Development Of an Internet-Based Telehealth System for Quality Healthcare Service Delivery in Abia State College of Education (Technical) Arochukwu

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Abstract- ***Nigeria is the most populous country in Africa with projected population of more than two hundred million people. To maintain high quality healthcare to her citizens, Nigeria requires sizeable number of healthcare workers such as doctors, nurses, midwives, pharmacists and social workers to match this large population. But due to the continuous emigration of healthcare professionals, the quality of healthcare system in Nigeria is deteriorating as the number of healthcare workers is decreasing day-by-day. One short term possible solution in area of mitigating this problem is the use of telehealth technology to provide good healthcare services to teaming Nigerians. Telehealth technology is proved to be effective and efficient in healthcare service delivery. As Abia State College of Education (Technical) Arochukwu (ASCETA) has only one nurse with no medical doctor to attend to staff and students, application of telehealth technology will improve the quality of healthcare service in ASCETA, Hence, the researcher proposed the development of an internet-based telehealth system for quality healthcare service delivery for ASCETA community.***

I. INTRODUCTION

Health in broad sense is the condition or state of one being free from sicknesses (both physical and mental), injury and social problems. In line with this conceptualization, World Health Organization (WHO) in Callahan (1973) defined health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity". These two definitions represent broad definition of health. Another variant definition is given by PubMed Central as "the absence of any disease or impairment". This project adopted the last definition of health. A healthy society or nation has the potential of reaching greatness in many areas of human endeavour be it economic, political, social or technological. But achieving a healthy nation is to a large extent depends on the quality healthcare services provided by healthcare workers. Such healthcare workers include doctors, nurses, midwives, pharmacists, laboratory scientists and social workers among others.

The current high cost of living in Nigeria coupled with the underpayment of healthcare professionals has fueled the mass immigration of healthcare professionals to other countries of the world for greener pasture. This ugly situation has impacted negatively to Nigerian healthcare system. One of the consequences of this development can be seen in the area of increase in the ratio of doctor to patient in Nigeria. For example, Kareem (2021) reported that the doctor to patient ratio in Nigeria in 2021 stood as one Doctor to 2,500 people (1:2,500). This is against the standard ratio of one Doctor to one thousand and six hundred people (1:1,600) set by WHO(World Health Organization).This ratio is rapidly increasing as more and more healthcare professionals are living the country. There is an array of strategies that could help to mitigate this negative impact. One of such strategies is the adoption of telehealth healthcare delivery system.

Telehealth as the name implies is a system that allows healthcare professionals to provide healthcare services to patients separated by distance. In more elaborate form, Telehealth is "the delivery of health-care services using information and communication technology (ICT), where patients and providers are separated by distance"(WHO,2021). Telehealth according to American Occupational Therapy Association (2013) is a service delivery method,

which enables health care professionals to utilize telecommunication and information technology to provide evaluation, consultation, and interventions at a distance from the physical location of the client. HRSA (2013) defined Telehealth " as the use of electronic information and telecommunications technologies to support long-distance clinical healthcare, patient and professional health-related education, public health, and health administration. American Medical Association (2022) described telehealth as "a digital health solution that connects the patient and clinician through real-time audio and video technology". These definitions point to the fact that telehealth does not involve face-to-face healthcare service delivery and requires both software and hardware. Therefore, this delivery system requires special knowledge and skill to accomplish it.

There are different types of telehealth. These include (i) live video; a two-way, face-to-face interaction between a patient and a provider using audiovisual communications technology;(ii) store-and-forward; remote evaluation of recorded video and/or images submitted by an established patient;(iii) e-visits; non-face-to-face patient-initiated communications through an online patient portal; (iv) remote patient monitoring; use of digital technologies to collect health data from patients in one location and electronically transmit that information securely to providers in a different location (data can include vital signs, weight, blood pressure, blood sugar, pacemaker information, etc.) ; (v)audio-only visits; use of telephone for visits without video, (vi) mobile health (mHealth); allows patients to review their personal health data via mobile devices, such as cell phones and tablet computers, which can be done from their home and assists in communicating their health status and any changes; often includes use of dedicated application software (apps), which are downloaded onto devices and (vii) case-based teleconferencing; method of providing holistic, coordinated, and integrated services across providers; usually interdisciplinary, with one or multiple internal and external providers and, if possible and appropriate, the client and family members/close supports(U.S. Department of Health and Human Services,2024).

Telehealth delivery method provides healthcare services available in areas where in-person services are not readily available or accessible (CMS, 2019). It provides healthcare services at the primary level of healthcare system at low cost. Telehealth has the potential to address many challenges to the primary health care (PHC) delivery system. These are related to accessibility, accountability, cost, quality, information exchange, and utilization of services (WHO, 2021). While telehealth provides the means for an equitable health service provision, in reality many persons with disabilities experience difficulties and challenges accessing and using telehealth services (WHO, 2022).Therefore, for telehealth system to be more effective and efficient, it must be designed and developed in such a way to take care of the needs of persons with disabilities. Other problems/challenges or disadvantages associated with telehealth include limitations with performing comprehensive physical examinations, possibilities for technical difficulties, security breaches, and regulatory barriers (Balestra, 2018).

Although, telehealth is associated with many challenges and limitations, but with time, advances in technology and continuous research efforts, such challenges and limitations will continue to decrease, thereby making it more effective and efficient. Leveraging on the advantages and benefits of the telehealth system, the researcher proposed development of an internet-based telehealth system for quality healthcare service delivery in Abia State College of Education (Technical) Arochukwu.

II. PROBLEM STATEMENT/JUSTIFICATION

Presently, the medical unit of Abia State College of Education (Technical) Arochukwu(ASCETA) has only one nurse with no medical doctor. This situation reduces the provision of quality healthcare service delivery in ASCETA. Improvement of provision of quality healthcare services in ASCETA requires employment of many healthcare workers but the current policy of single treasury account in Abia State does not favour the immediate employment of contract healthcare professionals to work in the medical unit of the College by the College management. Even Abia State government for the time being cannot give waiver for the employment of

permanent healthcare professionals for the College as the issue of a new minimum wage has not been settled as well as other financial challenges. One immediate solution to the above problem will be the application of telehealth technology to supplement the healthcare services provided by the medical unit of Abia State College of Education (Technical) Arochukwu (ASCETA). Hence, the researcher proposed the development of an internet-based telehealth system for quality healthcare service delivery for ASCETA community.

III. OBJECTIVE OF THE STUDY

The major objective of the study is to design and develop an internet-based telehealth system for quality healthcare service delivery in Abia State College of Education (Technical) Arochukwu.

IV. LITERATURE REVIEW

This section first presents the concept of telehealth and issues related to it. The section then presents some e-health systems developed in different areas of telehealth/ telemedicine respectively.

V. CONCEPT OF TELEHEALTH

Advances in Information and Communication Technology (ICT) usually accompanied with many possibilities. One of such possibilities is the emergence of telehealth. Telehealth according to Ikumapayi, Kayode, Afolalu, Nnochiri. & Olowe (2022) is the provision of health care services by all medical practitioners employing information and communications technology for the exchange of reliable information for the diagnosis, treatment, and prevention of diseases and injuries. Telehealth has the potential to address a wide range of issues in today's healthcare by improving the performance, accessibility, utilization, efficiency, and efficacy of care while also lowering costs and making it more accessible.

Telehealth can contribute to achieving universal health coverage (UHC) in countries by improving access to quality and cost-effective health services for patients regardless of their setting. It is particularly valuable for those who live in remote areas, for vulnerable groups and ageing populations. While telehealth provides the means for an equitable health service provision, in reality many persons with disabilities experience difficulties and challenges accessing and using telehealth services. In specific, the categories of persons that face such difficulties and challenges includes;(i) persons with vision impairment and blindness;(ii) persons who are deaf or hard of hearing;(iii) persons with speech difficulties;(iv) persons with mobility impairments;(v) persons with mental health conditions and psychosocial disabilities;(vi) persons with developmental and intellectual disabilities and (vii) persons with learning disabilities (WHO, 2022). Therefore, for telehealth system to be more effective and efficient, it must be designed and developed in such a way to take care of the needs of persons with disabilities.

Types of Telehealth

There are different types of telehealth. These include the following.

Live video – Also referred to as “real-time;” a two-way, face-to-face interaction between a patient and a provider using audiovisual communications technology

Store-and-forward – Remote evaluation of recorded video and/or images submitted by an established patient

E-visits – Non-face-to-face patient-initiated communications through an online patient portal

Remote patient monitoring – Use of digital technologies to collect health data from patients in one location and electronically transmit that information securely to providers in a different location (data can include vital signs, weight, blood pressure, blood sugar, pacemaker information, etc.)

Audio-only visits – Use of telephone for visits without video

Mobile health (mHealth) – Allows patients to review their personal health data via mobile devices, such as cell phones and tablet computers, which can be done from their home and assists in communicating their health status and any changes; often includes use of dedicated application software (apps), which are downloaded onto devices

Case-based teleconferencing – Method of providing holistic, coordinated, and integrated services across providers; usually interdisciplinary, with one or

multiple internal and external providers and, if possible and appropriate, the client and family members/close supports

Different Models of Tellehealth
There are different models of telehealth. These include;
Synchronous telehealth is when health information is delivered in real-time[through a live telehealth consultation. This is done through interactive video with the patient and health professional present at the same time. It is used to consult with, diagnose and treat patients.

Asynchronous telehealth or store and forward, refers to the collection of patient information (diagnostic images, vital signs, video clips) at the patient site. This information is then assessed and analysed by a health practitioner located at another site. An example of this is a patient tracking their activity or steps in a day - this information is then sent to the physiotherapist to monitor.

Hybrid telehealth includes a combination of live telehealth (synchronous) and store-and-forward therapy (asynchronous) consultations.A hybrid health care delivery model would be where both in-person and telehealth services are provided to the patient.

Remote patient monitoring (RPM) refers to the use of devices to remotely collect patient information, such as glucose and blood pressure monitoring. This information is then sent to a home health agency or a remote diagnostic testing facility (RDTF) for interpretation. It enables tracking and monitoring of the patient.

The newest model of telehealth is Mobile Health or mHealth - this includes online services and mobile phone applications that are marketed directly to consumers. It enables consumers to access health information, as well as online groups which provide peer-to-peer support.

Benefits of Telehealth
Telehealth has many benefits for patients, health care provider and society.
The benefits to the patient include:

- -Access to health services otherwise unavailable in remote locations
- -Removal of barriers such as travel time, parking, and waiting rooms
- -Improved safety for patients who are too ill to travel or have mobility restrictions
- -Not location dependent
- -An increase in the patient's autonomy to manage their health through online self-management and monitoring
- -More flexibility for patients as they can schedule therapy at times that suit them
- -More cost-effective therapy in terms of travel, leaving work early or leaving children or family with a caregiver
- -Reducing medical utilisation in certain patient groups (eg cardiac patients)

The benefits to the health care provider include:

- -Improved efficiency as there is less travel between clinic locations
- -Standardised service user pathways
- -Greater consistency in terms of patient self-management at home and monitoring standards of care and outcome
- -Opportunities for improved creativity in the standard of care with evolving technology

The benefits to society include:

- -Better use of public resources
- -Employer benefit, with less worker absenteeism
- -The patient/community is more autonomous and informed
- -Reduction in dependence on the medical system and increased encouragement for patients to self-manage their health
- -Fulfillment of people's expectations to be more digitally connected
- -More equitable access to healthcare
- -Decreased environmental footprint due to less travel
- Some Web-based systems Developed in Telehealth and Telemedicine

Antor, Jamil , Mamtaz, Khan, Alshamrani and Masud (2021) developed an online telemedicine web-based system that helps to promote collaboration between doctors, hospitals, and

patients. The system allows doctors to serve patients from remote areas. The system also allows both doctors and patients to communicate through video calls or text messages. Patients using the system can store information about their health, search for doctors, and consult medical professionals using text messages and video calls. Doctors can also register to serve patients, but they must ensure authenticity through registration. Doctors can write blogs, provide prescriptions, and can view the medical history of the patient. Hospitals can assign doctors in the respective departments. The system is tested in a lab environment The system is fast and reliable with a user-friendly interface, enhancing telemedicine services countrywide for people with online access. Figure 1 shows the block diagram.

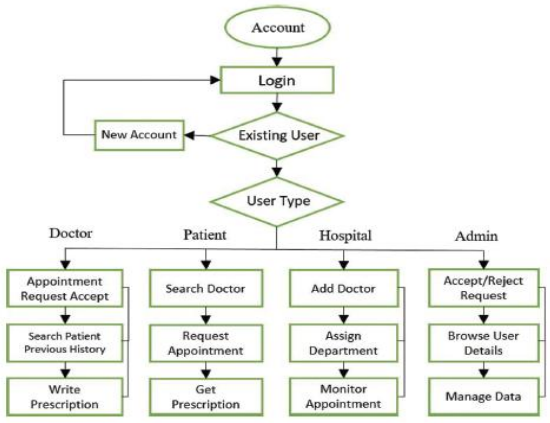

Figure 1: System's block diagram

Ahmed, Ahmad, Ismail, Fasek and Umar (2022) designed and implemented a Web-Based Patient Management System (PMS). The system provides the benefits of efficient tasks, improved administration & control, patient care, and improved effectiveness. This PMS is built on the C#, database, and object-oriented programming language techniques. My SQL (Structure Query Language) is used in areas where keeping the records in the database is required, this system uses C# as the Front-end software, which is an object-oriented programming technique and has connectivity with My SQL, the back-end software. Figure 2 shows an interface for checking students' records.

Figure 2: Records manipulation interface

Al-Ghrairi,Mohammed and Saeed(2021) developed a web-based e-healthcare management system using ASP.Net. The system consists of two major sides: client- server side (front end side and back end side). The client-side is everything involved with what the user sees. It was designed a web using HTML, CSS and JavaScript languages. The server-side consists of buttons for modifications(eg. updating). The system implemented using ASP MVC5 and C# programming language. SQL Server languages used for the database part and it make simple ease of use for patients to their health registrations. Consequently, it has simple and straight accessibility through a group of physicians for patient records. The system provide accessibility with easy manner of pertinent information to the management organizations for instance the Medicaid and Medicare. Furthermore, the system reduces the mistake in healthcare, and reduce the cost of delivery of healthcare.

VI. METHODOLOGY

Live / real time type of Telehealth was employed for the development of this software. This follows the synchronous model of Telehealth. This web application is connected to a database which stores data and connects it to the database. The database and data base connection have been developed using the structured query language (SQL) . The site is secure and reliable. Only the admin has full access to the database. The doxy telechat software was used to provide video calls between the doctor and the patient. For the front end design, Hypertext Markup Language (HTML) , Cascading style sheets (CSS) were used while Hypertext Pre-Processor (PHP) and Java scripts were used for the back end design.

Block Diagram

This web system aids patients in receiving the medical care they require. It helps users to consult

with a specialized doctor for remote treatment. A user can sign in as a patient or a doctor. Patients can make an appointment with a doctor through voice calls, messages and video calls from remote areas .

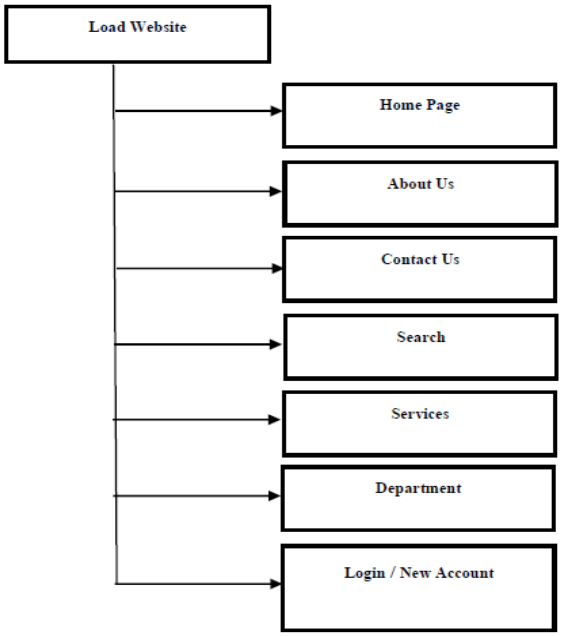

Figure 3: Block diagram of the System

Use Case Diagram

The characteristics of the web based Telehealth system are revealed in the diagram. The use case diagram involves the information system and general modelling of the Telehealth system. It shows how a user can engage with the entire system.

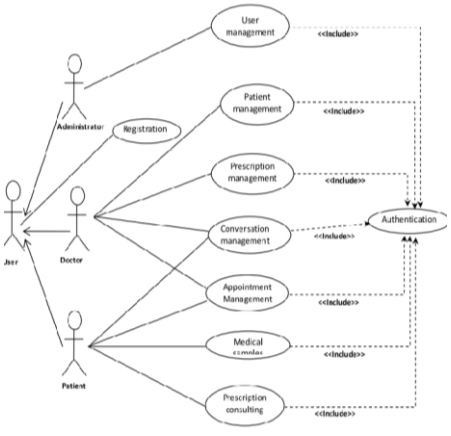

Fig 4: Use Case Diagram

VII. RESULTS

Web Application Functionalities

- Landing page

The landing page also known as the homepage of the website has been designed in a user friendly way with bright colours which will be appealing to the user as shown in Fig 5. This design was done using Dreamweaver application. Users can view the services on the landing page without logging in. The page allows anyone to see the content. The user can create an account to commence further activity after finding a service of interest on the page . It is the most important page because all services are shown mainly on this page.

Fig 5: Landing Site

- Login and Registration

The login page allows the users to use the telemedicine service by operating the user interface for applications. The users must provide some information to validate their registration.

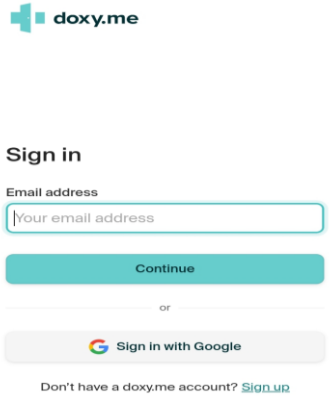

Fig 6: Login and Registration

- Appointment

The appointment icon as shown in Fig 7 leads to the appointment process. Appointments are needed to avail healthcare services. Users can know the time and date of consultation when making an appointment. They can log in and interact with the doctor through messages and video calls.

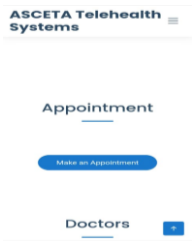

Fig 7: Appointment

- Video calling

Video calls are used for meeting purposes. Doctors need to see their patients for better treatment. Patients can connect with a doctor through video calls after booking an appointment. The telechat software known as doxy has been used to develop the video call system.

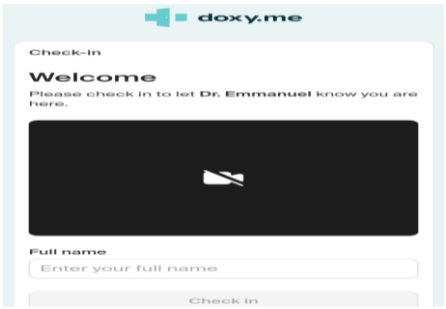

Fig 8: Video Calling

- Prescription and Referral

Prescriptions are written in PDF. The PDF is the most usable format for storing composed data. The doctor writes the prescription which is automatically converted to pdf format and guides the patient on the necessary medicine requirements following the outcome of the consultation with the doctor. In cases where further specialized consultations are required, the referral services provide an avenue for further referrals by the doctor.

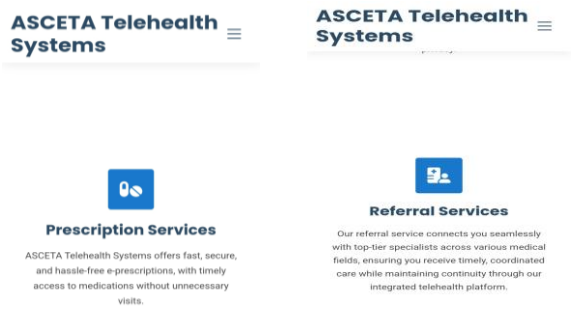

Fig 9: Prescription and Referral Services

CONCLUSION

Telehealth offers an innovative alternative solution to providing healthcare to distant, underdeveloped and incapacitated areas. This work has examined the design and development of a Telehealth system for medical tele-consultation in Abia State College of Education (Technical) Arochukwu relying on a web application. The system is easy to comprehend, fast and reliable with a userfriendly interface. This system will promote collaboration between healthcare providers and patients thereby enhancing efficient health care delivery.

REFERENCES

[1] Ahmed,M.G., Ahmad,S.K., Ismail,A. , Fasek,N.F.&, Umar,A.J. (2022). Design and Implementation of Web-Based Patient Management System Using C#. *IOSR Journal of Computer Engineering (IOSR-JCE),24(4),69-72.*

[2] Al-Ghrairi,A.H.T. Mohammed,A.A. and Saeed,H.M.(2021). An Application of Web-based E-Healthcare Management System Using ASP.Net. *Webology*,18(1), 285-298

[3] American Medical Association(2022). Telehealth Implementation Playbook. Retrieved on 22nd September,2023.

[4] Antor,M.B. Jamil ,A.H.M.S. Mamtaz, Khan,,M.M. Alshamrani,,S.S. & Masud,M. (2021). Development of a Web-Based Telemedicine System for Covid-19 Patients. *Intelligent Automation & Soft Computing*,30(3),899-915.

[5] Balestra, M. (2018).Telehealth and Legal Implications for Nurse Practitioners. *J Nurse Pract.*14 (1):33–39. doi: 10.1016/j.nurpra.2017.10.003

[6] Callahan, D. (1973).The Concept of Health.*The Hastings Center Studies*,1(3),77-87.

[7] CMS(2019).Exploring Telehealth Delivery Methods for Substance Use Disorder Treatment. Retrieved on 22nd September, 2024.

[8] Ikumapayi, O.M. Kayode,J.F.Afolalu,S.A., Nnochiri,E.S. & Olowe,K.O.(2022).Telehealth and Telemedicine – An Overview. Proceedings of the 4th African International Conference on Industrial Engineering and Operations Management Nsukka, Nigeria, April 5-7, 2022

[9] Kareem (2021). As Doctors Emigrate, Nigerians are left with four Doctors to every 10,000 Patients. Retrieved on 22nd September,2024.

[10] Nnabuko,U.C., Iroegbu ,I.O. Ugwuoke,C.I., Eteng, I.E. & Okoronkwo, M.C. (2013). An object based result processing system. *International Journal of Natural and Applied Sciences (IJNAS)*, vol. 8(1& 2), 27 – 34

[11] PubMed Central (2006). The Meanings of Health and its Promotion. *Croat Medical Journal*.47(4): 662–664.

[12] U.S. Department of Health and Human Services,2024).Telehealth for Providers: What you Need to Know. Retrieved on 22nd September,2024..

[13] WHO (2021).Leveraging Telehealth for Efficient Delivery of Primary Health care in the WHO South-East Asia Region. Retrieved on 22nd September,2024.

[14] WHO(2022).WHO_ITU Global Standard for Accessibility of Telehealth Services.. Retrieved on 22nd September,2024.