

# The Application of Artificial Intelligence to Digital Healthcare in the Nigerian Tertiary Hospitals: Mitigating the Challenges

Okpala Somkenechi Chinwe<sup>1</sup> and Okpala Charles Chikwendu<sup>2</sup>

*Correspondence Address*

<sup>1</sup>Department of Paediatrics

University of Nigeria Teaching Hospital,  
Ituku/Ozalla, Enugu - Nigeria

<sup>2</sup>Industrial/Production Engineering Department  
Nnamdi Azikiwe University, P.M.B. 5025 Awka  
Anambra State - Nigeria.

Emails: [somkene82@yahoo.com](mailto:somkene82@yahoo.com), [cc.okpala@unizik.edu.ng](mailto:cc.okpala@unizik.edu.ng)

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## **Abstract**

*In recent years, the integration of artificial intelligence (AI) into digital healthcare systems has shown immense promise in revolutionizing medical practices and improving patient outcomes, through the improvement of patient care, optimized workflows, and advanced medical research. However, the successful application of AI in Nigerian tertiary hospitals although at its early stage, faces various challenges that impede its seamless adoption. This article explores the unique challenges encountered in implementing AI in digital healthcare in the Nigerian Tertiary Hospitals (NTHs) and proposes strategies to mitigate these obstacles. It discusses various AI applications currently utilized, such as diagnostic tools, predictive analytics, and robotic surgeries, and highlights how these technologies can address key healthcare challenges in Nigeria. Furthermore, the article examines the obstacles hindering the widespread implementation of AI in Nigerian healthcare settings and proposes strategies to overcome these challenges*

**Keywords:** *artificial intelligence, digital healthcare, Nigerian tertiary hospitals, data security, interoperability, ethics, predictive analytics, robot assisted surgery*

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## **I. Introduction**

Shaheen (2021), observed that the healthcare industry is in the midst of revolution because of increasing total health-care cost as well as a rising decline of health-care experts. He explained that as a result that the healthcare industry is seeking to implement new information technology-based solutions and processes that can cut costs and also proffer solutions to these rising difficulties. This explains the need for the integration of Artificial Intelligence (AI) to Digital Health Care (DHC) by hospitals. According to Okpala, Igbokwe and Nwankwo (2023), AI whose “tasks encompass a wide range of activities such as learning, reasoning, problem-solving, perception, and language understanding has emerged as a transformative force that revolutionizes various aspects of human life, industry, and technology.” They explained that it is a transformative technology that involves the development of algorithms and systems that enable machines to perform tasks that typically require human intelligence.

The integration of Artificial Intelligence (AI) to digital healthcare entails the application of software and the algorithms of machine learning, to use input data to arrive at approximate conclusions, by mimicking the reasoning of humans for evaluation and perception of complicated medical data, in order to surpass man’s competence through the provision of efficient means of prevention, diagnosis, and treatment of diverse sicknesses. By executing robotic surgeries, enhancing drug discovery and medical diagnosis, handling data, as well as improving patients’ experience, AI seamlessly and timely performs human works at a reduced cost. Moglia et al. (2021), explained that AI has been applied to numerous healthcare domains, and in some cases it out-performs experienced Physicians as demonstrated in dermatology.

In the dynamic landscape of healthcare, the application of AI into digital healthcare systems has emerged as a transformative force, promising to revolutionize patient care delivery and management. Nigeria, with its diverse healthcare landscape, is gradually embracing the transformative potential of AI in improving healthcare outcomes. Tertiary hospitals, serving as the apex of the healthcare system, play a crucial role in

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providing specialized medical care. Integrating AI into these institutions could enhance diagnostics, treatment planning, and patient care. Nevertheless, the implementation of AI in this context is met with several challenges. Chan et al. (2018), posited that AI has the capability to detect meaningful relationships in a dataset, and has been widely used in many clinical situations for diagnosis, treatment, and prediction of results.

One of the primary areas where AI can make a substantial impact is in medical imaging. With the scarcity of radiologists in many Nigerian hospitals, AI-powered image analysis tools can assist in the timely and accurate interpretation of medical images, leading to faster diagnosis and treatment decisions. Moreover, AI algorithms can help detect abnormalities in medical scans with high precision, thereby reducing the likelihood of misdiagnosis and improving patient outcomes. According to Devi et al. (2023), AI has the power to transform healthcare by boosting patient care, improve diagnostic accuracy, optimize treatment plans, save healthcare costs, cut down on medical mistakes, and also promote more individualized therapy.

Another crucial aspect of healthcare where AI can be instrumental is in predictive analytics and personalized medicine. By analyzing large volumes of patient data, AI algorithms can identify patterns and trends that human clinicians might overlook, enabling more accurate predictions of disease progression and treatment responses. This predictive capability not only facilitates early intervention but also allows for the customization of treatment plans to suit individual patient needs, ultimately leading to better clinical outcomes.

Furthermore, AI-powered virtual assistants and chatbots have the potential to streamline administrative tasks and enhance patient engagement. These digital tools can provide patients with personalized health information, schedule appointments, and even offer basic medical advice, thereby relieving the burden on healthcare staff and improving the overall patient experience.

As people navigate the ever-evolving landscape of healthcare, it is evident that the integration of artificial intelligence (AI) into digital healthcare systems presents a promising avenue for enhancing patient care and operational efficiency. Generally, the healthcare sector in Nigeria, particularly in tertiary hospitals, faces numerous challenges ranging from limited resources and high burden of diseases to inadequate infrastructure and skilled workforce. The integration of AI technologies offers a transformative solution to these issues by enhancing diagnostic accuracy, optimizing treatment plans, and improving patient management. However, the implementation of AI in NTHs is hindered by unique challenges that require targeted interventions.

## **II. Applications of AI in Healthcare**

Artificial Intelligence has made significant strides in transforming healthcare across various domains, from diagnostics to personalized treatment. Bohr and Memarzadeh (2020), noted that it is widely believed that AI tools will facilitate and improve human work and not replace the work of physicians and other healthcare officials. They explained that AI supports healthcare personnel with diverse tasks from administrative workflow to clinical documentation and patient outreach, as well as specialized support such as in image analysis, medical device automation, and patient monitoring.

AI technologies have the potential to significantly impact healthcare delivery in Nigerian tertiary hospitals. Diagnostic AI tools can assist in early disease detection and interpretation of medical images, addressing the shortage of skilled radiologists. AI-driven predictive analytics can identify at-risk patient populations for preventive interventions, optimizing resource allocation and reducing healthcare costs. Additionally, robotic surgeries powered by AI can enhance surgical precision and minimize post-operative complications. Some notable applications of AI in healthcare include the following:

**Medical Imaging and Diagnostics:** AI algorithms are proficient in interpreting medical images like X-rays, MRIs, and CT scans. They can detect abnormalities and assist radiologists in making accurate diagnoses faster. In recent years, the integration of AI technologies into medical imaging and diagnostics into the Nigerian tertiary hospitals has transformed the landscape of healthcare, enhancing accuracy, efficiency, and patient outcomes. Medical imaging, which includes techniques like X-rays, Magnetic Resonance Imaging (MRI), Computed Tomography (CT) scans, and ultrasound, plays a crucial role in disease detection, diagnosis, and treatment planning. AI-powered applications are revolutionizing these processes in several significant ways including enhanced diagnostic accuracy, automated image analysis, workflow optimization, personalized treatment planning, real-time decision support, and continual learning and improvement.

**Personalized Medicine:** In recent years, some NTHs has seen remarkable advancements due to the integration of AI technologies. One profound application of AI in healthcare is personalized medicine, a revolutionary approach that improves medical treatment to individual characteristics of each patient. Personalized medicine aims to provide customized healthcare solutions by considering factors such as genetics, lifestyle, and environment unique to each patient. This approach contrasts with traditional medicine, which often uses a one-size-fits-all treatment strategy. AI plays a critical role in enabling personalized medicine by processing vast amounts of data and extracting actionable insights.

AI can analyze large datasets, including genetic information and patient histories, to predict individual patient responses to treatment. This allows for tailored and more effective therapies. By harnessing AI technologies,

healthcare providers can deliver targeted, effective treatments that improve patient outcomes and pave the way for a more sustainable and patient-centric healthcare system.

**Drug Discovery and Development:** AI accelerates drug discovery by analyzing vast amounts of chemical data and simulating drug interactions. This leads to the identification of potential drug candidates quicker than traditional methods. While observing that nearly all key bio-pharmaceutical companies are applying AI in their manufacturing processes, Shaheen (2021), opined that Pfizer is applying IBM Watson, a machine learning-based system to enable it to discover immuno-oncology treatments, while Sanofi has decided to employ Exscientia's AI platform to seek for metabolic-disease medications, and that Roche subsidiary Genentech is depending on an AI system from GNS Healthcare in Cambridge to assist in its search for cancer treatments. He concluded that AI and machine learning will usher in a new era of drug development that is faster, cheaper, and more reliable.

AI has the potential to quicken the process of drug discovery and development in the NTHs through the analysis of numerous data for the identification and prediction of toxicity, efficacy and quality of drugs, as well as the optimization of their chemical structure. This innovation substantially reduces the cost and timeline of introducing new drugs to the market.

**Virtual Health Assistants:** One of the most impactful applications of AI in healthcare is the development and utilization of Virtual Health Assistants (VHAs). These intelligent systems are revolutionizing patient care, improving efficiency, and enhancing the overall healthcare experience. AI-powered virtual health assistants provide patients with personalized advice, medication reminders, and answers to medical queries. These assistants can also monitor patients remotely, enhancing preventive care. Bozic (2023), explained that AI-powered virtual health assistants, also known as "chatbots" can provide patients with real-time health information, schedule appointments, and answer questions about medications, symptoms, and lifestyle recommendations. He explained that these virtual assistants can enhance patient engagement, improve access to healthcare services, and reduce the burden on healthcare providers.

VHAs powered by AI represent a paradigm shift in healthcare delivery. These intelligent systems are poised to enhance access, efficiency, and quality of care while empowering patients to take an active role in managing their health. As AI continues to evolve, the potential for VHAs to positively impact Nigerian tertiary hospitals is immense, promising a future where personalized, intelligent assistance is a cornerstone of modern healthcare practice.

**Healthcare Management and Administration:** The field of healthcare management and administration has been significantly transformed by the integration of AI technologies. AI applications are revolutionizing how healthcare organizations operate, streamline processes, and deliver patient care. It optimizes administrative tasks such as scheduling, billing, and patient record management, thereby reducing administrative burden and improves overall efficiency.

By leveraging AI technologies, the Nigerian tertiary hospitals can enhance operational efficiency, improve decision-making processes, optimize resource utilization, and ultimately deliver higher-quality care to patients. As AI continues to evolve, its impact on healthcare management will undoubtedly reshape the future of healthcare delivery and administration

**Predictive Analytics and Disease Forecasting:** Predictive analytics involves the use of statistical algorithms and machine learning techniques to analyze current and historical data in order to make predictions about future events or behaviors. Predictive analytics and disease forecasting powered by AI represent a transformative frontier in healthcare. These technologies can empower NTHs and policymakers with actionable insights to enhance disease prevention, diagnosis, and treatment strategies.

Nia, Kaplanoglu and Nasab (2023), observed that the application of AI in the assessment of medical images has led to accurate evaluations being performed automatically, which in turn has reduced the workload of physicians, decreased errors and times in diagnosis, and improved performance in the prediction and detection of various diseases. In disease forecasting, AI algorithms analyze vast datasets including demographic information, travel patterns, climate data, and historical health records to identify potential disease outbreaks before they escalate. Early detection enables timely public health interventions such as vaccination campaigns and targeted containment strategies. As AI continues to evolve, its integration into healthcare systems holds immense promise for improving patient outcomes, reducing healthcare costs, and advancing population health management.

**Robot-Assisted Surgery:** One notable application of AI in healthcare is robot-assisted surgery, a cutting-edge approach that combines the precision of robotics with the expertise of skilled surgeons. Robot-assisted surgery involves the use of robotic systems to aid surgeons in performing complex procedures with enhanced precision, control, and flexibility. These systems are equipped with advanced sensors and cameras that provide real-time, high-definition images of the surgical site. Surgeons operate these robots through a console, where their hand movements are translated into precise actions by robotic arms inside the patient's body.

AI plays a pivotal role in robot-assisted surgery by enabling the robots to interpret data, make informed decisions, and execute tasks autonomously under the guidance of surgeons. Machine learning algorithms are

employed to analyze vast amounts of medical data, such as images, patient records, and surgical outcomes. This data-driven approach enhances surgical planning, assists in real-time decision-making during procedures, and ultimately improves patient outcomes. The adoption of robot-assisted surgery offers the following advantages over traditional surgical methods: enhanced precision and accuracy, minimally invasive, improved visualization, remote surgery, dexterity, and improved control during surgical procedures.

**Behavioral Modification and Monitoring:** Behavioural modification and monitoring are key applications of artificial intelligence (AI) in healthcare, offering innovative ways to improve patient outcomes and personalize care. AI applications in NTHs can analyze vast amounts of patient data including medical history, lifestyle habits, and environmental factors to develop personalized behaviour modification plans. These plans can incorporate targeted interventions such as reminders, educational content, or motivational messages tailored to individual needs

AI-powered systems can continuously monitor patient behaviours such as physical activity levels, sleep patterns, dietary habits, and medication adherence. This data is collected through wearable devices or smartphone apps and can provide real-time insights into a patient's health status. Overall, AI-driven behavioural modification and monitoring have the potential to revolutionize healthcare by empowering patients, improving outcomes, and optimizing the delivery of personalized care. However, it requires thoughtful integration into clinical workflows and ongoing evaluation to realize its full benefits while mitigating risks.

**Clinical Trial Optimization:** Clinical trial optimization is a critical area within healthcare where AI can significantly enhance efficiency, speed, and effectiveness. Clinical trials are fundamental for testing new treatments, drugs, or interventions before they can be approved for widespread use. However, these trials are often time-consuming, expensive, and subject to various challenges. AI technologies offer innovative solutions to address these challenges and optimize the entire clinical trial process.

The integration of AI in clinical trial optimization holds immense promise for transforming the drug development process, reducing costs, accelerating timelines, and ultimately delivering safer and more effective treatments to patients. However, it's essential to address challenges related to data privacy, algorithm transparency, and regulatory compliance to ensure the responsible and ethical deployment of AI in healthcare.

**Continuous Learning and Improvement:** AI systems continuously learn from new data and experiences, refining their algorithms and improving diagnostic accuracy over time. Continuous learning and improvement through AI application in healthcare is a transformative concept that leverages AI technologies to enhance various aspects of patient care, operational efficiency, and medical research. They revolutionize traditional medical practices by harnessing the power of data and algorithms to deliver more effective, personalized, and efficient care. This iterative process of learning and adaptation holds immense potential for transforming the future of healthcare delivery and medical research.

### 1. Challenges in the Application of AI in Nigerian Tertiary Hospitals

The application of AI in NTHs presents a unique set of challenges, primarily due to socio-economic, infrastructural, and educational disparities. Some of these challenges are discussed here:

**Insufficient Power Supply:** AI systems require continuous power to function effectively. Inconsistent power supply can lead to frequent disruptions or shutdowns of AI systems, affecting their reliability and performance. This unreliability can undermine the trust of healthcare professionals in AI-driven tools. Addressing the challenge of insufficient power supply is essential to unlocking the full potential of AI in Nigerian tertiary hospitals. This may require collaborative efforts between healthcare institutions, government agencies, and private sector stakeholders to improve power infrastructure and ensure reliable electricity supply for AI applications in healthcare.

**Limited Access to High-Speed Internet:** AI applications often require a stable and high-speed internet connection for tasks like data sharing, cloud computing, and real-time analysis. In many Nigerian tertiary hospitals, especially in rural areas, internet connectivity may be unreliable or insufficient, hindering the adoption of AI technologies that rely on cloud-based services or large-scale data processing.

**Data Privacy and Security Concerns:** Healthcare data, especially patient records, are highly sensitive and confidential. They often include personal information, medical history, and other sensitive details. AI applications in hospitals require access to this data for training and decision-making, thereby raising concerns about how this data is handled, stored, and protected. Also, AI systems depend heavily on large datasets, which can be attractive targets for cyberattacks.

Omomoemi and Amanawa (2024), observed that the use of AI in health-care raises concerns about the privacy and security of patient data, as striking a balance between innovation and protecting individuals' sensitive health information is a significant challenge. They noted that handling large amounts of sensitive medical imaging data requires robust privacy measures to protect patient confidentiality, as it is critical to protect against unwanted access and implement robust cybersecurity procedures. Many NTHs do not have robust cybersecurity measures

in place to protect against data breaches or unauthorized access. AI systems themselves can also be vulnerable to attacks if not securely designed and maintained.

**Interoperability and Integration:** Nigerian tertiary hospitals often use disparate and fragmented health information systems that do not communicate effectively with each other. Electronic Health Records (EHRs), laboratory systems, imaging systems, and other data sources operate in silos, thereby making it difficult to aggregate data for AI applications. Also, there are lack of standardized formats and protocols for data sharing and exchange across different hospital departments and systems. This hinders the seamless integration of AI tools that require access to diverse and standardized data sources.

**Inadequate IT Infrastructure:** Many NTHs lack robust IT infrastructure necessary for AI implementation. This includes outdated or insufficient hardware (e.g., computers, servers) to run complex AI algorithms and software. The absence of dedicated IT support teams to maintain and troubleshoot these systems further exacerbates the problem.

**Data Quality and Accessibility:** AI algorithms heavily depend on large amounts of high-quality data for training and validation. Nigerian hospitals often face challenges related to inconsistent data collection practices, poor data quality, and fragmented data storage across different departments or systems. Integrating and standardizing these data sources for AI applications can be complex and resource-intensive.

**Financial Constraints:** Acquiring and implementing AI technologies can be expensive. Nigerian tertiary hospitals, already grappling with budgetary constraints, may struggle to allocate funds for purchasing AI software, hardware, and the required infrastructure upgrades. Additionally, the ongoing costs of maintenance, training, and support further strain limited financial resources.

**Lack of Skilled Personnel:** The successful application of AI in NTHs requires trained professionals with expertise in AI, data science, and healthcare informatics. Nigeria faces a shortage of such skilled personnel, limiting the capacity to develop, deploy, and maintain AI systems within tertiary hospitals.

**Regulatory and Ethical Challenges:** Implementing AI in healthcare raises complex regulatory and ethical considerations related to patient data privacy, transparency of algorithms, and liability issues. Nigeria lack comprehensive regulations and guidelines specific to AI in healthcare, thereby creating uncertainty and barriers to its adoption. According to Wubineh, Deriba and Woldevohannis (2024), the integration of AI in healthcare presents a wide range of challenges in terms of privacy and ethics, including issues with patient data protection, ethical boundaries of innovation, and the actual impact of technology on both doctors and patients. They opined that to realize the full potential of AI in healthcare, strategic decisions must be made that balance competing interests and values, which include issues of privacy, accountability, intellectual property rights, and transparency.

**Education and Skills Gap:** AI requires specialized skills in data science, programming, and machine learning. Third-world countries like Nigeria often face challenges in providing quality education and training in these areas, leading to a shortage of skilled professionals capable of developing and implementing AI solutions.

**Cost:** Acquiring AI technology and expertise can be prohibitively expensive for many third-world countries, particularly those with limited financial resources and competing priorities for funding.

Addressing these challenges requires a coordinated effort involving governments, educational institutions, businesses, and international organizations to promote inclusive and sustainable AI adoption in NTHs. This will involve investing in infrastructure, promoting education and skills development, fostering local innovation ecosystems, and ensuring ethical and responsible AI practices.

### **III. Strategies for Mitigating the Challenges**

To facilitate the successful integration of AI into Nigerian tertiary hospitals, several strategies can be employed. Firstly, investment in robust data infrastructure and interoperable electronic health records is essential to facilitate data-driven AI applications. Collaborations with international organizations and academia can support capacity building and training programs for AI-specialized healthcare professionals. Furthermore, government policies promoting AI research and development, coupled with regulatory frameworks addressing ethical concerns, are crucial for fostering a conducive environment for AI adoption.

There is a need for robust infrastructure and reliable internet connectivity to support AI-powered systems effectively. Additionally, issues related to data privacy, security, and ethical considerations must be carefully addressed to maintain patient trust and confidentiality. Moreover, the limited availability of skilled professionals with expertise in AI and data science poses a significant barrier to the adoption of these technologies. To overcome this challenge, investments in training and capacity-building initiatives are essential to equip healthcare workers with the necessary skills to harness the power of AI effectively.

According to Petersson et al. (2022), there is a need to see the implementation of AI system in healthcare as a changing learning process at all organizational levels, necessitating a healthcare system that applies more nuanced systems thinking. They pointed out that it is very important to involve and collaborate with stakeholders and users inside the regional healthcare system itself and other actors outside the organization in order to succeed in developing and applying system thinking on AI implementation of.

Addressing these challenges requires a multi-faceted approach involving stakeholders at various levels. This includes investing in robust IT infrastructure, promoting data standardization and governance frameworks, fostering partnerships between healthcare providers and technology vendors, and prioritizing workforce development in AI and data analytics.

Additionally, policy interventions aimed at promoting interoperability and ensuring data security can create an enabling environment for the successful application of AI in NTHs. By addressing these challenges through a combination of regulatory compliance, technological measures, and capacity building, Nigerian tertiary hospitals can leverage AI while safeguarding patient data privacy and security. This approach is crucial for building trust in AI technologies and maximizing their benefits in improving healthcare outcomes.

#### **IV. Conclusion**

The integration of AI into digital healthcare in the Nigerian tertiary hospitals offers unprecedented opportunities to enhance patient outcomes and streamline healthcare processes. However, overcoming challenges related to data security, interoperability, AI literacy, ethics, and costs is essential for successful implementation. By adopting the proposed mitigation strategies, Nigerian tertiary hospitals can navigate these challenges and unlock the full potential of AI in revolutionizing healthcare delivery.

The successful integration of AI into digital healthcare in NTHs requires a concerted effort to address the existing challenges. By improving infrastructure, enhancing data security, fostering expertise, and promoting awareness, Nigeria can unlock the full potential of AI in healthcare, ultimately improving patient outcomes and contribute immensely to the advancement of the nation's healthcare system.

In conclusion, the application of artificial intelligence to digital healthcare in Nigerian tertiary hospitals holds immense promise for improving patient care and addressing the challenges faced by the healthcare system. By leveraging AI technologies to enhance medical imaging, predictive analytics, and patient engagement, Nigerian tertiary hospitals can usher in a new era of healthcare delivery that is more efficient, accessible, and patient-centered. However, concerted efforts are needed to overcome the barriers to implementation and ensure that AI serves as a catalyst for positive change in the Nigerian healthcare landscape.

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