

Improving Health Delivery in Nigeria Through Computer-Aided Health Management System

Flourish Funmilola ODEYEMI¹, Excel Tolulope ODEYEMI² and *Charity Segun ODEYEMI³

¹Department of Social Work, University of Ibadan, Oyo State Nigeria, odehyemidflourishfunmilola@gmail.com

²Federal Medical Center Owo, Ondo State Nigeria, odehyemiexcel@gmail.com

³Department of Computer Engineering, Federal University of Technology P. M. B. 704 Akure Ondo State Nigeria. charityodeyemi@gmail.com

*Author for Correspondence: charityodeyemi@gmail.com

Abstract: Nigeria's health delivery system is faced with challenges such as poor health financing, inadequate and uneven distribution of health care workers, poor infrastructure and medical equipment, health information interoperability problems, and maternal, neonatal, and child mortality. Such problems require innovations that can enhance increase access, efficiency, quality of service and decision-making in health care delivery. This paper discusses the history, current uses and future of Computer-Aided Health Management Systems (CAHMS), which is a technological framework that has been used to improve health care delivery. It explore the transformation from the use of paper medical files and primitive health information systems to modern systems using Electronic Health Records, Clinical Decision Support Systems, artificial intelligence, machine learning, telemedicine, remote patient monitoring, blockchain, and Internet of Medical Things. It presents how such technologies could enable health practitioners to monitor patients in real time, make an intelligent diagnosis, use predictive analysis, plan treatment and healthcare resource management. Thus, it shows how new technologically-enabled strategies will be needed to address health access, efficiency, quality, and decision-making problems, thereby driving an effective health care delivery system in Nigeria and other developing nations of the world.

Keywords: Electronic health record, Clinical decision support systems, Artificial Intelligence, Machine learning, Blockchain, Internet of medical things.

Introduction

Nigeria health system, as illustrated in figure 1 is characterized by pluralism and decentralization, having both private and public service providers at various levels of care delivery ranging from primary, secondary to tertiary. PHC was supposed to be the foundation of the health system and its provision includes preventive and promotive services, basic curative services, maternal and child health services, immunization, and community-based services. Secondary health institutions offer more specialized services while tertiary provides the most specialized and referral-based care. While the Federal government has the mandate to provide tertiary services, states' governments provide secondary care services and the Local governments work with the states to deliver primary health care services. However, overlapping of mandates, fragmented governance, and poor coordination and accountability continue to impede the performance of the health system (African Health Observatory Platform [AHOP], 2025a).

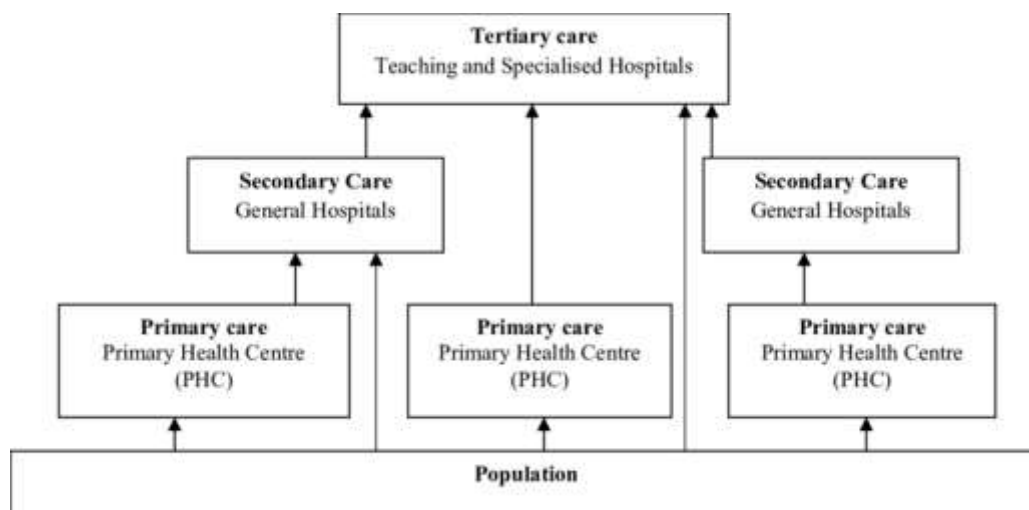


Fig.1: Block diagram of relationships in Nigeria health system (Otu, 2018)

Nigeria has implemented several reforms aimed at improving primary health care, promoting financial protection and strengthening service delivery as well as moving towards UHC. These include Basic Health Care Provision Fund (BHCPF), NHIA framework and Nigeria Health Sector Renewal Investment Initiative (NSHRII). The World Bank also indicates that there have been increased investments in the primary-care facilities and expansion

Challenges facing Health Delivery in Nigeria

Health financing and affordability

Poor health financing and high out-of-pocket spending represent some of the most prominent weaknesses within the health delivery system of Nigeria. As it can be seen from the 2025 Nigeria Health Systems and Services Profile, the level of current health expenditures represented around 4% of GDP in 2021, and the levels of government health expenditures have been remaining under the 15% benchmark set in the Abuja Declaration all along. Furthermore, the share of out-of-pocket payments within the health expenditure amounts to more than 75%, thus causing financial hardships and catastrophic health expenditures. Also, the mentioned source reveals that only a limited number of Nigerians had access to health insurance or any other form of health expenditure pooling mechanism (AHOP, 2025b).

As a result, individuals who are unable to pay for consultations, diagnostics, drugs, transportations, and even hospitalization may seek health care late or turn to other sources of health care. The World Bank also suggests that health services are becoming unaffordable for many Nigerian families and that this problem leads to preventable maternal and child mortality. Human-resource constraints. The other significant problem is the lack of healthcare professionals and their poor distribution. Nigeria faces an acute shortage of physicians, nurses, midwives, pharmacists, laboratory specialists, and many other health workers, with an uneven distribution of these individuals since there are too few of them in rural areas. The Federal Ministry of Health and Social Welfare singled out the issues associated with human resource crisis, brain drain, improper rural distribution of personnel, and strikes as one of the main problems impacting health system resilience (Federal Ministry of Health and Social Welfare, 2025). This issue is especially relevant to primary healthcare because rural and remote areas tend to lack qualified professionals and appropriate infrastructure. It implies that patients will need to spend much time traveling in order to receive the services which can be provided at the primary-care level.

Inadequate infrastructure, equipment, and essential supplies

Poor health infrastructure and the lack of medical equipment also pose additional challenges to the provision of health care services. While Nigeria is endowed with many PHCs, they are not always properly equipped. These challenges range from problems such as poor power and water supply to lack of diagnostic tools, poor transportation networks, lack of drugs, and poor ICT infrastructure. According to the AHOP 2025 report, poor infrastructure and human resource capacities have been the key factors for the relatively poor coverage of health services in Nigeria. This is evidenced by the fact that the AHOP 2025 service coverage index for Nigeria is around 38.4% (AHOP, 2025c). Maternal, neonatal, and child-health burden. It is worth noting that maternal and infant mortality in Nigeria continues to be a huge problem. According to the 2023 Nigerian Demographic and Health Survey as stated in Federal Ministry of Health and Social Welfare report, the maternal mortality ratio was 512 deaths per 100,000 live births, under-five mortality was 110 deaths per 1,000 live births and neonatal mortality stood at 41 deaths per 1,000 live births. While there has been progress compared to previous estimates, the statistics continue to be relatively high (Federal Ministry of Health and Social Welfare, 2025).

There is sufficient evidence from international literature that underlines the severity of the issue. The 2025 maternal-mortality estimates by WHO and other collaborating agencies have shown that there is disproportionate number of maternal deaths in low- and lower middle-income nations, with access to skilled care playing a pivotal role in survival (WHO, 2025). This means that maternal deaths in Nigeria could arise due to several factors including lack of emergency obstetric care, shortage of skilled birth attendants, late referrals, lack of transport, poverty and unavailability of drugs and equipment.

Fragmentation, data, and health-information challenges

The third critical problem is that of fragmented health information and low levels of interoperability. There is information about an individual patient's health history that could be generated independently by hospitals, laboratories, pharmacies, insurance companies, public health programs, and private practitioners, hence the difficulty in assembling a complete view of health information about an individual patient. The problem presents an important opportunity for computer-aided health management, artificial intelligence, electronic health records, telemedicine, internet of medical things (IoMT), and clinical decision support systems. The right designs for digital systems will make it possible to collect information in real time, help in clinical decision-making, patient monitoring, disease prediction, information management, referral coordination, and health system analysis. Nevertheless, digital health interventions will need infrastructure, good data management, interoperability, cybersecurity, manpower, and funding.

Computer-aided health management systems (CAHMS)

Computer-aided health management systems (CAHMS) have significantly transformed the healthcare industry, revolutionizing patient care, administrative processes, and medical decision-making. These systems leverage digital technologies to enhance the accuracy, accessibility, and efficiency of healthcare services. From rudimentary record-keeping systems that replaced traditional paper-based methods to sophisticated artificial intelligence-driven diagnostics, CAHMS have continuously evolved to meet the increasing demands of modern healthcare. The integration of electronic health records (EHR), decision support systems, and telemedicine platforms has streamlined workflows, reducing medical errors and improving patient outcomes. Advanced analytics, machine learning, and big data applications further enhance the predictive capabilities of these systems, enabling early disease detection and personalized treatment strategies (Chaiti *et al.*, 2024). Moreover, CAHMS contribute to healthcare sustainability by optimizing resource allocation and reducing operational costs.

Despite their numerous benefits, the implementation of CAHMS presents challenges, including data security concerns, ethical considerations, and the need for extensive interoperability between different healthcare systems. As technology advances, addressing these challenges will be crucial in ensuring seamless integration and equitable access to healthcare services. This paper explores the historical development, current technological advancements, and future prospects of CAHMS. It examines how these systems have evolved over time, their impact on modern healthcare, and the potential innovations that will shape the future of computer-aided health management.

Computer-Aided Health Management Systems (CAHMS), as illustrated by Odeyemi *et al.*, 2026 in figure 2 integrate advanced computing technologies to facilitate a wide range of healthcare services, including patient management, diagnostics, treatment planning, and administrative functions. These systems serve as the backbone of modern healthcare operations, ensuring seamless communication, data-driven decision-making, and enhanced efficiency in service delivery.

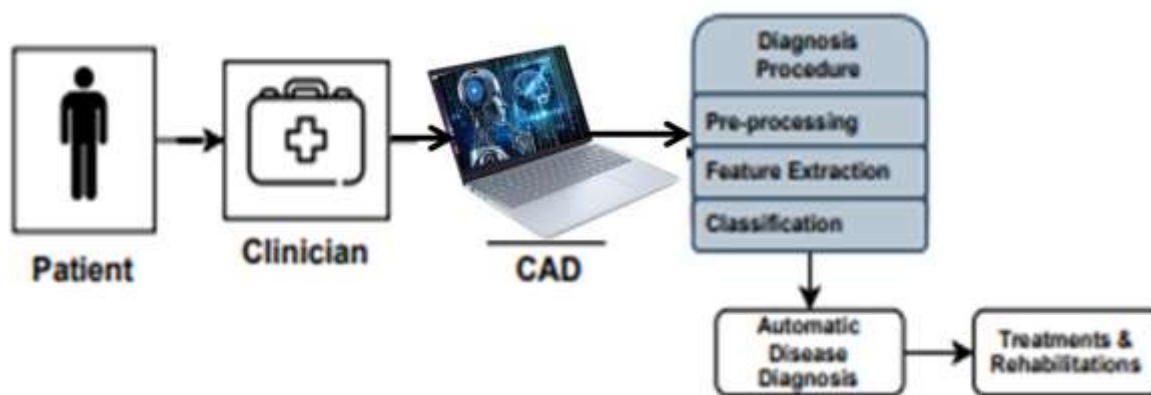


Fig. 2: Architecture of a Computer-Aided health Management System (Odeyemi *et al.*, 2026)

The adoption of CAHMS has been primarily driven by increasing healthcare demands, regulatory requirements, and the need to optimize medical workflows. With the growing complexity of patient care and the rapid advancement of medical technology, healthcare providers require robust digital solutions to manage large volumes of patient data, streamline clinical operations, and improve treatment outcomes. The integration of CAHMS addresses these challenges by automating processes, reducing human errors, and facilitating real-time monitoring of patient health (Shawane *et al.*, 2018).

Key components of CAHMS include:

- i. **User Interface:** Provides interfaces for doctors, nurses, patients, administrators, and other healthcare workers to interact with the system.
- ii. **Patient Data Management:** Captures, stores, retrieves, and manages patient demographic, medical, clinical, and treatment information.
- iii. **Electronic Health Records (EHR):** Maintains longitudinal digital records such as medical history, diagnoses, medications, laboratory results, and clinical notes.
- iv. **Support System:** Assists healthcare professionals in diagnosis, risk assessment, treatment selection, alerts, and clinical recommendations.

- v. *Diagnostic Module*: Processes symptoms, laboratory results, medical images, and other clinical information to support disease detection and diagnosis.
- vi. *Monitoring Module*: Continuously or periodically monitors vital signs and other health indicators, particularly useful in intensive care and chronic disease management.
- vii. *Laboratory Information System*: Manages laboratory requests, test results, specimen information, and communication of results to clinicians.
- viii. *Medical Imaging*: Stores, retrieves, transmits, and processes medical images such as X-rays, CT scans, MRI scans, and ultrasound images.
- ix. *Administrative and Resource Management*: Manages appointments, staff, hospital resources, billing, insurance, bed allocation, and other administrative activities. The increasing reliance on CAHMS has led to improved patient outcomes, cost reduction, and enhanced operational efficiency. However, challenges such as data privacy concerns, cybersecurity threats, and interoperability issues remain critical areas that need to be addressed to ensure the seamless integration of these systems into global healthcare frameworks.

Past Developments in Computer-Aided Health Management

Historically, healthcare management relied on paper-based record-keeping, which was prone to inefficiencies, errors, and difficulties in data retrieval. Patient files were stored in physical cabinets, making them vulnerable to damage, misplacement, and duplication. Additionally, medical professionals faced challenges in sharing patient information across healthcare facilities, often leading to misdiagnoses and delays in treatment.

The 1960s marked a turning point in healthcare management with the introduction of computer-based hospital information systems. One of the earliest systems was the Massachusetts General Hospital Utility Multi-Programming System (MUMPS), a high-level programming language developed for managing medical databases. MUMPS laid the foundation for modern Electronic Health Records (EHR) by enabling structured data storage and retrieval, improving patient record management and hospital workflows.

In the 1980s and 1990s, the healthcare industry witnessed rapid advancements in information technology, leading to the widespread adoption of EHR systems. These digital records replaced paper-based systems, allowing healthcare providers to access and update patient information electronically. Simultaneously, the development of medical expert systems, such as MYCIN, demonstrated the potential of artificial intelligence in healthcare. MYCIN was an AI-based program designed to assist doctors in diagnosing bacterial infections and recommending appropriate antibiotic treatments. Though limited by the computing power of its time, MYCIN pioneered the use of rule-based decision-making in medicine.

During this period, advancements in medical imaging also played a crucial role in shaping CAHMS. The introduction of Computerized Tomography (CT) and Magnetic Resonance Imaging (MRI) revolutionized diagnostic capabilities, allowing physicians to obtain detailed images of internal organs and detect diseases more accurately. Additionally, the development of Picture Archiving and Communication Systems (PACS) enabled hospitals to store, retrieve, and share medical images digitally, reducing the reliance on physical film-based records.

By the late 1990s, the integration of healthcare information systems across hospitals and clinics became a priority, leading to the establishment of Health Information Exchanges (HIEs). These networks facilitated the secure sharing of patient data between healthcare providers, improving care coordination and reducing redundant medical tests. The growing adoption of the internet also paved the way for telemedicine, enabling remote consultations and bridging gaps in healthcare accessibility.

Despite these advancements, early CAHMS faced challenges such as high implementation costs, limited interoperability between systems, and resistance from medical professionals accustomed to traditional workflows. However, these challenges set the stage for further technological innovations that would enhance the efficiency, accessibility, and security of computer-aided health management systems in the 21st century.

Present Technologies in Computer-Aided Health Management

Currently, Computer-Aided Health Management Systems (CAHMS) have become more sophisticated, leveraging advancements in cloud computing, big data analytics, artificial intelligence (AI), and blockchain technology. These modern innovations have significantly enhanced patient care, operational efficiency, and data security within the healthcare sector.

- i. Electronic Health Records (EHR): Modern EHR systems have evolved beyond simple digital patient records to comprehensive, interoperable platforms that integrate clinical, administrative, and financial data. These systems ensure real-time access to patient information across multiple healthcare providers, improving care coordination and reducing medical errors. Cloud-based EHR solutions facilitate secure data storage and retrieval, enabling seamless communication between hospitals, clinics, and insurance providers. Additionally, natural language processing (NLP) techniques are being incorporated into EHRs to enhance clinical documentation and streamline workflow efficiency (Kwarteng-Amaniampong, 2025).
- ii. Artificial Intelligence and Machine Learning: AI and machine learning have revolutionized medical diagnostics and treatment planning. AI-driven tools, such as IBM Watson Health and Google's DeepMind, assist in analyzing complex medical data, identifying disease patterns, and recommending personalized treatment plans. Machine learning algorithms are being used to predict patient deterioration, optimize hospital resource allocation, and detect anomalies in medical imaging. AI-powered chatbots and virtual assistants also enhance patient engagement by providing real-time health advice and appointment scheduling (Topol, 2019).
- iii. Clinical Decision Support Systems (CDSS): AI-powered tools that assist medical practitioners in making informed decisions based on real-time patient data and evidence-based guidelines. CDSS can provide alerts, treatment recommendations, and predictive analytics to enhance diagnosis and patient care.
- iv. Telemedicine and Remote Monitoring: The integration of Internet of Things (IoT) devices with healthcare systems has enabled real-time patient monitoring and remote consultations. Wearable devices, such as smartwatches and biosensors, track vital signs like heart rate, blood pressure, and glucose levels, allowing physicians to monitor chronic conditions remotely. Telemedicine platforms facilitate video consultations, reducing the need for in-person hospital visits and expanding healthcare access to rural and underserved populations. Remote patient monitoring (RPM) has been particularly beneficial in managing post-surgical recovery, chronic diseases, and elderly care, reducing hospital readmissions and improving patient outcomes (Keesara *et al.*, 2020).
- v. Blockchain for Data Security: With the increasing digitization of health records, data security and privacy concerns have become paramount. Blockchain technology provides a decentralized and tamper-proof system for storing and sharing medical data, ensuring data integrity and preventing unauthorized access. Blockchain-based health management systems enable secure patient identity verification, encrypted health record transactions, and improved interoperability between healthcare organizations. Smart contracts in blockchain can also automate insurance claims processing and consent management, reducing administrative burdens and fraud risks (Durneva *et al.*, 2020).

These technological advancements in CAHMS are transforming healthcare delivery, improving patient outcomes, and addressing critical challenges such as data security, accessibility, and cost-efficiency. However, challenges such as regulatory compliance, system interoperability, and ethical considerations remain key areas for further development and refinement.

Future Prospects of Computer-Aided Health Management

The future of Computer-Aided Health Management Systems (CAHMS) will be shaped by emerging technologies and evolving healthcare demands. As medical needs grow more complex, technological innovations will play a crucial role in advancing patient care, optimizing healthcare operations, and addressing global health challenges.

- i. AI and Precision Medicine: Artificial intelligence will continue to drive advancements in precision medicine, enabling highly accurate disease prediction, early detection, and personalized treatment plans. AI-powered algorithms will analyze vast datasets, including genetic information, lifestyle factors, and medical history, to recommend individualized treatments tailored to each patient's unique biology. AI-driven robotic surgery, automated pathology, and deep learning models for medical imaging will further enhance diagnostic precision and therapeutic outcomes (Collins & Varmus, 2015).
- ii. Wearable and Implantable Devices: The proliferation of wearable health devices and implantable biosensors will facilitate real-time health monitoring, empowering individuals to take a proactive approach to their well-being. Smartwatches, continuous glucose monitors, and ECG-equipped wearables will provide instant feedback on vital signs, while implantable sensors will monitor chronic conditions such as cardiovascular diseases and neurological disorders. These advancements will enable early intervention, reduce hospitalizations, and improve patient adherence to treatment regimens (Patel *et al.*, 2012).
- iii. Quantum Computing in Healthcare: Quantum computing is poised to revolutionize healthcare by significantly accelerating drug discovery, genomic analysis, and complex medical simulations. With its immense computational power, quantum technology will enhance molecular modeling, allowing scientists to identify new drug compounds more efficiently. Additionally, quantum-driven AI models will refine genetic sequencing techniques, leading to breakthroughs in personalized medicine, cancer treatment, and neurodegenerative disease research (Biamonte *et al.*, 2017).

- iv. 5G/6G and Telehealth Expansion: The global rollout of 5G/6G networks will dramatically enhance telemedicine capabilities, enabling seamless, high-speed, low-latency remote consultations and real-time patient monitoring. With improved network infrastructure, healthcare providers can conduct high-quality video consultations, remote robotic surgeries, and AI-assisted diagnostics with minimal delay. The integration of 5G/6G with IoT-powered medical devices will also enhance remote patient care, particularly in underserved and rural areas, bridging the healthcare accessibility gap (Ahad *et al.*, 2020).
- v. The Internet of Medical Things (IoMT) is the name used to describe the network of medical devices and systems that can collect and transmit health-related data using internet technology. The IoMT is an application of the Internet of Things (IoT) concept to the healthcare industry. It allows healthcare professionals to monitor their patients, collect clinical information, make diagnoses, and provide healthcare services remotely.

These future developments in CAHMS will contribute to a more patient-centric, efficient, and technologically advanced healthcare system. However, challenges such as ethical concerns, data security, regulatory compliance, and equitable access to technology must be addressed to ensure widespread and effective implementation.

Challenges and Ethical Considerations

While Computer-Aided Health Management Systems (CAHMS) offer numerous benefits, they also present significant challenges that must be addressed to ensure responsible and equitable healthcare implementation. These challenges span data privacy concerns, cybersecurity threats, regulatory compliance, and ethical dilemmas in AI-driven decision-making (Abimbola, 2024; Pham, 2025).

- i. Data Privacy and Security Concerns: The digitization of health records and the widespread adoption of cloud-based health management systems raise concerns about data security and patient confidentiality. Cyberattacks targeting healthcare organizations, such as ransomware and data breaches, put sensitive patient information at risk. Ensuring compliance with data protection regulations, such as the Health Insurance Portability and Accountability Act (HIPAA) and the General Data Protection Regulation (GDPR), is crucial to safeguarding patient privacy (Reddy, 2019).
- ii. Cybersecurity Threats: As CAHMS rely heavily on interconnected networks and internet-based services, they become vulnerable to cyber threats. Unauthorized access, hacking, and malware attacks can compromise healthcare operations, leading to disruptions in patient care and potential misuse of medical data. Implementing robust cybersecurity measures, including encryption, multi-factor authentication, and real-time threat detection systems, is essential to mitigate these risks.
- iii. Ethical Dilemmas in AI-Driven Decision-Making: AI-powered healthcare solutions, such as predictive analytics and automated diagnostics, raise ethical questions regarding accountability and transparency. AI algorithms may inadvertently introduce biases based on the data they are trained on, leading to disparities in healthcare outcomes. Additionally, the role of AI in clinical decision-making must be clearly defined to ensure that human oversight remains central to patient care, preventing over-reliance on automated systems.
- iv. Regulatory and Legal Challenges: The rapid advancement of CAHMS requires regulatory bodies to continuously update policies and legal frameworks to keep pace with technological changes. Standardizing health data exchange protocols, ensuring interoperability among different CAHMS platforms, and establishing clear guidelines for AI deployment in medical practice are necessary steps for effective governance.
- v. Equitable Healthcare Access: While CAHMS have the potential to improve healthcare delivery, disparities in access to technology remain a concern. Rural and underserved populations may face challenges in adopting digital health solutions due to limited internet connectivity, lack of digital literacy, and financial constraints. Addressing these disparities through targeted policies, infrastructure development, and inclusive technology design is essential to ensure that the benefits of CAHMS are accessible to all.

Computer-aided health management systems have come a long way, evolving from basic hospital information systems to sophisticated AI-driven diagnostic tools. As technological advancements continue to reshape healthcare, strategic implementation, ethical considerations, and robust regulatory frameworks will be crucial in maximizing their potential while mitigating associated risks. By addressing cybersecurity vulnerabilities, ensuring data privacy, and promoting equitable access, CAHMS can play a transformative role in building a more efficient, secure, and inclusive healthcare system.

References

Abimbola B. (2024).: Ethical Considerations in AI Applications for Biomedical Science and Patient Care. Am J Biomed Sci & Res. 2024 - 24(6). AJBSR.MS.ID.003269. DOI:[10.34297/AJBSR.2024.24.003269](https://doi.org/10.34297/AJBSR.2024.24.003269)

Ahad A, Tahir M, Aman Sheikh M, Ahmed KI, Mughees A, Numani A. Technologies Trend towards 5G Network for Smart Health-Care Using IoT: A Review. *Sensors (Basel)*. 2020 Jul 21;20(14):4047. doi: 10.3390/s20144047. PMID: 32708139; PMCID: PMC7411917.

African Health Observatory Platform. (2025a). *Health financing: Nigeria health system and services profile*. World Health Organization Regional Office for Africa.

African Health Observatory Platform. (2025b). *Health system coverage and system outcomes: Nigeria health system and services profile*. World Health Organization Regional Office for Africa.

African Health Observatory Platform. (2025c). *Organization and governance of the health system: Nigeria health system and services profile*. World Health Organization Regional Office for Africa.

Biamonte J, Wittek P, Pancotti N, Rebentrost P, Wiebe N & Lloyd S. (2017): Quantum machine learning. *Nature*. 2017 Sep 13;549(7671):195-202. doi: 10.1038/nature23474. PMID: 28905917

Chaiti L. Z., Asif N. B, Oeshi A. J., Hossain I. & Taleb A (2023): A Computerized Hospital Management System 1 *International Journal of Novel Research and Development (www.ijnrd.org)*, 8(2), 916-937

Collins, F. S., & Varmus, H. (2015). A new initiative on precision medicine. *New England Journal of Medicine*, 372(9), 793–795.

Durueva P, Cousins K, & Chen M (2020): The Current State of Research, Challenges, and Future Research Directions of Blockchain Technology in Patient Care: Systematic Review

J Med Internet Res 2020;22(7):e18619
doi: 10.2196/18619

Federal Ministry of Health and Social Welfare. (2025). *Inaugural address by the Honourable Minister of State for Health and Social Welfare at the 2025 Joint Annual Review Meeting*. Federal Republic of Nigeria.

Kwarteng-Amaniampong E. (2025); Electronic Health Records (EHRs) and quality healthcare delivery: qualitative study on selected hospitals in Ghana. *World Journal of Advanced Research and Reviews*, 2025, 25(03), 393-405

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

Odeyemi, C. S. ., Ubochi, B. C. ., Olowu, A. J. ., & Apena, W. O. . (2026). Artificial Intelligence-Based Computer-Aided Diagnosis of Neonatal Sepsis: Current Advances, Challenges and Clinical Opportunities in Nigeria. *American Journal of Data Science and Artificial Intelligence*, 2(2), 46-53. <https://doi.org/10.54536/ajdsai.v2i2.7798>

Out, E. (2018). Geographical access to healthcare services in Nigeria: A review. *International Journal of Interrogative Humanism*, 10(1), 17–16.

Patel M. S., Asch D. A., & Volpp K. G. (2015): Wearable devices and future healthcare. *Journal of the American Medical Association (JAMA)* in 2015, 394(10205), 158–160.

Pham T. Ethical and legal considerations in healthcare AI: innovation and policy for safe and fair use. *R Soc Open Sci*. 2025 May 14;12(5):241873. doi: 10.1098/rsos.241873. PMID: 40370601; PMCID: PMC12076083.

Reddy, S. (2019). Ethical considerations of AI in healthcare. *AI & Society*, 34(3), 431–442.

Sawaneh I. A., Kamara A., Koroma J. H. (2018): A Computerized Patient's Database Management System, *International Journal of Computer Science and Information Technology Research*, ISSN 2348-120X (online), 6(2)

Topol, E. (2019). *Deep medicine: How artificial intelligence can make healthcare human again*. Basic Books, 171-194.

World Health Organization. (2025). *Country health systems and services profiles: Nigeria*. WHO Regional Office for Africa.