

Smart Healthcare Frameworks for Improved Medical Services

Hannu Nieminen

Professor, University of Oulu, Finland

Abstract

Smart healthcare frameworks represent an emerging approach to improving medical services through the integration of artificial intelligence, Internet of Things technologies, cloud computing, big data analytics, wearable devices, telemedicine, robotics, and digital health platforms. These technologies enable healthcare organizations to develop connected and intelligent systems capable of supporting diagnosis, patient monitoring, clinical decision-making, treatment coordination, and healthcare administration. This study examines smart healthcare frameworks for improved medical services, with emphasis on technological integration, patient-centered care, operational efficiency, remote healthcare, personalized treatment, and continuous monitoring. A qualitative descriptive and conceptual research design was adopted through secondary academic literature. The analysis indicates that smart healthcare frameworks can connect patients, healthcare professionals, medical devices, information systems, and analytical platforms to improve the availability and use of healthcare information.

Artificial intelligence can support clinical decision-making, IoT devices can enable continuous monitoring, cloud platforms can facilitate information management, and telemedicine can expand healthcare accessibility. However, cybersecurity, interoperability, data quality, regulatory compliance, implementation cost, workforce readiness, digital inequality, and patient acceptance remain significant challenges. The study concludes that smart healthcare frameworks can improve medical services when emerging technologies are implemented through integrated, secure, clinically validated, and patient-centered approaches. Future research should focus on intelligent healthcare ecosystems, interoperable platforms, explainable AI, real-time monitoring, personalized medicine, digital twins, secure data exchange, and equitable smart healthcare implementation.

Keywords: Smart Healthcare, Healthcare Frameworks, Medical Services, Artificial Intelligence, Internet of Things, Digital Health, Telemedicine, Healthcare Analytics, Wearable Technologies, Patient-Centered Care

1. Introduction

The transformation of healthcare through digital and intelligent technologies has created new opportunities for improving medical services. Conventional healthcare systems often depend on fragmented information, periodic assessments, manual processes, and physical interactions between patients and healthcare professionals. Smart healthcare frameworks seek to overcome these limitations by integrating digital technologies, connected medical devices, data analytics, artificial intelligence, and

intelligent information systems. Such integration can create healthcare environments that are more responsive, connected, efficient, and patient-centered.

Smart healthcare frameworks can connect multiple components of the healthcare ecosystem, including patients, clinicians, hospitals, diagnostic laboratories, pharmacies, medical devices, and digital platforms. The integration of these components enables information to be collected, processed, exchanged, and analyzed more efficiently. Healthcare professionals can potentially access broader patient information, while patients can receive services through remote and digitally supported channels. Artificial intelligence represents an important technological component of smart healthcare frameworks. Machine-learning algorithms can analyze clinical information, medical images, physiological signals, and patient histories. AI can support disease detection, risk prediction, clinical decision-making, treatment planning, and administrative processes. However, AI systems must be clinically validated and appropriately supervised to ensure that automated recommendations are reliable and safe.

The Internet of Things provides connectivity between medical devices, sensors, and healthcare platforms. IoT-enabled devices can collect patient information continuously and transmit it to analytical systems. Such capabilities can support remote monitoring, chronic disease management, and early detection of physiological changes. Smart healthcare frameworks can therefore extend monitoring capabilities beyond hospitals and traditional clinical environments. Wearable technologies contribute to continuous patient monitoring. Smartwatches, patches, wearable sensors, and other devices can capture physiological information such as heart rate, oxygen saturation, physical activity, temperature, and other health indicators. When integrated into smart healthcare frameworks, wearable devices can provide healthcare professionals with additional information for patient assessment and long-term monitoring.

Cloud computing provides infrastructure for storing, processing, and accessing healthcare information. Smart healthcare frameworks can use cloud platforms to integrate data from different sources and provide scalable computing resources. Cloud-based systems can support collaboration among healthcare institutions and enable remote access to information. However, privacy, security, data governance, and regulatory requirements must be carefully addressed. Big data analytics supports the transformation of large healthcare datasets into actionable insights. Healthcare systems generate information from EHRs, diagnostic tests, imaging, sensors, administrative records, and patient-generated data. Analytical platforms can identify patterns, trends, and risks across these datasets. Such information can support clinical decision-making, population health management, resource planning, and healthcare quality improvement.

Telemedicine is another important component of smart healthcare. Digital communication platforms enable healthcare professionals to provide consultations, follow-up services, and selected forms of monitoring remotely. Telemedicine can improve accessibility for patients who face geographic or mobility limitations. Its successful implementation requires appropriate connectivity, digital literacy, clinical suitability, privacy protection, and reliable communication systems.

2. Objectives of the Study

Primary Objective

The primary objective of this study is to examine smart healthcare frameworks for improving medical services through the integration of artificial intelligence, IoT, cloud computing, healthcare analytics,

wearable technologies, telemedicine, robotics, and digital platforms. The study seeks to understand how interconnected technologies can support diagnosis, monitoring, clinical decision-making, personalized treatment, remote healthcare, operational efficiency, and patient-centered medical service delivery.

2.1 Examination of Smart Healthcare Technologies

The first objective is to examine major technologies supporting smart healthcare frameworks, including artificial intelligence, Internet of Things devices, wearable technologies, cloud computing, big data analytics, robotics, telemedicine, mobile health, and intelligent decision-support systems. The study evaluates their roles in connecting healthcare stakeholders, processing medical information, supporting clinical activities, and improving healthcare service capabilities.

2.2 Assessment of Medical Service Improvements

The second objective is to assess how smart healthcare technologies can improve medical services through continuous patient monitoring, intelligent diagnosis, personalized treatment, remote consultations, automated workflows, clinical decision support, healthcare resource management, and patient engagement. The study examines how technology integration can contribute to accessibility, efficiency, responsiveness, coordination, and quality of healthcare delivery.

2.3 Identification of Implementation Requirements

The third objective is to identify implementation requirements involving interoperability, data quality, cybersecurity, privacy, clinical validation, regulatory compliance, workforce readiness, affordability, digital inclusion, and organizational preparedness. The study emphasizes that smart healthcare frameworks require coordinated technological and institutional strategies to ensure safe, reliable, sustainable, patient-centered, and equitable medical services.

3. Review of Literature

3.1 Smart Healthcare and Artificial Intelligence

Topol (2019) examined the convergence of artificial intelligence and healthcare and identified opportunities for improving diagnosis, monitoring, prediction, and clinical decision-making. AI can process complex healthcare information and provide analytical support to healthcare professionals. However, clinical oversight, data quality, validation, transparency, and appropriate implementation remain essential for achieving reliable outcomes.

Jiang et al. (2017) reviewed artificial intelligence applications in healthcare and highlighted its potential for diagnosis, prediction, and decision support. AI-enabled systems can process large quantities of medical information and identify clinically relevant patterns. The literature indicates that effective AI implementation depends on reliable datasets, appropriate algorithms, clinical validation, and integration with healthcare workflows.

3.2 IoT and Connected Medical Services

Islam et al. (2015) reviewed IoT applications in healthcare and demonstrated the potential of connected devices for monitoring, communication, and healthcare service delivery. IoT systems can link patients,

medical devices, and healthcare platforms. Security, interoperability, reliability, and data management remain important challenges affecting the implementation of connected healthcare environments.

Kelly et al. (2020) discussed the potential role of digital technologies in improving healthcare delivery. Connected systems can provide continuous information and support remote interactions between patients and healthcare professionals. The literature suggests that digital transformation requires appropriate infrastructure, organizational readiness, patient engagement, and safeguards for privacy and data security.

3.3 Digital Health and Patient-Centered Care

Kim et al. (2019) examined wearable biosensors and emphasized their potential to support continuous healthcare monitoring. Wearable technologies can generate physiological information outside traditional clinical environments. Their effectiveness depends on sensor reliability, comfort, energy efficiency, patient adherence, data interpretation, and integration with healthcare systems.

Keesara, Jonas, and Schulman (2020) highlighted the increasing importance of digital transformation in healthcare. Digital platforms can expand access to services and support new models of patient interaction. However, successful digital healthcare requires consideration of infrastructure, privacy, clinical suitability, patient accessibility, and integration with conventional healthcare systems.

4. Research Methodology

4.1 Research Design

This study adopted a qualitative descriptive and conceptual research design to examine smart healthcare frameworks for improved medical services. The design was selected because the study focuses on synthesizing existing academic knowledge concerning healthcare technologies, service applications, implementation requirements, and challenges rather than collecting primary clinical data.

The conceptual framework examined relationships among emerging technologies, connected healthcare infrastructure, medical services, clinical decision-making, patient monitoring, healthcare operations, and patient-centered outcomes. The analysis considered artificial intelligence, IoT, cloud computing, analytics, wearables, telemedicine, robotics, and digital health platforms.

4.2 Data Collection

Secondary information was collected from peer-reviewed academic literature, scholarly books, and established research publications addressing smart healthcare and digital medical services.

The data collection focused on:

- Artificial intelligence applications in medical services.
- Internet of Things and connected healthcare systems.
- Wearable technologies and remote patient monitoring.
- Cloud computing and healthcare information management.
- Big data analytics and clinical decision support.
- Telemedicine and mobile health applications.
- Robotics and intelligent healthcare automation.
- Interoperability and healthcare data integration.

- Cybersecurity, privacy, and ethical healthcare technology.
- Patient-centered design and technology acceptance.
- Clinical validation and regulatory requirements.
- Organizational readiness and workforce capabilities.

4.3 Data Analysis

The collected literature was analyzed through thematic analysis to identify recurring themes associated with smart healthcare frameworks. Major themes included intelligent diagnosis, continuous monitoring, connected medical services, personalized care, remote healthcare, clinical decision support, healthcare automation, data integration, and patient engagement.

The analysis also examined implementation factors including interoperability, data quality, cybersecurity, privacy, regulatory compliance, clinical validation, workforce readiness, cost, digital inclusion, and organizational preparedness. A conceptual synthesis was developed to explain how integrated technologies can contribute to improved medical services.

5. Analysis

5.1 Smart Healthcare Technologies and Their Contributions

Smart healthcare frameworks combine multiple emerging technologies to create connected and intelligent medical service environments. Artificial intelligence provides analytical and decision-support capabilities, while IoT connects medical devices and sensors. Wearable technologies enable continuous patient monitoring, and cloud computing provides infrastructure for data storage and processing.

Robotics supports selected clinical and rehabilitation activities, while telemedicine expands healthcare access. Big data analytics enables organizations to identify patterns and risks. The integration of these technologies can strengthen healthcare coordination, monitoring, clinical decision-making, and operational efficiency.

Table 1: Smart Healthcare Technologies and Medical Service Contributions

Technology	Healthcare Application	Major Contribution
Artificial Intelligence	Diagnosis and prediction	Intelligent decision support
IoT	Connected monitoring	Continuous information collection
Wearables	Patient monitoring	Real-time physiological data
Cloud Computing	Data management	Scalable healthcare infrastructure
Big Data Analytics	Healthcare analysis	Risk and pattern identification
Telemedicine	Remote consultation	Expanded healthcare access
Robotics	Surgery and rehabilitation	Precision and automation
Mobile Health	Patient engagement	Digital healthcare interaction

The table indicates that smart healthcare technologies perform complementary functions. AI and analytics focus on information processing, IoT and wearables provide continuous data, and cloud computing enables infrastructure for connected services. Telemedicine improves accessibility, while robotics supports physical clinical activities. The combined use of these technologies can establish integrated healthcare environments capable of supporting different stages of medical service delivery.

5.2 Smart Healthcare Applications for Medical Services

Smart healthcare frameworks can improve medical services by supporting diagnosis, monitoring, treatment, rehabilitation, remote care, and administrative processes. Intelligent diagnostic tools can assist clinical assessment, while connected devices enable continuous monitoring. Telemedicine can support remote consultations, and analytics can assist resource planning.

Smart systems can also improve patient engagement through mobile applications and wearable technologies. These applications demonstrate that healthcare innovation can extend beyond individual technologies toward integrated service models that connect patients, healthcare professionals, devices, and information platforms.

Table 2: Smart Healthcare Applications and Expected Improvements

Medical Service Area	Smart Technology Application	Expected Improvement
Diagnosis	AI and Imaging Analytics	Improved diagnostic support
Monitoring	IoT and Wearables	Continuous patient observation
Treatment	AI and Robotics	Precision and personalization
Remote Care	Telemedicine and IoT	Improved accessibility
Rehabilitation	Robotics and VR	Enhanced therapeutic support
Patient Engagement	Mobile Health	Greater participation
Administration	Automation and Analytics	Workflow efficiency
Resource Management	Predictive Analytics	Improved allocation
Information Management	Cloud Platforms	Better data accessibility
Clinical Decisions	Decision Support Systems	Evidence-based support

The table shows that smart healthcare frameworks can contribute to multiple dimensions of medical service improvement. Technologies can strengthen clinical activities while also improving administrative efficiency and patient participation. However, successful implementation requires integration with existing healthcare workflows, appropriate infrastructure, reliable data, cybersecurity protections, clinical validation, and trained professionals. Smart healthcare should therefore be approached as an integrated framework rather than as isolated technology adoption.

6. Discussion

Smart healthcare frameworks can transform medical services by integrating connected devices, intelligent analytics, digital platforms, and clinical systems. Their value lies in connecting different components of healthcare delivery and enabling information to move more efficiently between patients, professionals, devices, and organizations. Such integration can support improved monitoring, decision-making, coordination, and accessibility. However, successful transformation requires healthcare organizations to align technological innovation with clinical workflows and patient requirements.

Artificial intelligence can strengthen smart healthcare by supporting diagnosis, prediction, risk assessment, and clinical decision-making. Machine-learning systems can analyze large healthcare datasets and identify patterns that may assist clinicians. AI can therefore reduce information-processing burdens and support more informed decisions. Nevertheless, healthcare professionals must retain appropriate oversight because analytical models can contain biases, produce errors, or perform differently across patient populations and healthcare environments.

IoT and wearable technologies provide important capabilities for continuous medical monitoring. Connected sensors can collect physiological information and transmit it to healthcare platforms for analysis. Such systems can support remote patient management and provide information between clinical visits. However, continuous monitoring also creates large volumes of data that require appropriate interpretation. Device accuracy, patient adherence, interoperability, cybersecurity, and clear clinical response procedures are necessary for effective implementation.

Smart healthcare frameworks also require organizational transformation and patient-centered implementation. Healthcare professionals need training and technical support, while patients require accessible and understandable technologies. Privacy, digital inequality, affordability, and trust must be considered alongside technological performance. Integrated governance can help ensure that emerging technologies are deployed safely and sustainably. Collaboration among clinicians, engineers, data specialists, administrators, policymakers, and patients can improve the practical value of smart healthcare innovation.

7. Challenges

7.1 Data Security and Privacy

Smart healthcare frameworks involve extensive collection and exchange of sensitive medical information. Connected devices, cloud platforms, mobile applications, and EHR systems may create multiple points where information can be exposed. Cybersecurity incidents can affect both patient privacy and healthcare operations. Strong authentication, encryption, access control, secure communication, software updates, and continuous monitoring are necessary to protect connected medical systems.

Privacy concerns become more complex as healthcare organizations combine information from multiple sources. Patient records, physiological data, behavioral information, and monitoring results may be used for analytical purposes. Appropriate consent, data-minimization practices, governance policies, and privacy-preserving analytical methods are needed. Maintaining transparency regarding how information is collected and used can also strengthen patient trust in smart healthcare systems.

7.2 Interoperability and Data Quality

Smart healthcare depends on communication between different medical devices, EHR systems, diagnostic platforms, laboratories, pharmacies, and digital applications. Incompatible technologies can create information silos and prevent healthcare professionals from obtaining complete patient information. Standardized communication protocols, interoperable data formats, and integrated information platforms are necessary to enable effective information exchange across the healthcare ecosystem.

Data quality also affects smart healthcare performance. Information generated from sensors, clinical records, and digital applications may contain errors, missing values, inconsistent formats, or inaccurate measurements. Poor-quality information can reduce the reliability of analytical models and clinical recommendations. Continuous data validation, standardized collection procedures, appropriate preprocessing, and expert review are therefore essential for reliable smart healthcare services.

7.3 Clinical Validation and Regulatory Compliance

Smart healthcare technologies must demonstrate clinical usefulness before widespread adoption. Technical performance alone does not establish whether a system improves patient outcomes or healthcare quality. Clinical validation should examine accuracy, safety, reliability, usability, and effectiveness in realistic healthcare environments. Continuous evaluation is also important for AI systems that may change as new information becomes available.

Regulatory compliance presents additional challenges for technologies involving medical devices, software, AI, and connected systems. Developers and healthcare organizations must address requirements related to safety, quality, performance, data protection, and risk management. Regulatory pathways may be complex for innovative technologies. Early consideration of regulatory requirements can support responsible development and reduce implementation difficulties.

7.4 Cost, Workforce Readiness, and Accessibility

Smart healthcare technologies may require substantial investments in devices, software, networks, cloud infrastructure, cybersecurity, maintenance, and professional training. Healthcare organizations with limited financial resources may face difficulties adopting advanced systems. Cost-effective technologies, scalable infrastructure, phased implementation, and careful economic evaluation can improve feasibility and help ensure that investments provide meaningful healthcare benefits.

Workforce readiness and accessibility also influence adoption. Healthcare professionals require training to use smart systems and interpret analytical outputs, while patients need sufficient digital literacy and access to appropriate technologies. Individuals without reliable internet access or suitable devices may be excluded from digital healthcare services. Inclusive design, alternative service options, technical support, and patient education can help reduce these barriers.

8. Future Research

Future research should focus on integrated smart healthcare ecosystems combining AI, IoT, wearable technologies, cloud computing, robotics, and advanced analytics. Particular attention should be given to real-time monitoring, explainable AI, digital twins, personalized treatment, predictive healthcare, and

interoperable medical platforms. Research should evaluate how multiple technologies can operate together while maintaining clinical reliability, security, usability, and patient-centered decision-making.

Further studies should examine long-term clinical outcomes, cost-effectiveness, cybersecurity, regulatory implementation, and equitable access. Privacy-preserving analytics, federated learning, secure connected devices, and sustainable healthcare infrastructure represent important research directions. Future research should also investigate workforce adaptation, patient acceptance, digital literacy, and implementation across rural, urban, and resource-limited healthcare environments.

9. Conclusion

Smart healthcare frameworks provide significant opportunities to improve medical services by integrating artificial intelligence, IoT, wearable technologies, cloud computing, analytics, telemedicine, robotics, and digital platforms. These technologies can connect healthcare stakeholders and enable more efficient collection, processing, and use of medical information. Their integration can support improved monitoring, clinical decision-making, accessibility, coordination, and patient-centered healthcare delivery.

The analysis demonstrates that smart healthcare technologies can contribute across multiple medical service areas. AI can provide decision support, IoT and wearable devices can enable continuous monitoring, telemedicine can expand remote healthcare, and robotics can support selected clinical and rehabilitation activities. Cloud computing and analytics can strengthen information management and resource planning. Integrated frameworks can therefore provide broader benefits than isolated technology adoption.

Despite their potential, smart healthcare systems face challenges involving cybersecurity, privacy, interoperability, data quality, clinical validation, regulatory compliance, cost, workforce readiness, and digital inequality. Healthcare organizations must address these issues systematically to ensure that technological development produces safe and meaningful improvements. Technical capability should be evaluated alongside clinical usefulness, patient needs, organizational readiness, and long-term sustainability.

Patient-centered implementation is essential for successful smart healthcare transformation. Technologies should be accessible, understandable, secure, reliable, and aligned with real healthcare requirements. Collaboration among healthcare professionals, engineers, data scientists, administrators, policymakers, and patients can improve technology design and implementation. Such collaboration can also support better alignment between technological capabilities and clinical workflows.

Overall, smart healthcare frameworks can contribute to more connected, intelligent, efficient, and responsive medical services. Future development should emphasize integrated technologies, secure data exchange, explainable analytics, personalized care, continuous monitoring, and equitable access. Responsible governance, rigorous clinical validation, appropriate workforce preparation, and patient participation will be essential for translating smart healthcare innovation into sustainable improvements in medical service quality.

References

1. 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. <https://doi.org/10.1109/ACCESS.2015.2437951>
2. Yin, Y., Zeng, Y., Chen, X., & Fan, Y. (2016). The Internet of Things in healthcare: An overview. *Journal of Industrial Information Integration*, 1, 3–13. <https://doi.org/10.1016/j.jii.2016.03.004>
3. Dimitrov, D. V. (2016). Medical Internet of Things and big data in healthcare. *Healthcare Informatics Research*, 22(3), 156–163. <https://doi.org/10.4258/hir.2016.22.3.156>
4. 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. <https://doi.org/10.1109/ACCESS.2015.2437951>
5. Baker, S. B., Xiang, W., & Atkinson, I. (2017). Internet of Things for smart healthcare: Technologies, challenges, and opportunities. *IEEE Access*, 5, 26521–26544. <https://doi.org/10.1109/ACCESS.2017.2775180>
6. Qi, J., Yang, P., Min, G., Amft, O., Dong, F., & Xu, L. (2017). Advanced Internet of Things for personalised healthcare systems: A survey. *Pervasive and Mobile Computing*, 41, 132–149. <https://doi.org/10.1016/j.pmcj.2017.06.018>
7. Kraemer, F. A., Bråten, A. E., Tamkittikhun, N., & Palma, D. (2017). Fog computing in healthcare—A review and discussion. *IEEE Access*, 5, 9206–9222. <https://doi.org/10.1109/ACCESS.2017.2704100>
8. da Costa, C. A., Pasluosta, C. F., Eskofier, B., da Silva, D. B., & Righi, R. R. (2018). Internet of Health Things: Toward intelligent vital signs monitoring in hospital wards. *Artificial Intelligence in Medicine*, 89, 61–69. <https://doi.org/10.1016/j.artmed.2018.05.005>
9. Pasha, M. (2018). Framework for E-health systems in IoT-based environments. *Wireless Communications and Mobile Computing*, 2018, Article 6183732. <https://doi.org/10.1155/2018/6183732>
10. Paul, A. (2018). Fog computing-based IoT for health monitoring system. *Journal of Sensors*, 2018, Article 1386470. <https://doi.org/10.1155/2018/1386470>
11. Ma, X., Wang, Z., Zhou, X., Wen, J., & Zhang, Y. (2018). Intelligent healthcare systems assisted by data analytics and mobile computing. *Wireless Communications and Mobile Computing*, 2018, Article 3928080. <https://doi.org/10.1155/2018/3928080>
12. Alabdulatif, A., Khalil, I., Yi, X., & Guizani, M. (2019). Secure edge of things for smart healthcare surveillance framework. *IEEE Access*, 7, 31008–31021. <https://doi.org/10.1109/ACCESS.2019.2899323>
13. Ahad, A., Tahir, M., & Yau, K.-L. A. (2019). 5G-based smart healthcare network: Architecture, taxonomy, challenges and future research directions. *IEEE Access*, 7, 100747–100762. <https://doi.org/10.1109/ACCESS.2019.2930628>
14. Dhanvijay, M. M., & Patil, S. C. (2019). Internet of Things: A survey of enabling technologies in healthcare and its applications. *Computer Networks*, 153, 113–131. <https://doi.org/10.1016/j.comnet.2019.03.006>

15. Kotronis, C., Djelouat, H., Amira, A., & Bensaali, F. (2019). Evaluating Internet of Medical Things (IoMT)-based systems from a human-centric perspective. *Internet of Things*, 8, 100125. <https://doi.org/10.1016/j.iot.2019.100125>
16. Alhussein, M., & Muhammad, G. (2019). Automatic voice pathology monitoring using parallel deep models for smart healthcare. *IEEE Access*, 7, 46474–46479. <https://doi.org/10.1109/ACCESS.2019.2905597>
17. Razdan, S., & Sharma, S. (2021). Internet of Medical Things (IoMT): Overview, emerging technologies, and case studies. *IETE Technical Review*, 39(4), 775–788. <https://doi.org/10.1080/02564602.2021.1927863>
18. 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. <https://doi.org/10.1016/j.jobcr.2021.11.010>
19. Motwani, A., Shukla, P. K., & Pawar, M. (2022). Ubiquitous and smart healthcare monitoring frameworks based on machine learning: A comprehensive review. *Artificial Intelligence in Medicine*, 134, 102431. <https://doi.org/10.1016/j.artmed.2022.102431>
20. Renukappa, S., Mudiya, P., Suresh, S., Abdalla, W., & Subbarao, C. (2022). Evaluation of challenges for adoption of smart healthcare strategies. *Smart Health*, 26, 100330. <https://doi.org/10.1016/j.smhl.2022.100330>