

# Systematic Overview of Remote Patient Monitoring in Nigeria (West Africa)

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## Abstract

In Nigeria and West Africa, remote patient/physiologic monitoring (RPM) improves the quality of care and helps control healthcare costs. In this regard, RPM makes a significant contribution to advance telemedicine. This article presents the growth and application of RPM in Nigeria. The authors discuss the application of RPM to manage diseases, relevant regulatory issues, and challenges in connectivity to remote and rural areas.

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Remotely applied healthcare is defined as a strategic approach to monitor and direct treatment of diseases afflicting patients outside the hospital. This is accomplished through the use of information and technology applications. To that end, remote patient monitoring (also known as remote physiologic monitoring) applies digital technologies to observe and capture medical and other patient health data. This information is then transmitted electronically to healthcare providers for assessment and recommendations. Today in Nigeria, advances in telemedicine from a patient's home are facilitating the growth of remote patient/physiologic monitoring (RPM) in the management of non-life-threatening diseases.

RPM is targeted to a variety of patient subgroups that require ongoing monitoring. These include, but are not limited to, those with chronic diseases, mobility challenges, post-surgical patients, newborns, and the elderly.<sup>1</sup> Documented benefits of telemedicine include improved patient wait times leading to more cost-effective medical care.<sup>2</sup> Increased Internet broadband penetration is a significant factor influencing the future success of telemedicine in Nigeria and RPM in Africa.<sup>3</sup> As early as 2010, some organizations and educational institutions, including the University of Lagos (UNILAG), began developing telemedicine infrastructures.<sup>3</sup>

According to the World Health Organization (WHO), a country's doctor-to-patient ratio should be 1:600.

In Nigeria, the current doctor-to-patient ratio is approximately four times greater—1:2,500.<sup>3</sup> This doctor-to-patient ratio has led to the expansion of telemedicine platforms in Nigeria and Africa. One of the primary applications of RPM is in monitoring chronic illnesses. RPM-enabled software and medical devices include an innovative design comprising four unique functional parts (Table 1).<sup>4</sup>

## RPM Devices and Applications

Remote patient monitoring is applied in many health-related scenarios today. Devices used in telemedicine are divided into three broad categories:<sup>5</sup>

1. Store and forward/asynchronous devices
2. Remote monitoring devices
3. Interactive/synchronous or live service devices

### Store and Forward Telemedicine/Asynchronous Devices

Store and forward telemedicine store patient data digitally and asynchronously forward this information to a specialist or other healthcare provider for the patient.<sup>5</sup> Examples include, but are not restricted to, x-ray images, cardiology results, and laboratory test results. This information is stored in the hospital or healthcare organization's database and does not require the presence of both parties for assessment.

Store and forward devices are primarily utilized in medical record-keeping, pathology, and radiology. The

Table 1. RPM-enabled software and medical devices\*

RPM Medical Devices	Uses	Limitations	Examples
Biomedical sensors	<ul style="list-style-type: none"> <li>Measure vital signs (heart rate, blood pressure, temperature).</li> </ul>	<ul style="list-style-type: none"> <li>Poor sensitivity for many clinically relevant parameters</li> </ul>	<ul style="list-style-type: none"> <li>Blood pressure monitors, glucometers, pulse oximeters</li> </ul>
Remote data storage	<ul style="list-style-type: none"> <li>Store data transmitted from biomedical sensors and other sources</li> </ul>	<ul style="list-style-type: none"> <li>Piece together legal systems while integrating new systems into the infrastructure</li> <li>Affordability to mass migrate data between storage systems</li> </ul>	<ul style="list-style-type: none"> <li>On premise storage: rack servers, hyper-converged solutions</li> <li>Off premise storage: IaaS and PaaS, Microsoft (Cloud computing)</li> </ul>
Diagnostic software	<ul style="list-style-type: none"> <li>Diagnostic software triggers clinician intervention via alerts, then formulates treatment recommendations based on data generated by the biomedical sensors.</li> </ul>	<ul style="list-style-type: none"> <li>Diagnostic errors, inaccurate or delayed diagnosis, data mismatch, provider aversion</li> </ul>	<ul style="list-style-type: none"> <li>EHR, medical image analysis, patient portals, E-prescribing software</li> </ul>
Data transfer and sharing within care teams	<ul style="list-style-type: none"> <li>Vital signs generated by RPM hardware devices and software are accessed by healthcare providers or third parties.</li> <li>Alert is sent to patient's healthcare providers if biosensors detect potential risk.</li> </ul>	<ul style="list-style-type: none"> <li>Cumbersome software is not generally interoperable.</li> <li>Risk of cyberattacks and prone to timing discrepancies</li> </ul>	<ul style="list-style-type: none"> <li>EMR: Epic, Allscripts, Praxis EMR, eClinicalWorks, Cerner, NextGen, Athenahealth</li> </ul>

\*The table lists EMR systems. RPM allows providers to continue tracking healthcare data after hospital discharge, including blood pressure monitors, weight scales, cardiac implants, blood glucose meters, and pulse oximeters (more common due to the COVID-19 pandemic). EHR, electronic health records; EMR, electronic medical records; PaaS, platform-as-a-service; RPM, remote patient/physiologic monitoring; SaaS, software-as-a-service.

main difference between this and the traditional medical consultation is there is no need for the patient's presence to provide history and examination before diagnosis. The diagnostic elements available to the healthcare provider include the digital images and clinical results, audio/video history, and clinical documentation. For example, when a patient presents with enteritis, test results are forwarded to the healthcare provider along with the patient's history. There is no need for a physical consultation if the test results are positive for typhoid, for example. The patient receives a prescription without seeing the doctor in person.

### Remote Patient Monitoring Devices

Self-monitoring devices, or self-tests, enable healthcare providers to monitor a patient's progress.<sup>5</sup> It is mainly utilized in chronic diseases that can be managed with basic information. Conditions include but are not limited to hypertension, diabetes, and asthma. Patients with these conditions can have devices at home to help read and record their vital signs and forward the information to the healthcare provider who coordinates care with advice to the patient, instructions or recommended treatment plans, and follow-up procedures. Leveraging the RPM device and virtual communication between the patient and healthcare provider reduces the need for in-person visits to the hospital or clinic. Furthermore, this helps to manage these conditions efficiently. Following this example makes RPM through telemedicine cost effective especially after the device is purchased. Examples of

devices in this category include sphygmomanometers and digital glucometers.<sup>4,5</sup>

### Interactive/Synchronous/Live Devices

Virtual consultations are implemented via synchronous or live phone, video, and online communication.<sup>5</sup> However, physical examinations and ophthalmology examinations remain traditional in-person visit consults. While these do not require special devices, aside from a phone with a good network connection and Internet access, it is often challenging to have these for a new patient whose history has not been taken in person beforehand.

### Diseases Managed Using RPM

Chronic diseases are characterized by high prevalence among populations, rising complication rates, and increased incidence of people with multiple chronic conditions, to name a few. In Nigeria, noncommunicable diseases account for 24% of all deaths.<sup>6</sup> According to the WHO, at least 80% of premature heart disease, stroke, type 2 diabetes, and 40% of cancer could be prevented through a diet, regular physical activity, and remote patient monitoring of patients reportedly living with chronic diseases.<sup>7</sup>

### Maternal and Infant Mortality

Qualcomm's Wireless Reach initiative, in collaboration with NPHCDA (Nigeria's National Primary Health Care Development Agency), Etisalat Nigeria, Evidence for

Action, Vecna Technologies (through its Vecna Cares Charitable Trust), and InStrat Global Health Solutions, are examples of the positive impact associated with mobile technology. The program equips midwives and other healthcare workers with tablets and connectivity in order to collect medical information from patients at the point of care and aid in analysis and diagnosis of clinical conditions associated with maternal and infant mortality. The program, deployed in 2014, used a system called the CliniPAK to track patient care and generate reports regarding treatment and outcomes. The program used smart devices such as tablets with infographics on the app, making it easy for healthcare workers to use, with little to no prior computer literacy.<sup>8</sup>

The program was served 51 medical clinics in Nigeria and was fully utilized in four different states (Federal Capital Territory [FCT], Ondo, Anambra, Kano). It gathered data from over 500,000 patients and monitored maternal healthcare data in the available states with updated disease surveillance.<sup>8</sup>

#### *Ebola Outbreak*

The CliniPAK mobile health system was implemented to manage the dissemination of Ebola-related information to frontline workers. The system functions in Kenya, Nigeria, Tanzania, and the United States. It functioned as a “clinic in a box” tool that helped health workers with primary diagnosis and vitals during the Ebola outbreak in 2011.<sup>9</sup> The CliniPAK mobile health system aided in developing other mobile applications aimed at educating people about the disease.<sup>8</sup> Data collected using the CliniPAK mobile health system helped in identifying healthcare capacity gaps. It saved time writing and compiling reports and in identifying and reducing service gaps.<sup>8</sup>

#### *Tropical Diseases*

A deployable framework for Mobile Telemedicine Applications for Tropical Diseases (MTATD) uses medical resources available at health centers to support health practitioners.<sup>9</sup> This framework provides access to a telemedicine unit, which provides hand-held devices over a PSTN/GSM (public switched telephone network in Global System for Mobile Communications) and the Internet, which provides room for collaborative healthcare delivery and education.<sup>10</sup> These network termination devices (NTDs) include lymphatic filariasis (elephantiasis), onchocerciasis (river blindness), leishmaniasis, trachoma (granular conjunctivitis), schistosomiasis, rabies, leprosy, etc.

#### *Nigerian Initiatives to Incorporate Telemedicine*

Many initiatives in the world today promote telemedicine.<sup>11</sup> Beginning in approximately 2006, and advancing during the last decade, Nigeria has witnessed slow but

progressive improvement in acceptance and use of telemedicine. Examples of key initiatives incorporated telemedicine in Nigeria include but are not limited to those listed in Table 2.

#### **Laws Regulating RPM in Nigeria**

Telemedicine touches on a variety of legal issues, including intellectual property (the platform used to connect patients and physicians), e-consent, telecommunications, data privacy, malpractice, licensing, and e-consultation, to name a few. Moreover, laws govern social institutions such as business transactions, marriage, banking, taxation, and insurance. This demonstrates the importance of a solid regulatory framework that encompasses various areas of law to which telemedicine is tied. A sound legislative framework for telemedicine and RPM will help expand and develop the e-health industry in Nigeria, thereby contributing to the country’s economic development.<sup>17</sup>

The Nigerian government has a critical role in ensuring telemedicine’s success in the country. This responsibility stems from current health-related legislation. According to Section Seventeen<sup>3</sup> of the Constitution of the Federal Republic of Nigeria (CFRN), the onus is on the government to guarantee that appropriate medical and dental services are available.<sup>18</sup> Long term, this means that citizens should have a reliable Internet connection, a smartphone, and tablet or laptop, as the bare minimum for conducting a teleconsultation. Similarly, item two of the fourth schedule imposes the obligation to provide care, while section One of the National Health Act 2014 (NHA) provides that the National Health System is responsible for protecting and enforcing the people’s right to healthcare.<sup>19</sup>

Similarly, the National Health Insurance Scheme is responsible for guaranteeing that everyone has access to high-quality health care services.<sup>20</sup> As a result, the National Health Council and the National Health Insurance Council should ensure the delivery and deployment of telemedicine services.

Furthermore, Article Sixteen (1) of the African Charter on Human and People’s Rights (ACHPR) safeguards individuals’ rights to the best physical and mental health. This is formalized in Article Twelve<sup>1</sup> of the International Covenant on Economic, Social, and Cultural Rights (ICESCR). Furthermore, Article Sixteen<sup>2</sup> declares that “state parties are expected to take reasonable steps to protect their citizens’ health.” This would include the efficient use and regulation of telemedicine throughout the country.

#### **RPM Advancement in Nigeria**

The COVID-19 pandemic brings to the fore the need for remote work with limited interactions. In the health sector, the overwhelming number of patients and the shortage of personnel make telemedicine a vital consideration

Table 2. Telemedicine initiatives in Nigeria

Company/Agency	Telemedicine Initiative	Year	Uses
Barton Associates	<ul style="list-style-type: none"> <li>VSee: HIPAA-compliant telehealth application and video conferencing software development company</li> </ul>	2013	<ul style="list-style-type: none"> <li>The corporation worked on a pilot project for employing VSee telemedicine equipment to deliver telehealth services to personnel at Shell Nigeria's Bonga field.<sup>12</sup></li> <li>The Vsee kit enables staff members receive a comprehensive medical evaluation for any illness.</li> <li>Vsee was used in the management of upper respiratory tract infection at Obio Cottage Hospital Port-Harcourt via video conferencing with the medical specialist.</li> </ul>
Microsoft 4Afrika	<ul style="list-style-type: none"> <li>A Microsoft initiative focused on improving digital access and supporting innovation in Nigeria, as well as throughout Africa.</li> </ul>	2013	<ul style="list-style-type: none"> <li>Fuel economic development and enhance digital skills using cloud technology.<sup>12</sup></li> </ul>
National eGovernment Strategies Ltd	<ul style="list-style-type: none"> <li>Telecardiology</li> </ul>	2006	<ul style="list-style-type: none"> <li>Conducted a telecardiology study utilizing synchronous telehealth methods.<sup>13</sup></li> </ul>
The National Space Research and Development Agency (NASRDA)	<ul style="list-style-type: none"> <li>Telemedicine initiative using NIGCOMSAT-I</li> </ul>	2007	<ul style="list-style-type: none"> <li>Provides healthcare delivery, telemonitoring, and cross border teleconsultation services to Nigerians residing in rural communities.<sup>14</sup></li> <li>Also used in the mobile testing of coronavirus testing.<sup>14</sup></li> </ul>
Indian Telecommunication company	<ul style="list-style-type: none"> <li>Telemedicine program in Lagos</li> </ul>	2010	<ul style="list-style-type: none"> <li>Enables university-based medical professionals at the National Hospital in Abuja to connect via teleconferencing technology with the National Sickle Cell Foundation in Lagos.<sup>15</sup></li> </ul>
Lagos state government	<ul style="list-style-type: none"> <li>e-health initiative as an interactive Hospital Management Information System (HMIS)</li> </ul>	2009	<ul style="list-style-type: none"> <li>Main goal was to embrace ICT to increase health access.<sup>16</sup></li> </ul>

HIPAA, Health Insurance Portability and Accountability Act of 1996; ICT, interactive college technology; NIGCOMSAT-I, Nigerian Communications Satellite Limited.

for doctors to reach patients in remote areas and manage chronic diseases.

As the country's population increases, the Nigerian healthcare system faces growing challenges in the face of a limited number of healthcare service providers. The latest data from WHO reveal that the ratio of Nigerian doctors to patients is 4:10,000. That is 1:2,500. The situation is no better in other parts of the world, with a ratio of 26:10,000 in the United States and 28:10,000 in the United Kingdom.<sup>21</sup>

Medical practice in Nigeria is under great pressure to meet the needs of its citizens, most of whom reside in remote areas with no professionals caring for their medical needs. Telemedicine in Nigeria is a solution to this problem, as it can bridge this gap and improve the healthcare system, as well as the general wellbeing of the population. Healthcare providers and patients in Nigeria embrace technology advancement as it eases the workload and reduces queues for medical attention in Nigerian hospitals.<sup>22</sup>

To fully utilize the benefits of remote patient management in a developing country like Nigeria, improvements are needed in our healthcare system. With respect to telemedicine, the challenge is to complete an extensive

upgrade in order to achieve a realistic adaptation of telemedicine. Reliable electricity is essential, while proper equipment servicing must also become a top priority. This upgrade in infrastructural challenges will significantly improve Nigeria's health indices.

So far in Nigeria, the concept of telemedicine is gaining wider acceptance as private healthcare providers are integrating telemedicine practice and service offerings into their practice. Presently, there are more than 20 telemedicine startups in Nigeria, and while some operate locally, others are international. While this advancement in healthcare aims to bridge the gap in healthcare between health professionals and inaccessible rural areas,<sup>23</sup> much of this population is now more disconnected, as they have no access to the virtual devices needed to execute telemedicine.<sup>24</sup> These challenges hinder the growth of telemedicine and its ability to reach its full potential in the country. Some of the obstacles hindering the advancement of telemedicine in rural areas include cost, growth, and connectivity.

#### Cost of Telemedicine

In a developing country like Nigeria, telemedicine is still a luxury for most citizens. This is due to poverty and the

sizeable gap between the rural and urban areas. The cost of telemedicine equipment, cameras, and computers is deprioritized in healthcare budgets, and that poses a significant impediment to the implementation of telemedicine.

#### *Growth of Telemedicine*

Advancement of this technology requires a framework overseen by the Federal Ministry of Health (FMoH). In comparison, numerous telemedicine hubs are springing up in the private sector. Rules guiding their activities and education of patients who can opt in instead of using the traditional consultation process are needed.

#### *Connectivity to Remote and Rural Communities*

Telemedicine relies on the Internet and technology infrastructure. This is one aspect that Nigeria is focused on addressing and improving. To optimize and improve patient experience, creating adequate network infrastructure must lead to initial investments and be kept in place to ensure the utilization growth of telemedicine and RPM by Nigerian healthcare providers and patients. It is critical to address the needs of those living in rural areas where Internet connection or cellphone network is poor or non-existent. These problems hinder the growth of telemedicine in Nigeria. Addressing them adequately will pave the way for the effective utilization of RPM technology to help solve poor healthcare delivery and outcomes in Nigeria.

#### **Recommendations**

Telemedicine can be integrated into the conventional Nigerian healthcare delivery system. Challenges to be addressed to realize this goal include policy reviews, with the adoption and implementation of budgets/funding set aside for telemedicine and RPM operations. Development of strategic facilities or federally funded telehealth resource and education centers as in the United States (where there exists collaboration among 12 regional and two national telehealth resource centers, committed to implementing telehealth programs for rural and underserved communities)<sup>25</sup> will foster and encourage the adoption of telemedicine and RPM in communities and regions with limited infrastructure.<sup>26</sup> Grants, loans, and financial incentives can be offered to organizations, providers, and patients to access telemedicine services and be a spark for a culture of RPM innovation and entrepreneurship for Nigeria and Africa.

#### **Conclusions**

Nations must confront the challenge of providing adequate healthcare for their people. This is true of advanced as well as developing countries. Our shared priorities can benefit from the globalization of telemedicine and RPM, which create networks containing knowledge that addresses the disparate healthcare needs of citizens in our global community. One estimate of the anticipated

growth rate of telemedicine, including RPM, between 2019 and 2026, shows a growth of CAGR (compound annual growth rate) at 14.9%, as it is anticipated that more hospitals and healthcare facilities will incorporate technology into their practice.<sup>27</sup> Telemedicine and RPM can change the way healthcare is provided today. Each must be part of the mix to contain health costs while providing the best care for patients in remote areas.

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#### **Authors' contributions**

IU: Revised and reviewed the paper; wrote the paper. LA: Writing – original draft; writing – review, and editing. BA: writing – review and editing; supervision. All authors read and approved the final manuscript.

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