytsyni, khirurhii, stomatolohii, onkolohii [The use of artificial intelligence in medicine, surgery, dentistry, and oncology]. *Klinichna onkolohiia – Clinical Oncology,* Vol. 14, No. 3(55), pp. 1–4. [in Ukrainian].

9. Viswanadham N. (2021). Ecosystem model for healthcare platform. *Sādhanā,* Vol. 46, Article 188. DOI: https://doi.org/10.1007/s12046-021-01708-y

10. Constantinides P. (2023). An ecosystem approach to digital transformation. In: *Digital Transformation in Healthcare.* London, UK: Routledge. DOI: https://doi.org/10.4324/9781032619569-6

11. Torab-Miandoab A., Samad-Soltani T. & Rezaei-Hachesu P. (2024). Open innovation in healthcare ecosystem: A systematic review. *Journal of Health Management,* Vol. 26, No. 4, pp. 632–653. DOI: https://doi.org/10.1177/09720634241276079

12. Koumpis A., Bamidis P. D., Costa E. & Konstantinidis E. (2025). Editorial: Ecosystems-centered health and care innovation. *Frontiers in Medicine,* Vol. 12, Article 1567993. DOI: https://doi.org/10.3389/fmed.2025.1567993

13. Bajwa J., Munir U., Nori A. & Williams B. (2021). Artificial intelligence in healthcare: Transforming the practice of medicine. *Future Healthcare Journal,* Vol. 8, No. 2, pp. e188–e194. DOI: https://doi.org/10.7861/fhj.2021-0095

14. European Commission. (2026). Artificial intelligence in healthcare. European Commission. Available at: https://health.ec.europa.eu/ehealth-digital-health-and-care/artificial-intelligence-healthcare_en (accessed: 20.07.2026).

15. Olawade D. B., David-Olawade A. C., Wada O. Z., Asaolu A. J., Adereni T. & Ling J. (2024). Artificial intelligence in healthcare delivery: Prospects and pitfalls. *Global Medicine,* Article 100108. DOI: 10.1016/j.glmedi.2024.100108.

16. Akila K., Gopinathan R., Arunkumar J. & Malar B. S. B. (2025). The role of artificial intelligence in modern healthcare: Advances, challenges, and future prospects. *European Journal of Clinical Medicine,* Vol. 25, No. 4. DOI: https://doi.org/10.61336/ejcm/25-04-94

17. Angus D. C., Khera R., Lieu T. et al. (2025). AI, health, and health care today and tomorrow: The JAMA Summit Report on Artificial Intelligence. *JAMA,* Vol. 334, No. 18, pp. 1650–1664. DOI: https://doi.org/10.1001/jama.2025.18490

18. Topol E. J. (2019). High-performance medicine: The convergence of human and artificial intelligence. *Nature Medicine,* Vol. 25, No. 1, pp. 44–56. DOI: https://doi.org/10.1038/s41591-018-0300-7

19. Jiang F., Jiang Y., Zhi H. et al. (2017). Artificial intelligence in healthcare: Past, present and future. *Stroke and Vascular Neurology,* Vol. 2, Article e000101. DOI: https://doi.org/10.1136/svn-2017-000101

20. Joshi P., Patel T., Vachhani A., Gupta R., Tanwar S. et al. (2025). Explainable AI-assisted dementia disease classification framework in Healthcare 4.0. In: *2025 IEEE International Conference for Women in Innovation, Technology & Entrepreneurship (ICWITE),* September 26–27, 2025. IEEE. DOI: https://doi.org/10.1109/ICWITE64848.2025.11306994

21. Gor J., Shah H., Patel J., Tanwar S. et al. (2025). Explainable ML-based secure communication framework for robotic telesurgery in healthcare. In: 2025 International Conference on Metaverse and Current Trends in Computing (ICMCTC), April 10–11, 2025. IEEE. DOI: https://doi.org/10.1109/ICMCTC62214.2025.11196540

22. Singh B. & Kaunert C. (2024). Cloud computing and IoMT in disease screening and diagnosis: AI approaches in transmuting healthier homes. In: *Revolutionizing Healthcare Systems Through Cloud Computing and IoT.* Cham: Springer, pp. 99–120.

23. Singh B. & Kaunert C. (2024). Accelerating healthcare outcomes uplifting patient experiences pairing artificial intelligence (AI): Transforming the healthcare industry in the digital arena. In: *Impact of Digital Solutions for Improved Healthcare Delivery.* Hershey, PA: IGI Global, pp. 121–145.

24. Bielick C. G., Awwad A., Ellen J., Pfohl S. R., Celi L. A. et al. (2026). Moving beyond the benchmarks: Five foundational principles for meaningful AI evaluation in healthcare. *PLOS Digital Health,* Vol. 5, No. 5, Article e0001115.

25. Grand View Research. (2026). Artificial intelligence in healthcare market size, share & trends analysis report. San Francisco, CA: Grand View Research. Available at: https://www.grandviewresearch.com/industry-analysis/artificial-intelligence-ai-healthcare-market

26. Boniol M., Kunjumen T., Nair T. S., Siyam A., Campbell J. & Diallo K. (2022). The global health workforce stock and distribution in 2020 and 2030: A threat to equity and 'universal' health coverage? *BMJ Global Health,* Vol. 7, No. 6, Article e009316. Available at: https://pmc.ncbi.nlm.nih.gov/articles/PMC9237893/

27. Varkey, P. (2026). Leading transformation in rural health: How Mayo Clinic Health System is redefining care, culture, and the use of AI. *NEJM Catalyst Innovations in Care Delivery.* Available at: https://catalyst.nejm.org/doi/full/10.1056/CAT.26.0258

28. Palantir Technologies Inc., & Cleveland Clinic. (2023). Cleveland Clinic and Palantir Technologies partner to improve hospital performance through Virtual Command Center [press release]. Denver, CO/Cleveland, OH: PR Newswire; January 19, 2023. Available at: https://prnewswire.com/news-releases/cleveland-clinic-and-palantir-technologies-partner-to-improve-hospital-performance-through-virtual-command-center-301725481.html

29. Department of Health and Social Care (UK). (2026). AI to speed up cancer diagnosis for millions of NHS patients [press release]. London: UK Government; June 11, 2026. Available at: https://wired-gov.net/wg/news.nsf/articles/ai+to+speed+up+cancer+diagnosis+for+millions+of+nhs+patients+11062026141500

30. Kaiser Permanente. (2018). Predictive analytics [fact sheet]. Oakland, CA: Kaiser Permanente. Available at: https://permanente.org/wp-content/uploads/2018/10/Fact-Sheet_Predictive-Analytics_2018.pdf

31. Apollo Hospitals. (2026). Digital transformation and AI for better care. Chennai, India: Apollo Hospitals. Available at: https://www.apollohospitals.com/digital-transformation-and-ai-better-care

СПИСОК ВИКОРИСТАНИХ ДЖЕРЕЛ

1. Висоцький А. А., Суріков О. О., Василюк-Зайцева С. В. Розвиток штучного інтелекту в сучасній медицині. *Український медичний часопис.* 2023. № 2(154). DOI: https://doi.org/10.32471/umj.1680-3051.154.241221

2. Горкуненко А. Б. Штучний інтелект у медицині: масштаби ринку та напрями розвитку. *Вісник соціальної гігієни та організації охорони здоров'я України.* 2025. № 1. С. 35–41. DOI: https://doi.org/10.11603/1681-2786.2025.1.15340

3. Шостакович-Корецька Л. Р. Застосування штучного інтелекту в клінічній медицині, наукових дослідженнях та освіті в умовах воєнного стану. *Інфекційні хвороби.* 2025. № 2. С. 71–77. DOI: https://doi.org/10.11603/1681-2727.2025.2.15302

4. Волков О. С. Штучний інтелект у медицині: перспективи діагностики та лікування до 2035 року. *Інформаційні технології в сучасному світі : матеріали міжнародної науково-практичної конференції здобувачів вищої освіти і молодих учених (ITSS '25).* Харків : ДБТУ, 2025. С. 75.

5. Hlushchenko V., Ivakhniuk T., Oleshko T., Berladir K., Smiyanov V., Oleshko O. Modern approaches and possibilities of application of 3D modeling for tissue engineering and bone regeneration. Literature review. *East Ukrainian Medical Journal.* 2023. Vol. 11, No. 4. P. 337–351.

6. Бродкевич В., Людиченко В. Штучний інтелект і машинне навчання в галузі охорони здоров'я: виклики і перспективи. *Інформаційні технології та суспільство.* 2022. № 2(4). С. 20–28. DOI: https://doi.org/10.32689/maup.it.2022.2.3

7. Хайтович М. В., Турчак Д. В. Застосування штучного інтелекту в клінічній фармакології. *Медична наука України.* 2025. Т. 21, № 2. С. 142–153. DOI: https://doi.org/10.32345/2664-4738.2.2025.15

8. Свінціцький А. В., Климова В. В., Сендецький С. С. Використання штучного інтелекту в медицині, хірургії, стоматології, онкології. *Клінічна онкологія.* 2024. Т. 14, № 3(55). С. 1–4.

9. Viswanadham N. Ecosystem model for healthcare platform. *Sādhanā.* 2021. Vol. 46. Article 188. DOI: https://doi.org/10.1007/s12046-021-01708-y

10. Constantinides P. An ecosystem approach to digital transformation. In: *Digital Transformation in Healthcare.* London : Routledge, 2023. DOI: https://doi.org/10.4324/9781032619569-6

11. Torab-Miandoab A., Samad-Soltani T., Rezaei-Hachesu P. Open Innovation in Healthcare Ecosystem: A Systematic Review. *Journal of Health Management.* 2024. Vol. 26, No. 4. P. 632–653. DOI: https://doi.org/10.1177/09720634241276079

12. Koumpis A., Bamidis P. D., Costa E., Konstantinidis E. Editorial: Ecosystems-centered health and care innovation. *Frontiers in Medicine.* 2025. Vol. 12. Article 1567993. DOI: https://doi.org/10.3389/fmed.2025.1567993

13. Bajwa J., Munir U., Nori A., Williams B. Artificial intelligence in healthcare: transforming the practice of medicine. *Future Healthcare Journal.* 2021. Vol. 8, No. 2. P. e188–e194. DOI: https://doi.org/10.7861/fhj.2021-0095.

14. European Commission. Artificial intelligence in healthcare. *European Commission.* 2026. URL: https://health.ec.europa.eu/ehealth-digital-health-and-care/artificial-intelligence-healthcare_en (accessed: 20.07.2026).

15. Olawade D. B., David-Olawade A. C., Wada O. Z., Asaolu A. J., Adereni T., Ling J. Artificial intelligence in healthcare delivery: prospects and pitfalls. *Global Medicine.* 2024. Article 100108. DOI: https://doi.org/10.1016/j.glmedi.2024.100108

16. Akila K., Gopinathan R., Arunkumar J., Malar B. S. B. The role of artificial intelligence in modern healthcare: advances, challenges, and future prospects. *European Journal of Clinical Medicine.* 2025. Vol. 25, No. 4. DOI: https://doi.org/10.61336/ejcm/25-04-94

17. Angus D. C., Khera R., Lieu T., et al. AI, health, and health care today and tomorrow: The JAMA Summit Report on Artificial Intelligence. *JAMA*. 2025. Vol. 334, No. 18. P. 1650–1664. DOI: https://doi.org/10.1001/jama.2025.18490

18. Topol E. J. High-performance medicine: the convergence of human and artificial intelligence. *Nature Medicine.* 2019. Vol. 25, No. 1. P. 44–56. DOI: https://doi.org/10.1038/s41591-018-0300-7

19. Jiang F., Jiang Y., Zhi H., et al. Artificial intelligence in healthcare: past, present and future. *Stroke and Vascular Neurology.* 2017. Vol. 2. Article e000101. DOI: https://doi.org/10.1136/svn-2017-000101

20. Joshi P., Patel T., Vachhani A., Gupta R., Tanwar S., et al. Explainable AI-Assisted Dementia Disease Classification Framework in Healthcare 4.0. In: *2025 IEEE International Conference for Women in Innovation, Technology & Entrepreneurship (ICWITE).* Bangalore, India : IEEE, 2025. DOI: https://doi.org/10.1109/ICWITE64848.2025.11306994

21. Gor J., Shah H., Patel J., Tanwar S., et al. Explainable ML-Based Secure Communication Framework for Robotic Telesurgery in Healthcare. In: *2025 International Conference on Metaverse and Current Trends in Computing (ICMCTC).* 2025. DOI: https://doi.org/10.1109/ICMCTC62214.2025.11196540

22. Singh B., Kaunert C. Cloud Computing and IoMT in Disease Screening and Diagnosis: AI Approaches in Transmuting Healthier Homes. In: *Revolutionizing Healthcare Systems Through Cloud Computing and IoT.* Cham : Springer, 2024. P. 99–120.

23. Singh B., Kaunert C. Accelerating Healthcare Outcomes Uplifting Patient Experiences Pairing Artificial Intelligence (AI): Transforming the Healthcare Industry in the Digital Arena. In: *Impact of Digital Solutions for Improved Healthcare Delivery.* Hershey, PA : IGI Global, 2024. P. 121–145.

24. Bielick C. G., Awwad A., Ellen J., Pfohl S. R., Celi L. A., et al. Moving Beyond the Benchmarks: Five Foundational Principles for Meaningful AI Evaluation in Healthcare. *PLOS Digital Health.* 2026. Vol. 5, No. 5. Article e0001115.

25. Grand View Research. Artificial Intelligence in Healthcare Market Size, Share & Trends Analysis Report. *Grand View Research.* 2026. URL: https://grandviewresearch.com/industry-analysis/artificial-intelligence-ai-healthcare-market

26. Boniol M., Kunjumen T., Nair T. S., Siyam A., Campbell J., Diallo K. The global health workforce stock and distribution in 2020 and 2030: a threat to equity and 'universal' health coverage? *BMJ Global Health.* 2022. Vol. 7, No. 6. Article e009316. URL: https://pmc.ncbi.nlm.nih.gov/articles/PMC9237893/

27. Varkey P. Leading Transformation in Rural Health: How Mayo Clinic Health System Is Redefining Care, Culture, and the Use of AI. *NEJM Catalyst Innovations in Care Delivery.* 2026. URL: https://catalyst.nejm.org/doi/full/10.1056/CAT.26.0258

28. Palantir Technologies Inc., Cleveland Clinic. Cleveland Clinic and Palantir Technologies Partner to Improve Hospital Performance Through Virtual Command Center [press release]. *PR Newswire.* 2023. URL: https://surli.cc/carggl

29. Department of Health and Social Care (UK). AI to Speed Up Cancer Diagnosis for Millions of NHS Patients [press release]. *UK Government.* 2026. URL: https://wired-gov.net/wg/news.nsf/articles/ai+to+speed+up+cancer+diagnosis+for+millions+of+nhs+patients+11062026141500

30. Kaiser Permanente. Predictive Analytics [fact sheet]. *Kaiser Permanente.* 2018. URL: https://permanente.org/wp-content/uploads/2018/10/Fact-Sheet_Predictive-Analytics_2018.pdf

31. Apollo Hospitals. Digital Transformation and AI for Better Care. *Apollo Hospitals.* 2026. URL: https://www.apollohospitals.com/digital-transformation-and-ai-better-care

Рекуненко І.І., Матвєєва Ю.А., Чередніченко, Д.С., Мао Є. *Сумський державний університет.* ***Інформаційні системи на основі штучного інтелекту для управління ресурсами в екосистемах охорони здоров'я в умовах невизначеності.***

Анотація. *В статті обґрунтовано доцільність розгляду штучного інтелекту не лише як інструменту підтримки клінічних рішень, а як технологічної основи інформаційних систем, здатних забезпечувати координацію ресурсів, інформаційних потоків та взаємодії між учасниками екосистеми охорони здоров'я.* ***Мета статті.*** *ідентифікувати та систематизувати інформаційні системи на основі штучного інтелекту для управління ресурсами в екосистемах охорони здоров'я, проаналізувати міжнародний досвід і розробити концептуальну модель адаптивного управління ресурсами в умовах невизначеності.* ***Методика дослідження.*** *Інформаційну основу становлять наукові публікації, проіндексовані у Scopus. Застосовано бібліометричний аналіз, VOSviewer для аналізу спільної появи ключових слів, а також методи систематизації, порівняння, узагальнення та структурно-логічного аналізу.* ***Результати.*** *Узагальнення досліджень показало, що AI у healthcare переважно застосовується для клінічної діагностики, медичної візуалізації, прогнозування захворювань, персоналізованої медицини та підтримки клінічних рішень. Водночас недостатньо досліджено AI-driven інформаційні системи як інструмент інтегрованого управління ресурсами екосистеми охорони здоров'я. Визначено ключові AI-технології – машинне та глибоке навчання, прогнозну аналітику, NLP, Explainable AI, Big Data та IoMT – та їх потенціал для прогнозування ресурсних потреб, оптимізації розподілу, моніторингу й підтримки управлінських рішень. Встановлено науковий розрив, пов'язаний із недостатньою інтеграцією AI, інформаційних систем, екосистемного підходу та ресурсного управління в умовах невизначеності.* ***Практична значущість результатів дослідження.*** *Практична значущість полягає у можливості використання визначених підходів і технологічних рішень для вдосконалення інформаційного забезпечення управління ресурсами медичних закладів та інших учасників екосистеми охорони здоров'я. Результати можуть бути використані для формування AI-driven інформаційних систем, спрямованих на прогнозування ресурсних потреб, оптимізацію розподілу ресурсів, підвищення оперативності управлінських рішень та забезпечення більшої адаптивності системи охорони здоров'я до змін і невизначеності.*

Ключові слова: *штучний інтелект; інформаційні системи на основі штучного інтелекту; екосистема охорони здоров'я; управління ресурсами; невизначеність; предиктивна аналітика; підтримка прийняття рішень.*

Дата надходження статті: 26.07.2026
Дата прийняття статті до публікації: 15.08.2026
Дата публікації статті: 10.09.2026