Review Article

Artificial Intelligence and Cardiology Practice in Nigeria: Are We Ready?

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Abstract

Cardiovascular diseases are the leading cause of death globally. As cardiovascular risk factors continuously rise to pandemic levels, there is intense pressure worldwide to improve cardiac care in preventive cardiology, cardio-diagnostics, therapeutics, and interventional cardiology. Artificial intelligence (AI), an advanced branch of computer science has ushered in the fourth industrial revolution with myriad opportunities in healthcare including cardiology. The developed world has embraced the technology, and the pressure not to be left behind is intense for both policymakers and practicing physicians/cardiologists in low to middle-income countries (LMICs) like Nigeria. This is especially daunting for LMICs who are already plagued with a high burden of infectious disease, unemployment, physician burnt, brain drain, and a developing cardiac practice. Should the focus of cardiovascular care be on men or machines? Is the technology sustainable in a low-resource setting? What lessons did we learn from the COVID-19 pandemic? We attempt to zero in on the dilemmas of AI in the Nigerian setting including AI acceptance, the bottlenecks of cardiology practice in Nigeria, the role of AI, and the type of AI that may be adapted to strengthen cardiovascular care of Nigerians.

Keywords: *Artificial intelligence, cardiology practice, Nigeria*

Introduction

Artificial intelligence (AI) is a branch of computational science that allows computers to carry out tasks that require human intelligence. It has in recent times revolutionized technology worldwide. The growth of AI has gone astronomically high in recent times and the applications are diverse in every field of human endeavor and have been described as the harbinger of the fourth industrial revolution.[1] AI systems are increasingly complex and have evolved over the years to capabilities that supersede humans. The health sector is not left behind. AI systems have developed through deep learning, machine learning, and complex programming that mimic human behavior as shown in Figure 1.[2] The potential for alleviating human suffering, reducing mortality, and prolonging life has led to a radical adoption of AI in medical practice. This is very unlike the usual hassles in medical practice, where drugs and vaccines must be thoroughly screened before public use. Because of the wide adoption and profit turnover, the AI industry has become a multi-billion-dollar investment scheme. This rush for AI technology in the developed world has led to the development of chatbots and other robotics with superhuman abilities. This has resulted in a pressure build-up for low to middle-income countries (LMICs) to catch up with this fourth industrial revolution.

Nigeria is an LMIC with a growing population and potential for AI technology. However, like many other LMICs, it is grappling with a weak health system, heavy burden of infectious diseases, poor health indices, high rates of unemployment, brain drain, and poverty. Despite this, AI can be adapted to low-resource settings.[3]

Cardiology practice is also fraught with many problems in Nigeria. First, epidemiologic data is largely disjointed

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and many times unavailable. This makes it difficult for proper health planning and intervention. This is particularly important as cardiovascular disease is the global leading cause of death in LMICs as shown in Figures 2 and 3.[4] Moreover, hypertension is a global threat with a prevalence of 31.1% of adults (1.3 billion) worldwide, two-third of which live in LMICs.[5] This must be understood in the Nigerian context, the most populous black nation on earth; the black race being a risk factor for adverse cardiovascular outcomes.[6] Furthermore, the practice of cardiology is encumbered by a dysfunctional primary health care system, which is meant to be the hope of universal health coverage.[7] Health workers at the community level are meant to be the frontline staff to aid in collecting epidemiologic data, screening, community health education, improving the relationship between health services and the community, providing psychosocial support, and early referral to

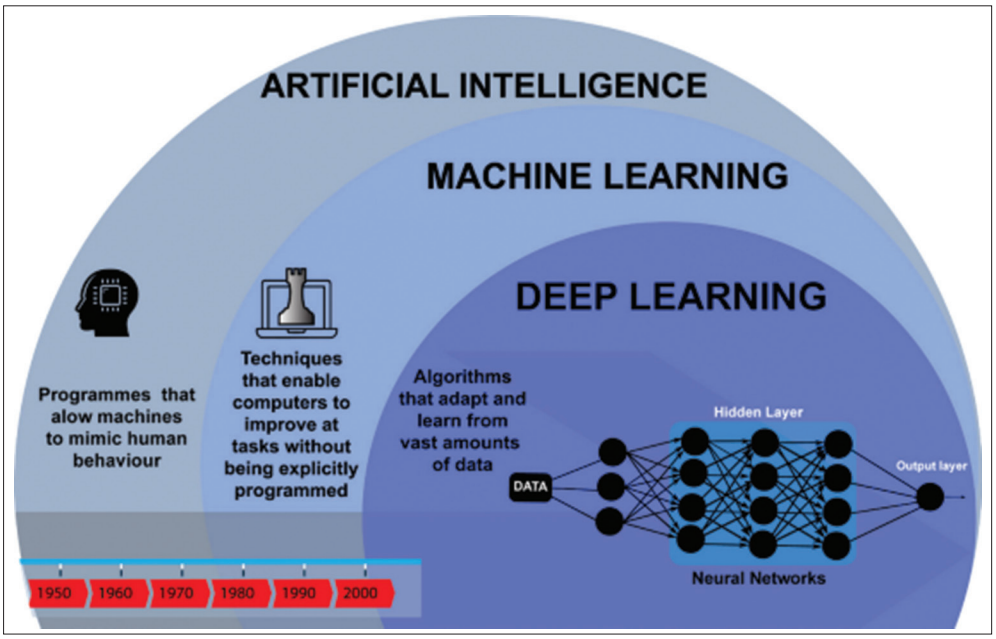

Figure 1: Showing evolution of AI with time. *Adapted from de Marvao A, Dawes TJ, Howard JP, O'Regan DP. Artificial intelligence and the cardiologist: what you need to know for 2020. Heart. 2020 Mar; 106 (5):399-400*

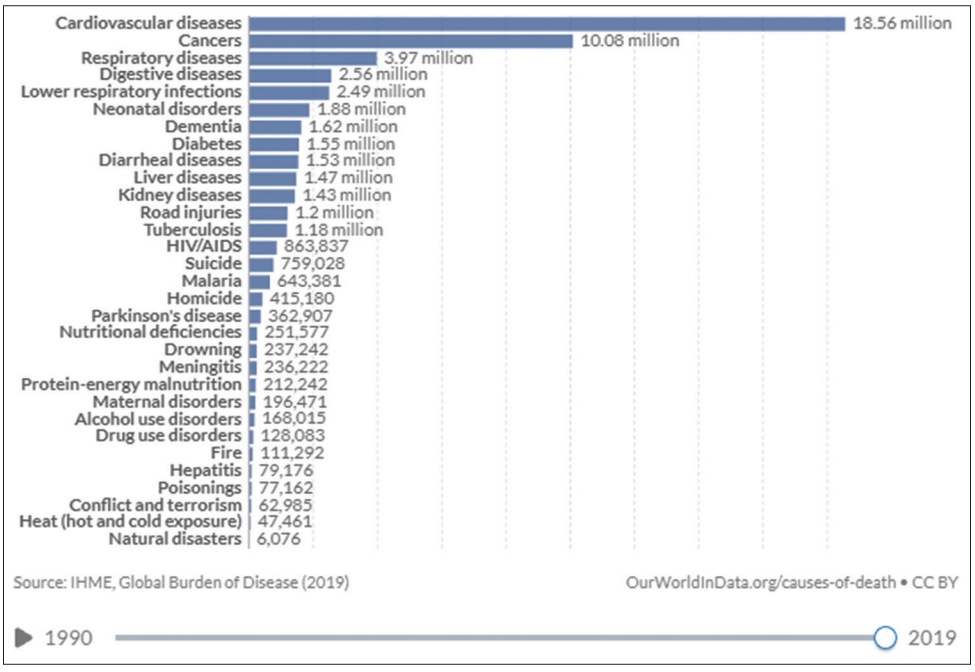

Figure 2: Showing the leading global causes of death as at 2019. *Adapted from Hannah Ritchie, Fiona Spooner and Max Roser (2018) - "Causes of death". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/causes-of-death' [Online Resource]*

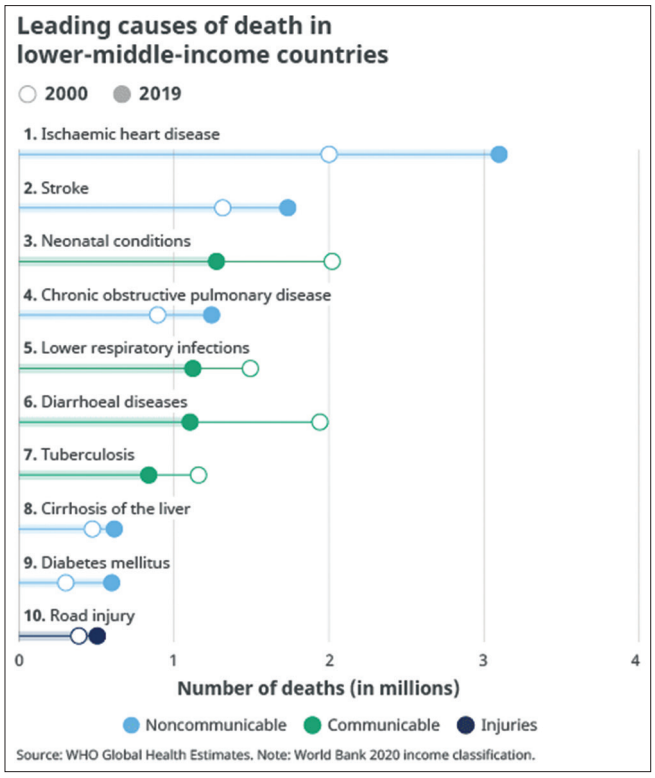

Figure 3: Showing ten top causes of death in LMICs. *Adapted from The top 10 causes of death (who.int)*

general practitioners.[8] However, the focus of community health workers in Nigeria has been reduced largely to childhood immunization programs and surveillance for infectious diseases such as tuberculosis and HIV/AIDS. Hence, community screenings in cardiovascular care are largely limited to free health outreaches sponsored by individuals, peer groups, or corporate organizations. This break in the health pyramid results in enormous numbers of cardiovascular morbidities usually seen in cardiology clinics. This coupled with the limited numbers of practicing cardiologists and increasing brain drain results in physician burnt. There is also the problem of insufficient basic cardio-diagnostics.[9] Most cardio-diagnostics such as electrocardiographs and echocardiography are found in urban areas, where the cardiologists usually reside and practice. Invasive cardio-diagnostics such as coronary angiograms and interventional cardiology techniques are sparse in most urban settlements in the country.[10,11] Although in areas where those services are available, out-of-pocket health expenditure because of low insurance coverage makes it difficult to access top-notch cardiac care.[12]

Before delving into the specifics of adapting AI use in cardiology in Nigeria, it is worthy of note that AI use in cardiology is already revolutionizing electrophysiology, cardiac imaging including echocardiography, interventional cardiology, heart failure prediction, diagnosis, and prognosis, adult congenital heart disease, and the 'internet of things' as shown in Figure 4.[13] The internet of things refers to "a network of devices interacting with each other using machine-to-machine communications, enabling collection and exchange of data".[14] It helps in remote monitoring of patients, especially those with chronic conditions such as heart failure, ischemic heart disease, and chronic arrhythmias. For example, an ECG signal, blood pressure, or pulse can be picked up from a wearable device and subsequently transmitted through Bluetooth to a smartphone for data analysis. This will enable the user's smartphone to process the signal generated and built-in communications are employed to raise an alarm if a heart attack or decompensated heart failure was identified. This has immense use in telemonitoring of cardiovascular risk factors (e.g., blood pressure and blood sugar), remote monitoring of high-risk cardiovascular patients including the aged,[14] diagnosis, and prognosis of cardiac disease.[15,16] Long-range communication systems based on the internet of things can be used to transmit signals over longer distances to physicians, relatives, and other caregivers.

The concerns of AI use in medicine in the developed world borders on a few major issues: AI-human collaboration, the ability of AI for precision diagnosis in this era of Omics, the conflict of the clinician with a health insurance AI algorithm that limits certain prescriptions, the unclear standards for accepting AI and its role as a research tool.[17] As wonderful as these may be, these are far from the concerns in Nigeria. We are still grappling with issues of AI acceptance which has its own social, cultural, and religious concerns. For instance, we have seen apathy to other interventions in the past such as the polio vaccine, family planning, and the COVID-19 vaccine.

The national health ICT strategic framework from 2015 to 2020 which would have set the health system ready for the COVID-19 pandemic was not implemented.[18] The COVID-19 pandemic was a blessing in disguise to the Nigerian health sector because, for the first time, the consideration of telemedicine was brought to the fore. Many health systems depended on Skype for meetings and telephonic medicine for consultations. It is rather unfortunate we have not consolidated the gains of telemedicine. For successful use of any form of AI in Nigeria, we need to strengthen internet connectivity, especially in rural areas.

There are five identifiable key areas where AI can influence cardiology practice in Nigeria. First, epidemiologic mapping for preventive cardiology. AI has revolutionized infectious disease epidemiology through early warning, pathogen classification, risk assessment,

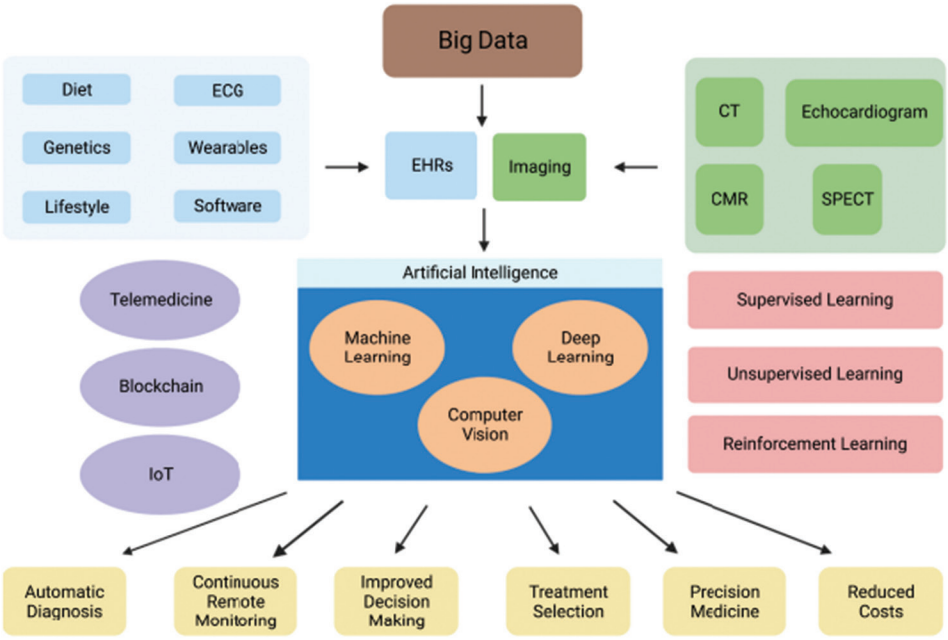

Figure 4: Illustrating the role of AI in cardiovascular medicine. Abbreviations: EHRs, electronic health records; CMR, cardiac magnetic resonance; CT, computed tomography; IoT, internet of things; SPECT, single photon-emission computerized tomography. *Adapted from Karatzia L, Aung N, Aksentijevic D. Artificial intelligence in cardiology: Hope for the future and power for the present. Front Cardiovasc Med. 2022 Oct 13; 9:945726*

source identification, hotspot detection, tracking, and forecasting.[19] This has been applied to track BP in clinical trials such as the Urinary Proteomics Combined with Home Blood Pressure Telemonitoring for Health Care Reform where a patient's mobile phone is connected to a digital sphygmomanometer and results are uploaded to the patient's webpage.[20] This allows for telemonitoring of blood pressure by both the patient and the managing physician. This singular act can improve drug compliance and patient adherence to cardiovascular care. Cardiovascular risks for a region can be successfully mapped by AI algorithms that can track cardiovascular risks and plot them on maps. This is key in risk stratification and reduction in cardiovascular morbidity and mortality.

Second, AI can revitalize the primary healthcare system through the employment and supervision of community healthcare workers (CHWs) who should be first-line workers in the cardiovascular health of society. The vision of the African School of hypertension an initiative of the African regional advisory group of the International Society of hypertension resonates with this. Software incorporated in mobile phones that can connect community health workers with patients and specialists/emergency departments for cardiac morbidities and associated complications should be encouraged. These software should have alarm systems incorporated in them that alert the CHW of deterioration in health status e.g., a rise in blood pressure.

Third, AI will help in data acquisition and in proper clinical trials. This will help build a true data bank for Nigerians and our group's ongoing work on pregnancy-related heart disease registry as well as heart failure outcome trial registry with emphasis on telemonitoring and shared care seems to be anchored on exploring this aspect of AI. Digitalization of health records using electronic medical records (EMRs) will be a huge step in ensuring quality data acquisition and storage. However, EMR is infrequently used in most hospitals because of frequent power outages and reduced manpower. Most clinical trials in cardiology are conducted outside Africa using other black ethnicities, who may be epigenetically different from black Africans. However, the results are usually inferred and used by Africans because of the unavailability of data. This should not be the standard in these days of personalized medicine (genomics, proteomics, and metabolomics). Furthermore, heart failure clinics are relatively common and usually busy in Nigeria. Although AI algorithms are currently tested for the prediction and diagnosis of heart failure in the developed world, the emphasis in Nigeria should be holistic. We need useful apps that can help follow-up patients and reliably reduce clinic attendance. This is because the cost of heart failure care is substantial globally and this is worse when expenditure is majorly out of pocket as seen in Nigeria.[21] Many factors contribute to heart failure costs.[22] One study in Nigeria identified transportation costs as being a major contributor to outpatient heart failure care.[23]

With current increasing inflation rates and dwindling resources, the economic burden of heart failure care will only become worse. Algorithms that allow physicians to follow-up patient symptoms and investigations remotely will also reduce the cost of prolonged clinic wait times, loss of useful man hours, and transportation to access cardiology care. Physician burnt is of serious concern in the face of brain drain, high doctor-patient ratio, poor physician remuneration, and high clinic attendance. Finally, AI algorithms that can accurately interpret ECG like chest x-rays may help general practitioners properly stratify patients for urgent cardiology review and intervention when necessary.

In conclusion, the COVID-19 pandemic has brought new dynamics into medical knowledge, health care, and communication. This revolution will be magnified beyond measure with the advent of AI. The developing world should incorporate it and not lag despite its challenges. However, in LMICs, where a steady power supply is a luxury many cannot afford, a discussion on AI may seem exoteric. This may make countries such as Nigeria view AI with trepidation.

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Conflicts of interest

There are no conflicts of interest.

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