

## Original Research Article

# Telemedicine promise for tomorrow: The role of video synchronous medical consultation in a primary health center (PHC) in a sub-Saharan Africa setting

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### Abstract

**Purpose:** To demonstrate the use of telemedicine electronic communications to exchange medical information from one site to another to improve a patient's clinical and medical care during a remote clinical service. The goals and purpose of this research were centered around improving healthcare delivery in Edo State, Nigeria, by leveraging telemedicine technologies.

**Methods:** This 12-month retrospective case study involved a live, two-way telemedicine primary care service in three rural primary health centers (PHCs) in Edo State. Patients were identified through outreach efforts and met criteria including chronic conditions like hypertension or diabetes, lack of access to physicians, and financial barriers to care. Weekly telemedicine visits with USA-based physicians were documented in the electronic health records (EHR), capturing diagnoses, vital metrics, medication adherence, and patient satisfaction.

**Results:** Seventy-five patients (66 % female, mean age 66) participated. Among hypertensive patients, systolic blood pressure (SBP) reductions ranged from 22 mmHg ( $p < 0.0001$ ) at Oredo and Ukpenu PHCs to 5 mmHg at Ugbor PHC, with diastolic blood pressure (DBP) improvements at most sites. Diabetic patients at Ukpenu PHC showed significant fasting glucose reductions ( $p < 0.002$ ), but changes were minimal at other PHCs.

**Conclusion:** Telemedicine demonstrated its potential to enhance chronic disease management and healthcare access in resource-limited settings, yielding positive clinical outcomes and high patient satisfaction.

**Keywords:** Telemedicine, SubSaharan Africa, Chronic diseases, Electronic health records, Remote clinical service

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## INTRODUCTION

Telemedicine care delivery methods began emerging as a novel option to provide medical and mental health services in the mid-20<sup>th</sup> century in developed countries. Its extensive use was most notably seen during the Severe acute respiratory

chronic non-communicable diseases in Nigeria [13]. The life expectancy in Nigeria is alarmingly low, averaging 50 - 55 years, and there is a widening disparity between rural and urban populations due in part to limited access to basic healthcare services.

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syndrome-COVID pandemic, when thousands of healthcare providers, including physicians and allied clinicians, adopted it to maintain continuity of healthcare [1]. Health professionals and patients alike in these regions were impressed by the opportunities presented by this novel modality of healthcare delivery [2,3]. However, the same cannot be said for developing countries and emerging economies such as Nigeria, whose adoption has lagged significantly behind [4,5]. Primary care serves as the frontline of the healthcare system, providing the first point of contact for patients. It encompasses prevention, wellness, and treatment for common illnesses while maintaining long-term relationships with patients. It is especially critical in managing chronic medical conditions, offering integrated and accessible health services that address most personal healthcare needs [6]. Despite these benefits, Nigeria's primary care infrastructure struggles to meet demand, exacerbated by limited access to quality healthcare in rural and underserved areas [7]. The authors of this case study propose an ecosystem of primary healthcare powered by a digital operating model in and for Nigeria and the sub-Saharan African region in general. This model leverages telemedicine to address the unique healthcare challenges in these areas.

Telemedicine uses electronic communications to exchange medical information from one site to another to improve a patient's clinical and medical care during a remote clinical service [8,9]. A key component is synchronous telemedicine, where audio and video are provided in real-time for live, two-way audiovisual interaction between patients and physicians. Simultaneously, clinical data and vital records of patients are uploaded and stored in the patient's electronic health records automatically [10,11]. In Nigeria, the top contributors to morbidity and mortality are also the top non-communicable chronic diseases: stroke and ischemic heart disease. These, in turn, have the top risk factors alongside the most prevalent non-communicable chronic diseases in Nigeria: Hypertension and Diabetes Mellitus [12,13]. These two diseases, by themselves, account for more than half of the mortality rates attributable to

Primary healthcare is crucial in managing chronic conditions, yet Nigeria's healthcare system faces a severe physician shortage. The physician-to-patient ratio stands at 1:10,000 in most rural areas and 4:10,000 in most urban areas and cities. This compares poorly with the World Health Organization's recommended ratio of 1:600, as well as developed countries like the United States and the United Kingdom, where the physician-to-patient ratio is 30:10,000 [14]. This shortage significantly limits access to care, particularly for those with chronic conditions, which drive 80 % of healthcare costs. Telemedicine could fill this gap.

There are 36 States in Nigeria. Edo State is in South-South Nigeria, with an estimated population of over four million. Strategically positioned as a transit hub between Northern, Southern, Eastern, and Western Nigeria, Edo State is ideal for studying tech-driven primary care paradigms. Nigeria's primary healthcare centers (PHCs) are typically designed to serve populations of 5,000 to 10,000 people, primarily in towns and villages [15]. However, these centers often need more physicians, rendering them underutilized and inefficient. Studies involving adults in developing countries like Nigeria have highlighted significant challenges in technology adoption and internet connectivity. According to a 2021 World Bank report, over 50 % of Nigeria's population lacks digital skills, hindering their ability to utilize data services effectively [16]. This digital divide has hindered the effectiveness of telehealth apps in reaching this vulnerable population. A potential solution is the establishment of a hub-and-spoke paradigm, where telemedicine hubs are centralized in key PHCs, with patients traveling to these hubs for primary care services. Our partnership and collaboration have introduced electronic health records (EHR) and synchronous videoconferencing modules, ensuring patient encounters are captured and stored in real-time. This system is crucial for maintaining patient confidentiality and ensuring safe record-keeping.

The goals and purpose of this research were centered around improving healthcare delivery in Edo State, Nigeria, by leveraging telemedicine

technologies. Specifically, the study aimed to enhance access to quality healthcare for individuals with chronic medical conditions and underserved, hard-to-reach populations in the region. By implementing a telemedicine model at PHCs the research sought to address the physician shortage. The study's objectives included: 1) Improving access to healthcare for chronic disease patients in underserved areas; 2) Increasing medication adherence and enhancing treatment outcomes through telemedicine interventions; 3) Establishing a scalable infrastructure for synchronous video-based telemedicine across Nigeria's 36 states; 4) Training and building the capacity of clinical and non-clinical staff to manage telemedicine services at PHCs; 5) Implementing secure EHR systems to ensure real-time capture of patient encounters, with a focus on Health Insurance Portability and Accountability Act-compliant privacy and confidentiality standards. We hypothesized that we could effectively manage chronic diseases using a telemedicine primary care ecosystem.

## METHODS

### Study setting

This study was a video, two-way, live, interactive synchronous telemedicine primary care delivery service [3] and system implemented over 12 months in three rural PHCs in Edo State, Nigeria, namely, Oredo PHC on Sapele Road, Benin City, Oredo Local Government Area, Ugbor PHC on Ugbor Village Road, Benin City, Oredo Local Government Area, and Central PHC, Ukpenu, Ekpoma, Esan West Local Government Area. Each PHC typically operates without an on-site physician and is designed to serve populations ranging from 5,000 to 10,000 people.

Registered nurses (RNs) and community health extension workers (CHEWs) are the healthcare professionals primarily responsible for managing these centers, with a site-specific Director of Nursing overseeing operations. The services provided at these centers include infant and childhood immunizations, well-child visits, prenatal care, and health education. The institutional review board at Mercer University College of Pharmacy approved this protocol.

### Study population and measurements

Patients enrolled in the study were identified through medical outreach efforts at the PHCs. Inclusion criteria included patients with at least one chronic medical condition, specifically hypertension or diabetes mellitus, adults without a physician for follow-up care, and individuals who

could not afford hospital visits or medication costs. The study population included individuals requiring general primary care, with a minimum follow-up period of 90 days for patients with chronic conditions. Exclusion criteria included patients with assigned and known primary care doctors, patients with financial resources and support for their ongoing medical care, or patients < 50 years of age. The primary outcomes assessed were the treatments administered during the initial visit and subsequent follow-up at 3 months. For each patient, we tracked diagnoses of hypertension and/or diabetes mellitus, medication prescriptions, adherence, and patient satisfaction with the telemedicine visit.

### Telemedicine primary care ecosystem

In this model, patients and primary health center staff were in Nigeria, while the primary care physician (PCP) was based in Atlanta, USA.

### The telemedicine visit

The scheduler contacted patients before the telemedicine visit, and confirmed appointments are entered into EHR software. The EHR was locally developed and designed in Nigeria. The author participated in the initial design and adaptation of this modality of primary care delivery, the first of its kind in sub-Saharan Africa. Consent is obtained orally or in writing. The video camera is positioned during the visit to allow good eye contact with the patient. Video cameras were utilized on laptops or desktop computers rather than mobile devices like mobile phones or iPads.

This decreased movements and distractions during the telemedicine visits. The virtual encounter is also affected by the quality of internet services, including Wi-Fi connection and bandwidth capacity. Clinic staff carry a telephone to contact the patient should technical difficulties arise. Privacy issues are also addressed before discussing patients' health information, ensuring compliance with confidentiality protocols. After obtaining the patient's medical history, a global visual assessment was conducted during the telemedicine session. However, the physical examination was typically more focused and limited than in-person encounters.

### Statistical analysis

All demographic information was examined using descriptive statistics (i.e., mean, and standard deviation for continuous data). Specifically, data were compared using a 2-tailed t-test, chi-square test, or one-way ANOVA as appropriate. The a priori level of significance was set at 0.05. All

analyses were performed using SPSS 29.0 software (IBM Corporation, Armonk, NY).

## RESULTS

Seventy-five synchronous telemedicine video visits were conducted with a physician in the United States and patients at the three PHCs. There was no significant association between PHC and whether the patients had hypertension (HTN) only or both hypertension and diabetes mellitus (DM). Table 1 displays the other baseline characteristics among the groups.

### Blood pressure and blood glucose outcomes

Figure 1 depicts the change in blood pressure for all patients. At Oredo PHC, patients with both HTN and DM experienced a median systolic blood pressure (SBP) reduction of 22 mmHg ( $p < 0.0001$ ) and a median diastolic blood pressure (DBP) reduction of 6 mmHg ( $p = 0.02$ ) when comparing baseline to final levels. For patients with HTN alone, the median SBP decreased by 32 mmHg ( $p < 0.001$ ), while the DBP dropped by 6 mmHg ( $p = 0.01$ ). There was, however, no significant change in blood glucose levels among

the patients with DM at Oredo PHC. At Ukpenu PHC, hypertensive patients showed a mean SBP reduction of 22 mmHg ( $p < 0.0001$ ) and a DBP reduction of 8 mmHg ( $p < 0.006$ ). Conversely, at Ugbor PHC, hypertensive patients experienced a modest SBP reduction of 5 mmHg, while the DBP remained unchanged. For patients with DM, a significant decrease in fasting glucose levels was observed at Ukpenu PHC ( $p < 0.002$ ). In contrast, there was no notable change in fasting glucose levels among patients at Ugbor PHC.

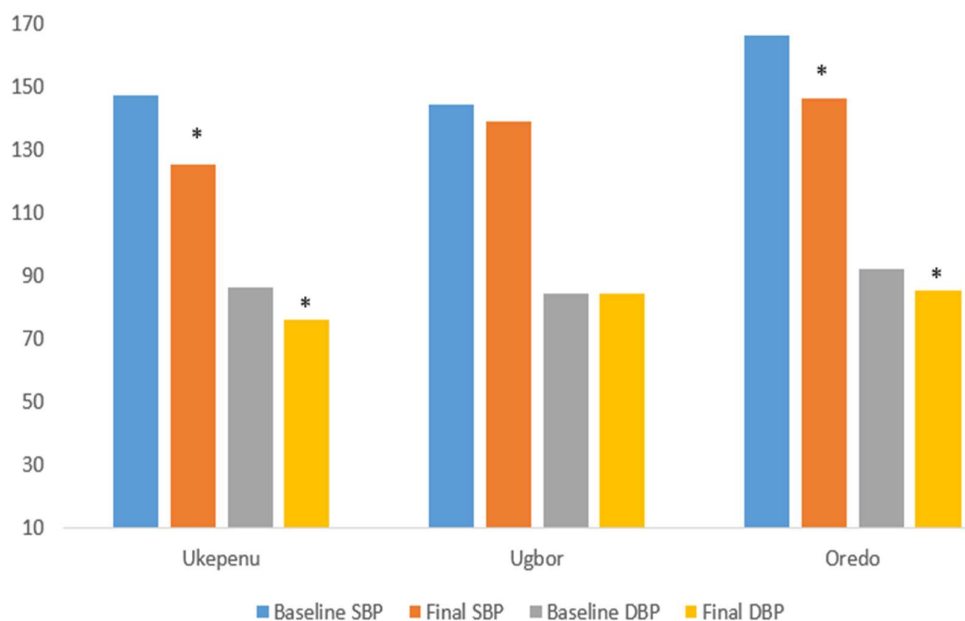
### Patient satisfaction survey

A total of 40 patients completed the satisfaction survey, with 80 % of respondents being female and 20 % male. All respondents confirmed using video during telemedicine visits; see Figure 2 for the patient satisfaction survey summary. Regarding technical issues, 46 % experienced some problems that were resolved during the visit, and 13 % experienced technical difficulties that were not satisfactorily resolved. Overall, 100 % of patients were satisfied with the telemedicine encounter, with 26.7 % indicating they were satisfied and 73.3 % indicating they were very satisfied.

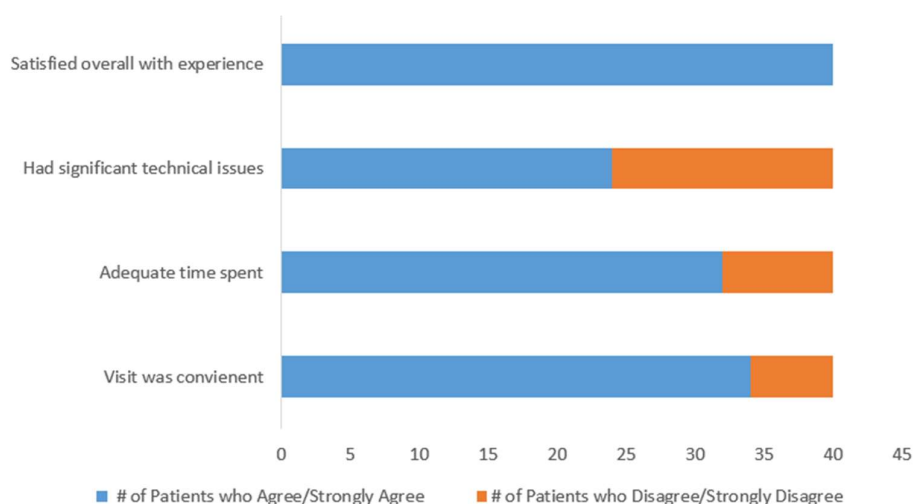
**Table 1:** Selected baseline characteristics of the study patients

Variable	Ukpenu (n=24)	Ugbor (n=20)	Oredo (n=31)	P-value*
Age (years), mean $\pm$ SD	61.3 $\pm$ 11.2	70.0 $\pm$ 7.1	67.33 $\pm$ 6.3	<0.01
Female sex, N(%)	20(83)	12(60)	17(55)	0.07
Hypertension only, N(%)	12(50)	14, (70)	19(61)	0.77
Diabetes only, N(%)	4(17)	0(0)	0(0)	
Hypertension and diabetes, N(%)	8(33)	6(30)	12(39)	0.77
<b>Baseline values</b>				
Systolic blood pressure (mmHg; median, (IQR))	145 (25)	140 (30)	163 (31)	< 0.01
Diastolic blood pressure (mmHg; median (IQR))	85 (10)	85 (10)	92 (16)	0.04

\* $P < 0.05$  is statistically significant



**Figure 1:** Median change in blood pressure (mmHg) in all patients (N = 75); \*p < 0.05 is statistically significant



**Figure 2:** Patient satisfaction survey (n = 40)

## DISCUSSION

To the best of our knowledge, this case study is the only one of its type that successfully piloted and deployed telemedicine in Nigeria's primary care and health centers. This pioneering work presents an opportunity to significantly increase access to quality healthcare, especially for chronic disease management, while mitigating the country's severe physician shortage and providing care for rural and remote areas. Chronic diseases, such as hypertension and diabetes mellitus, require ongoing medical attention over extended periods, often exceeding 12 months, to improve quality of life, prevent complications, and prolong survival. The most prevalent chronic non-

communicable diseases, hypertension and diabetes mellitus, significantly increase the risk of atherosclerotic cardiovascular disease, contributing to morbidity and mortality rates [13]. In Edo State, Nigeria where this study was conducted, hypertension and diabetes mellitus are particularly prevalent, with respective rates of 27 and 12 % [12].

Telemedicine successfully bridged this healthcare gap by providing remote, synchronous video consultations with board-certified physicians. This study demonstrates that telemedicine improved vital metrics, such as blood pressure and blood glucose levels, and compared favorably to traditional, in-person visits. This paradigm shift in care delivery is a significant step forward for

PHCs, offering a fast, affordable, and convenient model for chronic disease management. Given current medical school enrollment and training capacities, it is estimated that it will take 50 - 75 years to meet the World Health Organization's standards for physician-to-patient ratios. In the interim, telemedicine provides a viable solution for primary care in regions with limited healthcare resources. One of the primary challenges we faced was the need for improvement in blood pressure and glucose levels at one PHC. This could be attributed to poor medication adherence and inadequate follow-up, which were exacerbated by the lack of transportation to the telemedicine hub. Additionally, medication costs were identified as a significant barrier to adherence, highlighting the need for cost-effective interventions.

Despite these challenges, healthcare professionals and patients expressed high levels of satisfaction with the telemedicine model, praising its adaptability and the opportunity it provided for regular chronic disease management. The PHCs viewed telemedicine as an ideal platform for delivering routine care, particularly in resource-limited settings. This approach revolutionizes the role of PHCs, transforming them into hubs for accessible, high-quality telemedicine care for chronic diseases.

### **Limitations of this study**

Several technical and infrastructural challenges limit the effectiveness and scalability of telemedicine in this setting. First, digital literacy and the "digital divide" presented disparities in access, as some patients and providers struggled with using the technology. Technical difficulties, including limited broadband coverage, poor internet connectivity, and frequent power outages, frequently disrupted visits and affected the quality of the telemedicine encounters. Another limitation was patient follow-up, often hindered by the lack of transportation to telemedicine hubs and financial constraints preventing patients from accessing medications or services. The high cost of medication also affected adherence, particularly in settings where patients could not afford the necessary treatments.

A significant clinical limitation of telemedicine is the inability to conduct a comprehensive physical examination. While video consultations provide valuable insights, they cannot fully substitute for in-person visits in cases requiring physical assessments. As a result, telemedicine may not be suitable for all patients or clinical scenarios, limiting its applicability. The success and expansion of telemedicine largely depend on

sustained public and private support. Securing consistent partnerships with government or private entities remains a challenge to ensure the long-term viability of this model.

### **CONCLUSION**

Telemedicine has the potential to transform primary care delivery in resource-limited settings, providing accessible, high-quality healthcare to patients with chronic conditions such as hypertension and diabetes mellitus. Our findings demonstrate that telemedicine can successfully manage chronic diseases in underserved populations with appropriate support and infrastructure, reducing critical health metrics and improving patient satisfaction. While telemedicine is not a complete substitute for in-person visits, particularly for patients requiring physical examinations, it offers a valuable complement to traditional care. We strongly believe that the best care for patients is primary care delivered within their communities. Telemedicine will continue to play a crucial role in achieving this goal, helping to bridge the healthcare gap in regions where access to medical professionals is limited.

### **DECLARATIONS**

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#### ***Ethical approval***

None provided.

#### ***Availability of data and materials***

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

#### ***Conflict of interest***

No conflict of interest is associated with this work.

#### ***Contribution of authors***

We declare that this work was done by the author(s) named in this article, and all liabilities pertaining to claims relating to the content of this article will be borne by the authors.

- Philip Osehobo, MD, PhD, FACP (conceptualization, methodology, data collection, and preparation of original draft).
- Dr Pamela M Moye (data analysis, visualization, review and editing).
- Dr. Teresa I Pounds (project administration, supervision, review, and data validation).
- Professor Obehi Akoria (review, validation, and final approval).

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