Internet of Medical Things (IOMT), Digital Health, and Smart Healthcare Technologies: Challenges and Future Directions

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Abstract: The swift advancement of healthcare technologies has converted conventional medical services into intelligent, interconnected, and patient-centric systems. The Internet of Medical Things (IoMT), in conjunction with Digital Health and Smart Healthcare Technologies, facilitates continuous patient monitoring, remote diagnosis, personalized treatment, and efficient healthcare management via interconnected medical devices, wearable sensors, cloud computing, artificial intelligence (AI), and advanced communication networks. These technologies have markedly enhanced healthcare accessibility, diminished operational expenses, and refined clinical decision-making, especially in the aftermath of the COVID-19 pandemic, which expedited the worldwide embrace of digital healthcare solutions. Notwithstanding these achievements, numerous hurdles persist that hinder the extensive use of IoMT-based healthcare systems. Significant challenges persist, including cybersecurity threats, patient data protection, interoperability across diverse medical devices, regulatory compliance, ethical concerns, and infrastructural limits. Moreover, the growing volume of healthcare data necessitates secure, scalable, and sophisticated data management systems that can facilitate real-time analytics and decision-making. This paper offers an extensive analysis of IoMT, Digital Health, and Smart Healthcare Technologies by evaluating their design, applications, advantages, existing obstacles, and developing trends. The document examines the incorporation of Artificial Intelligence, Blockchain, Edge Computing, Digital Twins, and advanced communication technologies like 5G and 6G in the creation of safe and intelligent healthcare ecosystems. The paper delineates current research deficiencies and proposes future research trajectories to enhance the establishment of robust, efficient, and patient-centered healthcare systems. The results are anticipated to aid scholars, healthcare practitioners, policymakers, and technology developers in comprehending the opportunities and obstacles linked to digital healthcare revolution.

Keywords: Internet of Medical Things (IoMT), Digital Health, Smart Healthcare, Artificial Intelligence, Wearable Medical Devices, Telemedicine, Blockchain, Edge Computing.

INTRODUCTION

Healthcare systems worldwide are undergoing dramatic digital change, fuelled by the rapid progress in information and communication technologies. The traditional healthcare delivery models that depended mainly on hospital-based diagnosis and face-to-face consultations are being increasingly displaced by connected, intelligent and data-driven healthcare services. This transition has been expedited by the growing need for remote patient monitoring, tailored treatment, and effective healthcare resource management. The confluence of the Internet of Medical Things (IoMT), Artificial Intelligence (AI), cloud computing, wearable sensors, and advanced wireless communication technology has given rise to a new generation of healthcare systems that can deliver real-time medical services with improved accuracy and accessibility. The Internet of Medical Things (IoMT) is a network of connected medical devices, wearable sensors, diagnostic equipment and healthcare applications that communicate via the Internet to gather, transmit and analyze health-related data. These interconnected gadgets allow continuous monitoring of patients, which helps healthcare professionals to make clinical choices in time while lowering hospital visits and healthcare expenditure. IoMT applications have gained more importance in controlling chronic diseases such as diabetes, cardiovascular diseases, hypertension and respiratory diseases, where continuous monitoring is very critical for improving treatment. Digital Health is a more inclusive term that refers to the use of digital technologies to improve healthcare delivery, patient involvement and public health services. This include telemedicine, electronic health records (EHRs), mobile health (mHealth) applications, artificial intelligence, big data analytics and remote healthcare platforms. These technologies assist evidence-based clinical decision making and improve communication between healthcare practitioners and patients. The COVID-19 pandemic has further underscored the relevance of Digital Health by accelerating the implementation of telemedicine, virtual consultations and remote monitoring technologies for patients around the world.

Smart Healthcare Technologies are the combination of IoMT with intelligent computing technologies such as Artificial Intelligence, Machine Learning, Blockchain, Cloud Computing, Edge Computing and 5G communication networks. These technologies allow predictive healthcare, automated disease diagnosis, individualized therapy suggestions and efficient hospital management. AI-based diagnostic technologies help doctors to interpret medical images and anticipate disease progression. Blockchain improves data security and integrity by enabling decentralized storage of electronic medical records. Edge Computing also reduces the transmission latency by processing the healthcare data closer to the source, enabling the real-time monitoring of the vital patients. The IoMT and Digital Health technologies have important benefits, but the challenge is to get large-scale adoption. Security risks, privacy concerns, interoperability issues across disparate devices, inadequate network infrastructure, regulatory compliance, ethical considerations and high implementation costs still hamper their wider deployment. One of the key problems for healthcare firms is protecting sensitive patient information from cyber-attacks and ensuring compliance with healthcare standards such as HIPAA and GDPR. Moreover, the heterogeneity of medical equipment from different manufacturers needs the development of standardized communication protocols and compatible structures for easy data sharing.

Emerging technologies such as Explainable Artificial Intelligence (XAI), Federated Learning, Digital Twins, 6G communication networks and Quantum Computing are projected to overcome many of these issues and further improve healthcare intelligence, security and operational efficiency. These developments could establish highly linked, autonomous and patient-centric healthcare ecosystems that can deliver individualized medical services with higher reliability and precision. The fast development of digital healthcare technologies has led to an increasing need to assess their existing applications, accompanying difficulties and prospects for future research. This paper provides a complete assessment of IoMT, Digital Health and Smart Healthcare Technologies by analyzing their architecture, applications, technological breakthroughs, implementation issues and future perspectives for sustainable and intelligent healthcare systems.

RESEARCH OBJECTIVES

1. To investigate the impact of the Internet of Medical Things (IoMT), Digital Health, and Smart Healthcare Technologies on enhancing healthcare delivery, patient monitoring, and clinical decision-making.
2. To ascertain the principal obstacles, research deficiencies, and prospective technical trajectories for the advancement of secure, intelligent, and sustainable smart healthcare systems.

LITERATURE REVIEW

Islam et al. (2016) provided one of the initial thorough analyses of the Internet of Things (IoT) in healthcare, highlighting the increasing importance of interconnected medical devices for patient surveillance and disease management. The authors elucidated that wearable sensors and wireless communication technologies facilitate continuous health monitoring and early disease identification. However, they also expressed considerable concerns around data security, interoperability, and the reliability of devices. Their research emphasized the necessity for standardized communication protocols and enhanced cybersecurity frameworks to securely communicate healthcare data.

Rahmani et al. (2017) presented an advanced healthcare architecture that integrates IoT with cloud and fog computing to facilitate real-time medical services. Their research indicated that processing healthcare data near medical devices diminishes network latency and enhances response times during emergencies. The researchers determined that fog computing improves the efficiency of distant healthcare systems; nonetheless, they acknowledged that resource allocation and system scalability continue to pose significant hurdles for large-scale implementation.

Jiang et al. (2017) examined the utilization of artificial intelligence in healthcare diagnostics and clinical decision support systems. The research indicated that AI algorithms markedly enhance diagnostic precision in medical imaging, disease forecasting, and therapy strategizing. Nonetheless, the authors underscored that AI-driven healthcare systems necessitate high-quality datasets and transparent algorithms to mitigate prediction bias and guarantee reliable clinical outcomes.

Raghupathi and Raghupathi (2018) analyzed the function of big data analytics in healthcare decision-making. Their research indicated that healthcare companies produce vast amounts of organized and unstructured data from electronic health records, wearable devices, and medical imaging systems. Utilizing predictive analytics enables hospitals to enhance patient care, decrease operational expenses, and optimize resource allocation. Nonetheless, the study also underscored problems pertaining to data quality, integration, and privacy protection.

Patel et al. (2018) explored the growing adoption of wearable medical devices in digital healthcare. Their research showed that smartwatches, ECG monitors, blood pressure sensors, and glucose monitoring devices enable continuous patient monitoring outside hospitals. These technologies improve chronic disease management and reduce unnecessary hospital admissions. Despite these advantages, the authors reported limitations related to battery life, sensor accuracy, and patient acceptance of wearable technologies.

Agbo et al. (2019) Examined blockchain applications in healthcare and analyzed its potential for safeguarding electronic health records. The researchers elucidated that blockchain offers decentralized, tamper-proof data storage, facilitating secure sharing of medical information across hospitals, patients, and healthcare professionals. Despite enhancing openness and trust, blockchain implementation encounters obstacles including elevated computing expenses, restricted scalability, and regulatory ambiguity.

Topol (2019) examined the revolutionary impact of artificial intelligence in medical practice. The research emphasized that deep learning algorithms can precisely analyze radiological images, pathology slides, and retinal scans, assisting physicians in illness diagnosis. Artificial intelligence facilitates individualized treatment strategies and anticipatory healthcare. The author emphasized that AI should augment, not supplant, medical personnel and highlighted the necessity of explainable and ethical AI systems.

Shi et al. (2020) examined the amalgamation of edge computing with IoMT-driven healthcare systems. Their research revealed that edge computing analyzes healthcare data proximate to the data source, hence diminishing latency, lowering bandwidth consumption, and facilitating real-time monitoring of critically ill patients. The researchers determined that edge intelligence is especially advantageous for emergency healthcare applications, although necessitates effective resource management and secure communication methods.

Keesara et al. (2020) examined the swift proliferation of digital health services during the COVID-19 epidemic. The study indicated that telemedicine, remote patient monitoring, and virtual consultations emerged as vital instruments for sustaining healthcare delivery while mitigating infection risks. The authors contended that digital health technologies will persist in transforming healthcare post-pandemic, despite significant issues related to digital inequality and infrastructural constraints.

Tjoa and Guan (2021) analyzed the significance of Explainable Artificial Intelligence (XAI) in healthcare applications. Their research indicated that healthcare personnel are more inclined to trust AI technologies when the decision-making process is transparent and comprehensible. The research found explainability as a crucial element for enhancing physician confidence, regulatory approval, and patient safety in AI-supported healthcare settings.

Ahamed and Farid (2021) Examined security and privacy concerns related to IoMT systems. Their research identified cyberattacks, malware, ransomware, illegal access, and insecure communication channels as significant hazards to interconnected medical devices. The authors proposed multi-factor authentication, lightweight encryption, intrusion detection systems, and blockchain integration as viable options for securing IoMT environments.

Bruynseels et al. (2022) established the concept of Digital Twins in healthcare, wherein virtual representations of patients are created from real-time physiological data gathered from IoMT devices. The research elucidated that Digital Twins facilitate predictive illness analysis, individualized treatment planning, and simulation-driven healthcare decision-making. Nonetheless, challenges with data veracity, computing complexity, and ethical considerations persist in hindering wider implementation.

Nguyen et al. (2023) investigated Federated Learning as a privacy-preserving machine learning approach for healthcare. Instead of transferring patient data to centralized servers, Federated Learning trains AI models locally on healthcare devices while sharing only model parameters. This approach significantly reduces privacy risks and supports secure collaborative learning across hospitals. However, communication overhead and heterogeneous data distribution remain important research challenges.

Javaid et al. (2024) examined recent developments in smart healthcare technologies, including Artificial Intelligence, IoMT, cloud computing, blockchain, and robotics. The study concluded that integrating multiple digital technologies can significantly improve healthcare quality, operational efficiency, and patient outcomes. However, the authors emphasized the need for standardized regulations, ethical AI frameworks, interoperability standards, and sustainable digital infrastructure to support future smart healthcare ecosystems.

RESEARCH METHODOLOGY

This study employs a qualitative systematic literature review (SLR) methodology to analyze recent advancements, obstacles, and prospective trajectories of the Internet of Medical Things (IoMT), Digital Health, and Smart Healthcare Technologies. A systematic review is suitable since it facilitates the thorough identification, assessment, and integration of existing research outcomes from various academic sources. The process was crafted to guarantee that the gathered literature is pertinent, dependable, and reflective of contemporary progress in digital healthcare technology.

Research Design

The research employs a descriptive and exploratory design grounded in secondary data analysis. Instead of engaging in primary data collection via surveys or experiments, the study meticulously examines previously published scientific literature to elucidate the progression of IoMT and smart healthcare technologies. The descriptive component aims to encapsulate the current state of knowledge, while the exploratory facet seeks to pinpoint research deficiencies, technological obstacles, and prospective avenues. This design is apt for assessing nascent technologies with an extensive existing academic corpus.

Data Collection

The present research work is based on secondary data collected from peer-reviewed journal articles, conference proceedings, review papers, and book chapters published in 2016–2025. The literature related to the issue was collected from reputable academic databases such as IEEE Xplore, SpringerLink, Elsevier ScienceDirect, MDPI, Wiley Online Library, Taylor & Francis, and Google Scholar. Keywords used to identify relevant publications included Internet of Medical Things (IoMT), Digital Health, Smart Healthcare, Artificial Intelligence in Healthcare, Telemedicine, Wearable Medical Devices, Blockchain in Healthcare, and Edge Computing. Only English-language papers related to IoMT and digital healthcare technologies were considered to ensure quality and relevance of the review. Duplicate articles, non-peer-reviewed sources, editorials and research with lack of technical or scientific information were excluded. Common themes, technological advances, challenges in implementation, and possible research paths were sought from a thorough review of the collected material. The analysis provides a credible and holistic framework for assessing the current status of IoMT-based smart healthcare systems, guaranteeing the findings are based on authentic and up-to-date academic research.

ANALYSIS AND DISCUSSION

The research is based on a survey of recent publications, published between 2016 and 2025, on Internet of Medical Things (IoMT), Digital Health and Smart Healthcare Technologies. The results suggest that healthcare is fast moving from traditional hospital-based services to intelligent, connected and patient-centric healthcare systems. Technologies such as Artificial Intelligence (AI), medical wearables, cloud computing, blockchain, edge computing, and telemedicine are progressively being incorporated into healthcare to improve patient outcomes, reduce operational costs, and enhance clinical decision-making. However, the implementation of these technologies presents a number of technological, security, ethical and regulatory problems.

Adoption of Smart Healthcare Technologies

The recent literature reveals that technology such as AI, IoMT devices, and telemedicine are widely adopted in modern healthcare systems. AI aids in disease diagnosis and prediction analytics, whereas IoMT provides continuous patient monitoring with wearable sensors. Telemedicine has made health care delivery more accessible, especially in rural and isolated places. Blockchain and edge computing are new technologies that can provide better security and real-time data processing, but they are still in the early phases of application.

Table 1: Adoption Level of Smart Healthcare Technologies

Technology	Major Application	Adoption Level
Artificial Intelligence	Disease diagnosis, predictive analytics	Very High
IoMT Devices	Remote patient monitoring	Very High
Telemedicine	Virtual consultation	High
Wearable Sensors	Continuous health monitoring	High
Cloud Computing	Healthcare data storage	High
Edge Computing	Real-time data processing	Moderate
Blockchain	Secure health records	Moderate
Digital Twins	Personalized healthcare	Emerging

Major Challenges in IoMT-Based Healthcare

Despite the great advances in the field of digital healthcare, various impediments still affect the large-scale application. Medical information is very sensitive and the most common problems reported are security and privacy. Heterogeneous medical devices still have interoperability problems in communicating with the healthcare networks. In addition, ethical issues associated with AI decision-making and regulatory compliance pose another challenge for healthcare businesses.

Table 2: Major Challenges Identified from Literature

Challenge	Impact on Healthcare
Cybersecurity Threats	Data breaches and ransomware attacks
Patient Data Privacy	Unauthorized access to medical records
Interoperability	Poor communication among devices
Regulatory Compliance	Delayed technology implementation
High Implementation Cost	Limited adoption in developing countries
Energy Consumption	Reduced battery life of wearable devices
AI Bias and Explainability	Reduced trust in AI-based diagnosis

4.3 Emerging Technologies and Future Potential

The studies' results show that the future smart healthcare systems will be based on the integration of several intelligent technologies, not on a single digital solution. Healthcare security, accuracy, and operational efficiency are predicted to be enhanced via Explainable Artificial Intelligence (XAI), Federated Learning, Digital Twins, 6G communication networks, and Quantum Computing. These technologies will provide real-time predictive healthcare, while ensuring patient privacy and regulatory compliance.

Table 3: Future Technologies in Smart Healthcare

Emerging Technology	Expected Contribution
Explainable AI	Transparent clinical decision-making
Federated Learning	Privacy-preserving machine learning
Digital Twins	Personalized treatment simulation
6G Communication	Ultra-low latency healthcare services
Quantum Computing	Advanced drug discovery and medical research
Edge AI	Faster real-time diagnosis

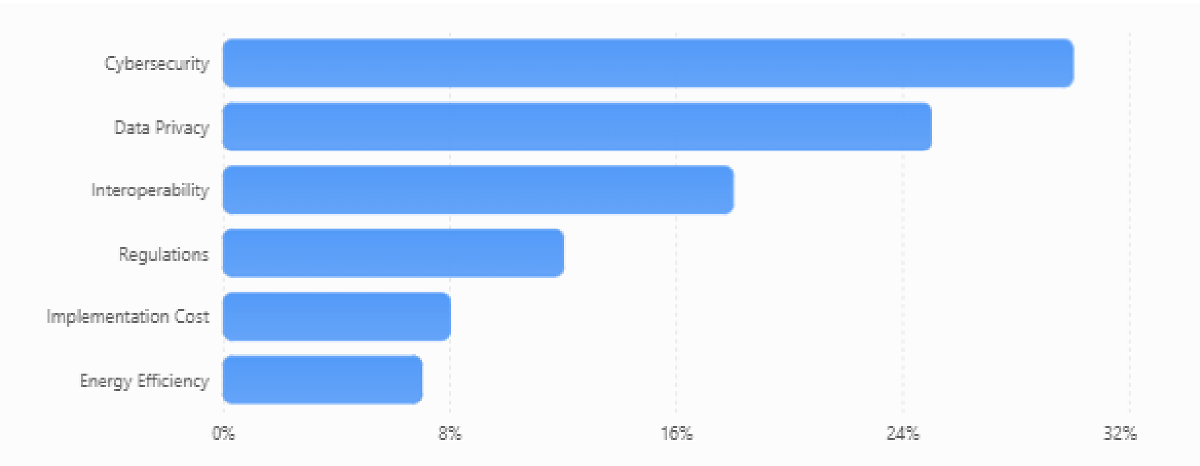

Figure 1: Distribution of Major Challenges in Smart Healthcare

Discussion:

The most discussed challenges in recent research are cybersecurity (30%) and data privacy (25%), as shown in the chart. With the increased connectivity of healthcare systems, securing sensitive patient information from cyberattacks is a critical responsibility. Interoperability and regulatory compliance are other major roadblocks as healthcare equipment from different vendors do not have established channels for communication.

CONCLUSION

The Internet of Medical Things (IoMT), Digital Health, and Smart Healthcare Technologies have become key elements of contemporary healthcare systems. The amalgamation of interconnected medical devices, wearable sensors, Artificial Intelligence (AI), cloud computing, edge computing, and telemedicine has markedly enhanced healthcare delivery through continuous patient monitoring, early disease detection, remote consultation, and personalized treatment. These technologies have improved clinical decision-making, lowered healthcare expenses, and expanded access to medical services, especially for patients residing in distant and underserved areas.

The literature examined in this study indicates that IoMT-based healthcare systems have significantly expanded since 2016, propelled by technological innovations and the rising need for efficient, patient-centric healthcare. Artificial Intelligence has enhanced diagnostic precision and predictive analytics, whilst telemedicine has emerged as a vital healthcare service in the aftermath of the COVID-19 epidemic. Likewise, wearable medical devices and mobile health applications facilitate real-time monitoring of chronic diseases, enabling healthcare providers to promptly respond to alterations in patients' health statuses. Notwithstanding these achievements, some hurdles persist in obstructing the extensive use of smart healthcare technologies.

Cybersecurity dangers, data privacy issues, interoperability challenges among diverse medical devices, substantial implementation costs, ethical dilemmas related to AI, and regulatory compliance persist as significant obstacles. Safeguarding sensitive patient information while facilitating seamless communication among healthcare systems necessitates established protocols, secure communication frameworks, and robust governance regulations. Resolving these difficulties is crucial for establishing reliable and sustainable digital healthcare ecosystems. The study indicates that IoMT and Digital Health technologies possess the capacity to transform healthcare services by enhancing their intelligence, accessibility, and efficiency. Achieving this objective necessitates ongoing technological innovation, interdisciplinary collaboration, and regulatory frameworks that foster secure, dependable, and patient-centered healthcare systems.

Future Directions

The future of smart healthcare will depend on the integration of advanced digital technologies that enhance security, intelligence, and operational efficiency. Several promising research directions have been identified based on the reviewed literature:

- **Explainable Artificial Intelligence (XAI):** Future healthcare systems should adopt transparent AI models that provide understandable clinical recommendations, increasing trust among healthcare professionals and patients.
- **Federated Learning:** Privacy-preserving machine learning techniques should be further developed to enable collaborative AI model training without exposing sensitive patient data.
- **Blockchain Integration:** Blockchain technology can strengthen healthcare data security, improve interoperability, and ensure the integrity of electronic health records through decentralized data management.
- **Digital Twin Technology:** Developing virtual patient models using real-time physiological data can support personalized medicine, predictive healthcare, and treatment simulation.
- **Edge and Fog Computing:** Future research should focus on optimizing edge computing architectures to reduce latency, improve emergency healthcare responses, and minimize network congestion.
- **5G and 6G Healthcare Networks:** High-speed communication technologies will facilitate ultra-low latency medical services, enabling real-time remote surgery, continuous monitoring, and intelligent ambulance systems.
- **Interoperability Standards:** Universal communication protocols should be established to ensure seamless integration among medical devices, hospital information systems, and healthcare applications developed by different manufacturers.
- **Sustainable Smart Healthcare:** Future healthcare infrastructures should prioritize energy-efficient IoMT devices, environmentally sustainable computing solutions, and cost-effective deployment models, particularly for developing countries.

Challenges

- Cybersecurity Threats
- Data Privacy and Confidentiality
- Interoperability Issues
- High Implementation Cost
- Regulatory and Legal Challenges
- Artificial Intelligence Reliability and Ethical Issues
- Network Reliability and Latency
- Energy Consumption of IoMT Devices

References

1. Agbo, C. C., Mahmoud, Q. H., & Eklund, J. M. (2019). Blockchain technology in healthcare: A systematic review. *Healthcare, 7*(2), 56.
2. Ahamed, F., & Farid, F. (2021). Applying Internet of Things and machine-learning for personalized healthcare: Issues and challenges. *Journal of Healthcare Engineering*, 2021, 1–15.
3. Bruynseels, K., Santoni de Sio, F., & van den Hoven, J. (2022). Digital twins in healthcare: Ethical implications and governance challenges. *Journal of Medical Ethics, 48*(3), 163–169.
4. Dwivedi, R., Mehrotra, D., & Chandra, S. (2022). Potential of Internet of Medical Things (IoMT) applications in building a smart healthcare system: A systematic review. *Journal of Oral Biology and Craniofacial Research, 12*(2), 302–318.
5. Islam, S. M. R., Kwak, D., Kabir, M. H., Hossain, M., & Kwak, K. S. (2015). The Internet of Things for health care: A comprehensive survey. *IEEE Access, 3*, 678–708.

6. Javaid, M., Haleem, A., Singh, R. P., & Suman, R. (2021). Substantial capabilities of robotics, artificial intelligence and machine learning in the current healthcare system. *Clinical Epidemiology and Global Health, 11*, 100761.

7. Jiang, F., Jiang, Y., Zhi, H., Dong, Y., Li, H., Ma, S., Wang, Y., Dong, Q., Shen, H., & Wang, Y. (2017). Artificial intelligence in healthcare: Past, present and future. *Stroke and Vascular Neurology, 2*(4), 230–243.

8. Keesara, S., Jonas, A., & Schulman, K. (2020). COVID-19 and health care's digital revolution. *The New England Journal of Medicine, 382*(23), e82.

9. Kelly, J. T., Campbell, K. L., Gong, E., & Scuffham, P. (2020). The Internet of Things: Impact and implications for health care delivery. *Journal of Medical Internet Research, 22*(11), e20135.

10. Lee, J., Davari, H., Singh, J., & Pandhare, V. (2018). Industrial AI and digital healthcare transformation: Challenges and opportunities. *Manufacturing Letters, 18*, 20–23.

11. Mehta, N., Pandit, A., & Shukla, S. (2020). Transforming healthcare with big data analytics and artificial intelligence. *Journal of Biomedical Informatics, 108*, 103500.

12. Nguyen, D. C., Ding, M., Pathirana, P. N., Seneviratne, A., Li, J., & Poor, H. V. (2023). Federated learning for Internet of Things: A comprehensive survey. *IEEE Communications Surveys & Tutorials, 25*(1), 264–314.

13. Patel, S., Park, H., Bonato, P., Chan, L., & Rodgers, M. (2018). A review of wearable sensors and systems with application in rehabilitation. *Journal of NeuroEngineering and Rehabilitation, 9*(1), 21.

14. Rahmani, A. M., Liljeberg, P., Jantsch, A., et al. (2017). Exploiting smart e-health gateways at the edge of healthcare Internet-of-Things. *Future Generation Computer Systems, 78*, 641–658.

15. Raghupathi, W., & Raghupathi, V. (2018). Big data analytics in healthcare: Promise and potential. *Health Information Science and Systems, 6*(1), 3.

16. Rghioui, A., Sendra, S., Lloret, J., & Oumnad, A. (2020). Internet of Things for measuring human activities in healthcare: A review. *Sensors, 20*(7), 210.

17. Shi, W., Cao, J., Zhang, Q., Li, Y., & Xu, L. (2016). Edge computing: Vision and challenges. *IEEE Internet of Things Journal, 3*(5), 637–646.

18. Singh, R. P., Javaid, M., Haleem, A., & Suman, R. (2020). Internet of Things (IoT) applications to fight against COVID-19 pandemic. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews, 14*(4), 521–524.

19. Topol, E. (2019). High-performance medicine: The convergence of human and artificial intelligence. *Nature Medicine, 25*(1), 44–56.

20. Tjoa, E., & Guan, C. (2021). A survey on explainable artificial intelligence (XAI): Toward medical XAI. *IEEE Transactions on Neural Networks and Learning Systems, 32*(11), 4793–4813.

21. Wang, X., Zhang, Y., Zhang, N., et al. (2018). Internet of Things in healthcare: Architecture, applications and challenges. *IEEE Wireless Communications, 25*(6), 58–65.

22. Yang, G., Xie, L., Mäntysalo, M., et al. (2018). A health-IoT platform based on the integration of intelligent packaging, unobtrusive bio-sensor, and intelligent medicine box. *IEEE Transactions on Industrial Informatics, 10*(4), 2180–2191.

23. Zhang, Y., Qiu, M., Tsai, C. W., Hassan, M. M., & Alamri, A. (2017). Health-CPS: Healthcare cyber-physical system assisted by cloud and big data. *IEEE Systems Journal, 11*(1), 88–95.

24. Zhao, Y., Sun, Y., Liu, J., & Xue, Y. (2023). Internet of Medical Things: A systematic review. *Neurocomputing, 557*, 126719.

25. Volkov, I., Radchenko, G., & Tchernykh, A. (2021). Digital twins, Internet of Things and mobile medicine: A review of current platforms to support smart healthcare. *Procedia Computer Science, 184*, 648–655.

26. Mouanda, G. (2024). Comprehensive up-to-date impact of the Internet of Medical Things in healthcare and patients. *arXiv*.

27. Xin, H., Ajibade, S. S. M., Alhassan, G. N., & Yilmaz, Y. (2025). Emerging trends and bibliometric analysis of Internet of Medical Things for innovative healthcare (2016–2023). *DIGITAL HEALTH*.

28. Javaid, M., Haleem, A., Singh, R. P., & Suman, R. (2024). Smart healthcare technologies: Current developments and future opportunities. *International Journal of Intelligent Networks, 5*, 1–15.

29. Romero, J., López, P., Vázquez Noguera, J. L., Cappo, C., Pinto-Roa, D. P., & Villalba, C. (2016). Integrated, reliable and cloud-based personal health record: A scoping review. *arXiv*.

30. Chango, W., Olivares, T., & Delicado, F. (2024). Topologies in the Internet of Medical Things (IoMT): Literature review. *arXiv*.