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REVIEW ARTICLE

Telehealth in Chronic Disease Management: Expanding Access to Public Health Services in Low-Resource Settings

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Abstract: Telehealth has become an important strategy in the management of chronic diseases, especially in regions with limited access to healthcare facilities. Using digital technologies, telehealth offers patients the opportunity to have a medical consultation, control, and education, thus connecting the two main pillars of the healthcare system—healthcare providers and patients in the hard-to-reach zones. This approach is especially useful for chronic diseases that need control and management, and diabetes, hypertension, and cardiovascular diseases are among them. In addition to providing a way of reaching out to people with limited access to essential healthcare services, telehealth also enhances patient outcomes through early detection and management and lightening the load of overworked healthcare systems. However, there are barriers to the integration of telehealth into low-resource settings, such as challenges with technology, digital literacy, and legal requirements. This review examines the part of telehealth in the supervision and control of chronic diseases and how it may help to increase the reach of the public health services in settings with limited resources, as well as the obstacles that must be solved to gain the advantages.

Keywords: *Telehealth, Chronic disease management, Low-resource settings, Public health services, Digital Healthcare*

1. Introduction

Some of the major non-communicable diseases include diabetes, hypertension, and cardiovascular diseases, which are the common causes of morbidity and mortality globally and contribute to a large part of the disease burden. These diseases are usually progressive and may need treatment over a long duration and at regular intervals; hence, frequent visits to health facilities are necessary to monitor the disease's progress and to prevent complications (1). However, in the majority of the low-resource settings, the access to the essential health care services is hindered by several barriers, including geographical, infrastructure, and human resource barriers. These challenges pose a barrier to early diagnosis and proper management of diseases, and hence, high mortality rates, particularly among patients with chronic diseases (2).

Telehealth, which includes providing healthcare services through digital technologies, is also seen as a viable solution to the mentioned challenges. Through the use of telehealth, patients can access medical care, information, and treatment through the use of communication technologies such as video conferencing, which eliminates the need for patients to visit healthcare facilities physically (3). This is especially useful in the management of chronic diseases, which require frequent checkups and appropriate management to ensure that the patient’s condition does not worsen.

The concept of telehealth is not new as it has been in development for the past few decades. In the beginning, telehealth consisted of the use of the telephone for consultation between the healthcare givers and the patients, which enabled the patients to consult the healthcare givers through distances (4). However, there has been an evolution in the field of digital technology that increased telehealth possibilities not only off to a simple video conferencing but also the virtual care, monitoring, and the use of mobile health (mHealth) solutions. The advancements that have been made in the field of technology helped in delivering a better and efficient healthcare service to the patients, especially in the areas where there are no proper healthcare facilities available (5).

Especially in the context of low-resource settings where there is often a strain on the healthcare systems and limited funding. For example, in rural areas where there may be limited healthcare facilities and fewer healthcare workers, telehealth can bring the healthcare providers closer to the

patients. This is because the problem of transport and the congestion of health facilities can be eased through the use of telehealth where patients have to travel long distances to access health care services (6,7). This is particularly crucial for patients with chronic diseases, whose conditions need to be monitored from time to time and managed steadily.

Beyond improving accessibility, telehealth fosters patient engagement by facilitating greater involvement in self-care. Digital platforms provide opportunities for patients to access health-related information, reinforcing adherence to treatment plans and promoting proactive disease management. These tools can assist patients to comprehend more about their diseases, the options they have, and the need to comply with the suggested treatment plans (8). As a result of the increased patient involvement and control over their health, telehealth can result in improved health status and improved quality of life of patients with chronic diseases.

A key advantage of telehealth is its ability to support continuous patient monitoring, which is particularly critical for managing chronic diseases. By leveraging digital health technologies, healthcare providers can track patients' vital signs and detect potential complications early, reducing the burden on in-person care facilities (9). This real-time data can be transmitted to the healthcare givers so that they can evaluate the patient and modify the treatment plan if need be. In low-resource settings where it may be difficult for the healthcare givers to access the patients frequently, telemonitoring provides an effective solution to support the patients and provide them with timely treatment and interventions. Despite its potential, the integration of telehealth into low-resource settings faces systemic barriers, particularly concerning infrastructure limitations. Reliable internet connectivity, electricity, and access to digital devices remain fundamental prerequisites for effective telehealth implementation (10). However, most of these facets are not readily available in low-resource settings, hence hampering the growth of telehealth. This is further compounded by the challenges that are associated with digital literacy since there are individuals in these areas who may not be well conversant with how to use digital devices or even navigate through telehealth websites.

Another big hurdle is the absence of adequate legal metrics that can accommodate the use of telehealth. These frameworks have to consider matters to do with the protection of data, the certification of the healthcare givers, and the payment for the telehealth services (11). Without proper guidelines, the application of telehealth in the care of chronic diseases can be constrained,

and patients may not be able to derive all the advantages that come with the use of telehealth. Additionally, the lack of standardized protocols for telehealth can lead to variations in the quality of care provided, which can undermine the effectiveness of telehealth interventions. Therefore, this study aims to review the effectiveness of telehealth interventions in improving chronic disease management and expanding access to public health services in low-resource settings.

2. Methodology

This paper is a based on the literature which focuses on a specific literature review that aims at giving an overview of the importance of telehealth in the management of chronic diseases especially in the context resource of environments. low The search for articles was done from online databases including PubMed, IEEE Xplore and Google Scholar using keywords such as 'telehealth', 'chronic disease management', 'low resource settings' and 'public health services.' The search was limited to articles published in the last decade and only English language articles were considered. The following inclusion criteria were set to choose the studies that could offer empirical data, theoretical frameworks or practical recommendations on the use of telehealth in chronic disease management. Peer-reviewed articles, conference papers and government reports were given high consideration while opinion pieces that had no supporting evidence were omitted. The data collected from the selected studies were categorized into themes such as the uses, difficulties, and prospects of telehealth in the management of chronic diseases. Since the objective of this paper is to synthesize the findings from the literature, a narrative approach was employed to integrate the findings in order to give a comprehensive view of the current status of telehealth in this particular field.

3. Applications of Telehealth in Chronic Disease Management

Telehealth has numerous implementations in the management of chronic diseases especially in the regions where the access to health care facilities is challenging. Some of the applications are remote consultations, telemonitoring and patient education and all these helps to enhance health outcomes and utilization of the public health services. The gradual rise of telehealth consultations especially in the last decade supports the increasing trend of using digital health care services. This graph shows that telehealth has the capacity of solving some of the healthcare challenges that exist

in areas of poor resource allocation as access to health care and technology increases **(Figure 1)**.

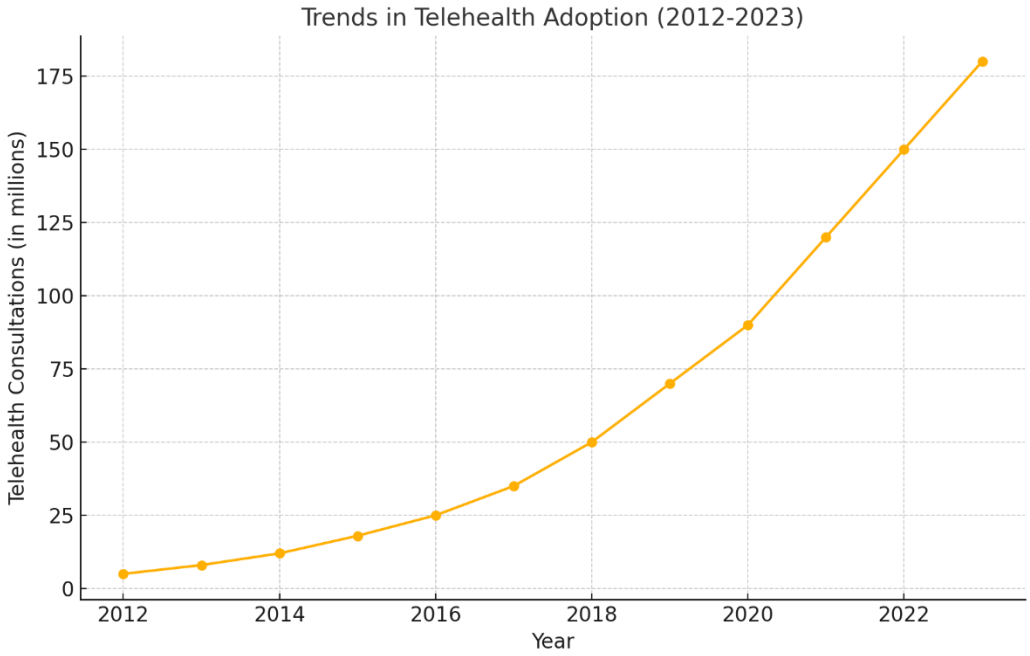

Figure 1: Growth in telehealth consultations globally from 2012 to 2023, showing the rapid adoption of telehealth technologies in healthcare systems.

3.1 Remote Consultations

The most important use of telehealth in the management of chronic diseases is remote consultations. Especially in circumstances where access to healthcare providers is a challenge, telehealth helps patients to get medical counsel and aftercare services. This is especially helpful for patients with chronic diseases since they need to be checked up on and their treatment plans tweaked from time to time (12).

Remote consultations can be conducted via video calls, phone calls, or even text messaging, depending on the available technology and the patient's preferences (13). These consultations enable the healthcare givers to interview the patients, evaluate the patients' symptoms and the proposed treatment plans, and give the necessary medical information that the patient may need and which may not necessarily need a visit to a health facility. It not only helps in terms of the patient's time and money but also lightens the load of the health care facilities so that they can attend to more serious cases.

3.2 Telemonitoring

Telemonitoring is another example of how telehealth can be used in the context of chronic disease management. markers It of is patients a in paradigm distant that locations. entails This the means employment that of the technology patients' to health track parameters and/or like assess the certain blood health pressure, status blood sugar levels and heart rate among others can be monitored regularly hence if there are any complications the healthcare providers can act on them before the patient's condition becomes worse (14,15).

In the circumstances where the healthcare givers cannot be able to reach the patients in their homes frequently, telemonitoring is a good solution. For instance, diabetic patients can use glucose meters that have features of sending the glucose levels to a certain database from which the healthcare givers can view the data and alter the patient's treatment plan (16). This approach enhances the disease control and makes the patients to be more involved in the management of their conditions.

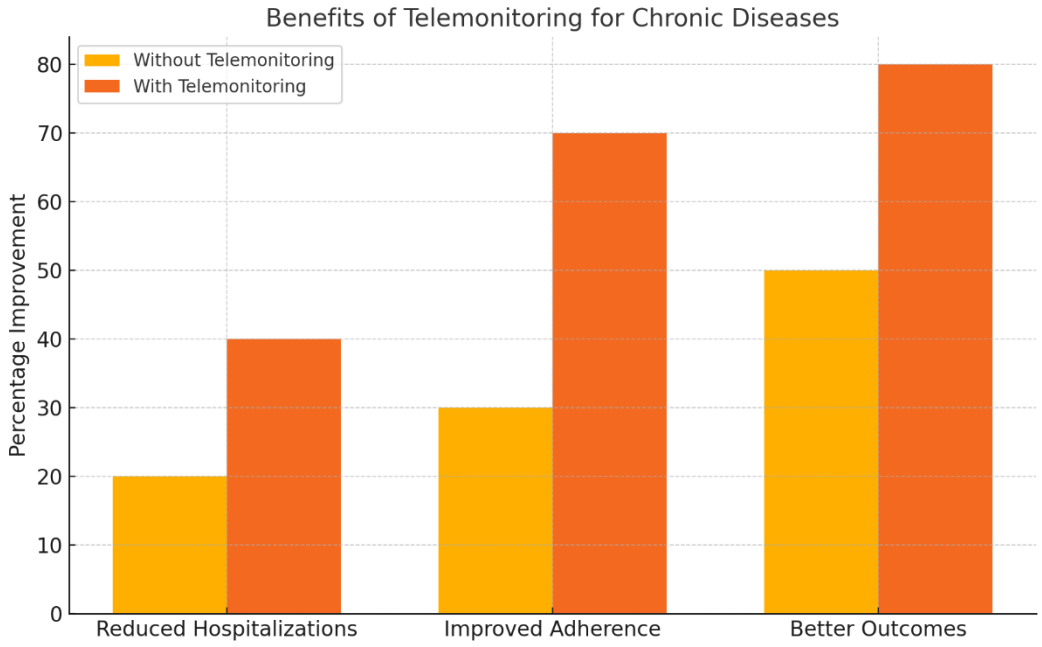

Figure 2: Bar chart Comparative analysis of health outcomes with and without telemonitoring for chronic disease management. Categories include reduced hospitalizations, improved treatment adherence, and better overall outcomes. Patients using telemonitoring demonstrate significantly better outcomes compared to those who do not. The data emphasizes telemonitoring's role in reducing hospitalizations by providing timely interventions, improving medication adherence, and enhancing the overall management of chronic conditions.

3.3 Patient Education

Education is an important aspect of the management of chronic diseases since it enables patients to take control of their health and deal with their conditions appropriately. This paper shows how telehealth can be used to provide patient education, which would otherwise be difficult to achieve in terms of accessibility and convenience, especially in areas with limited access to health facilities (17).

By using telehealth, patients can find information, communicate with other people suffering from the same disease, and get recommendations from healthcare professionals. The following are some of the topics that can be included in the education aspect: medication, changes in one's lifestyle, and ways of avoiding certain issues. Thus, the enhancement of the patients' knowledge of their diseases through telehealth can yield improved health results and an enhanced quality of life for chronic disease sufferers.

4. Challenges in Implementing Telehealth in Low-Resource Settings

Although telehealth has a great opportunity for enhancing the care of patients with chronic diseases in the context of limited resources, the application of telehealth is not without its difficulties. The challenges that follow have to be met to be able to take full advantage of telehealth and to be able to incorporate it into the public health institutions.

4.1 Technology Infrastructure

A major barrier to the integration of telehealth in low-resource settings is the absence of proper technology infrastructure **(Figure 2)**. Internet, electricity, and other digital devices are key elements that enable the provision of telehealth services. However, the majority of these facilities lack these necessities, hence hindering the growth of telehealth, especially on a large scale (18).

To overcome this challenge, there is a need to make investments in technology structure such as increasing the internet coverage, availing digital devices, and designing systems that are compatible with the existing technology. This can be done through public-private partnerships since the former can draw on resources from both the public and private sectors in order to enhance technology structure in the latter.

4.2 Digital Literacy

Another important barrier is the lack of digital literacy, which is one more issue in the context of telehealth. There are cases when some people in low-resource societies may not be well-versed in the use of digital devices or even telehealth platforms. This can reduce their chances of embracing telehealth and taking full advantage of the services it presents (19,20).

This is where the education and training of patients and providers on the aspect of digital literacy come in. Such programs should aim at helping people gain knowledge on how to use digital devices, navigate through the telehealth platforms, and comprehend the information given in the telehealth care settings (21). Thus, the programs for increasing digital literacy can ensure that all people have an opportunity to use the offered telehealth care services, regardless of their previous experience in the use of information and communication technologies. The major barriers to telehealth adoption in low-resource settings are illustrated (**Figure 3)**.

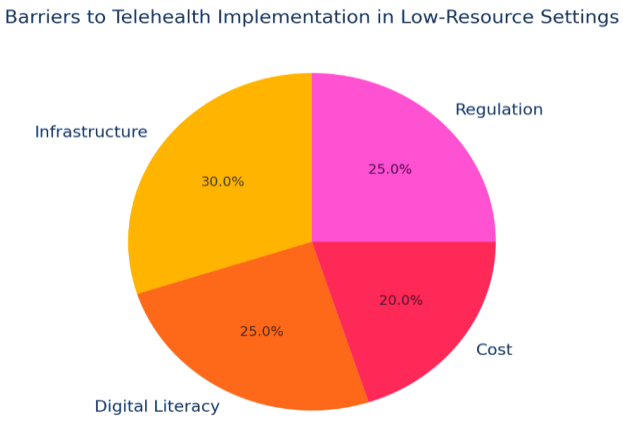

Figure 3: Pie chart showing the distribution of major barriers to telehealth adoption in low-resource settings, including infrastructure, digital literacy, cost, and regulatory challenges. Infrastructure issues (30%) and regulatory challenges (25%) are among the most significant barriers to telehealth adoption in low-resource settings. Addressing these challenges is critical for leveraging telehealth to improve healthcare delivery and outcomes in underserved communities.

4.3 Regulatory Frameworks

The same applies to the integration of telehealth into low-resource structures, and there is a need for the establishment of suitable legal requirements. Some of the areas that should be considered in the frameworks include data privacy, the practice of healthcare providers, and reimbursement for telehealth services. This implies that if appropriate guidelines are not put in place, the use of telehealth in the management of chronic diseases may not be optimal, and the patients may not be

able to derive the desired advantage. The development of the regulatory environment that will enable the integration of telehealth also needs the input of the government, the healthcare providers, and the technology companies. Such frameworks should address issues of patient privacy, quality of care in telehealth, and how telehealth can be incorporated into the current health care systems (22).

5. Emerging Technologies and Innovations in Telehealth for Chronic Disease Management

Due to the advancements in technology, the field of telehealth is in a constant evolution. These innovations are revolutionizing the way that chronic diseases are assessed and handled, with particular emphasis on the hard-to-reach areas where there are usually poor health care facilities. With the integration of advanced tools and systems, telehealth has also improved in terms of efficiency, accessibility, and personalized care for the patient.

The use of artificial intelligence (AI) is among the most significant and influential advancements as it is integrated into telehealth. AI is not just an empty trend – it is a real utility for the analysis of big data in health care (23). For instance, machine learning algorithms can analyze the data streams obtained from remote patient monitoring (RPM) equipment, including heart rate monitors or glucose trackers, for identification of risks (24). These algorithms have the capability of picking out some of the most complex patterns that can be hardly noticed by a human being, thus allowing for early intercessions. For diabetic patients, AI can help in determining the trends of the blood sugar levels and suggest changes in the diet or medication intake at the right time. In the same way, in identifying the abnormal area heart of rates cardiovascular or care, other AI-based issue solutions which can may use lead data to from strokes wearables and to other complications.

Another revolutionary shift is the integration of wearable technology into the field of telehealth. The modern wearables, for instance, smartwatches, fitness trackers, and biosensors, have not only limited capabilities of measuring simple metrics like steps or heart rate. These devices are capable of measuring more complex parameters, including oxygen saturation, blood pressure, and even biochemical parameters like cortisol levels (25,26). For patients suffering from chronic respiratory disorders, including asthma or Chronic Obstructive Pulmonary Disease (COPD), there are wearable devices that can be used to monitor breathing patterns and identify worsening of the condition. This information, sent to the healthcare givers in real time, helps to make quick medical

interventions, which often avoids admissions. In rural or hard-to-access areas, these wearable devices serve as a vital link between the patients and the doctors.

There is also the emergence of the Internet of Medical Things (IoMT), which is a network of interlinked medical devices that are interoperable with telehealth systems. This makes sure that the health information is safely exchanged in real time, and hence, the healthcare givers can have a complete picture of the patient. For instance, in the management of chronic diseases, IoMT devices include smart inhalers for asthma patients or connected glucometers that help monitor diabetes patients. These systems improve the decision-making process since the information that is gathered is not only from one point of contact; this gives the providers a better insight of the patient's condition (27).

Blockchain technology is being recognized as an important solution in solving some of the challenges that are associated with data security and privacy, which are important aspects of the acceptance of telehealth. Blockchain is a distributed ledger system that is immutable and thus used to store patient information securely but at the same time allowing only the legit people to have access to the information. In low-resource settings where people may have little confidence in digital platforms, blockchain provides an added level of trust, thus building trust between the patient and the provider.

There is also a lot of potential in the use of Virtual Reality (VR) and augmented reality in telehealth. Two technologies are being used to improve the quality of patient education as well as the treatment of patients with chronic diseases. For example, VR can help diabetics understand how it feels to live with the condition and learn about meal planning and blood sugar management. Augmented Reality (AR) is also being used in the field of remote physical therapy, where the providers can supervise the patients doing exercises with the help of arrows pointing to the right direction in real time (28). This not only improves adherence to therapy regimens but also ensures that patients in remote areas receive high-quality care.

Natural language processing (NLP), which is a branch of artificial intelligence, is also finding its application in the field of telehealth. By implementing intelligent chatbots and virtual assistants, NLP helps patients get the required information, make an appointment, or even remind them about the medication they need to take. These tools improve the patients' experience and help to make healthcare more accessible and less fearful. Also, they help to alleviate the pressure on the

healthcare workers so that they can concentrate on the patients who need advanced attention. In many low-resource settings, creative approaches are being used to address the issues of scarce resources. Solar powered telehealth units and mobile health solutions are bringing health care to the hard-to-reach areas where there is little or no access to electricity and the internet. These hubs are fitted with basic necessities that are required for the treatment of patients, including ultrasound machines or blood analyzers, thus enabling the healthcare workers to offer quality care. For instance, some portable devices can help in diagnosing anemia, different types of infections, or even certain chronic diseases, which have been very helpful for people living in remote areas and who have to travel long distances to get medical care.

Last but not least, the field of telehealth is also starting to use predictive analytics to predict when health problems are going to happen. Through the use of historical data coupled with real-time information, predictive models can identify people who are likely to develop complications. This is especially useful in managing diseases such as hypertension, where warnings of increased blood pressure can help in changing the medication dosage and avoid adverse events.

These innovations are not just a set of new equipment; they are revolutionizing the current state of the healthcare industry and the way patients with chronic diseases are treated. Thus, by adopting these new technologies, telehealth can become a complex system able to meet the needs of patients with chronic diseases. However, the realization of these potentials will depend on the sustainability of investment in research, proper policy guidance, and other supportive measures, including the active involvement of health care providers, technology firms, and policy makers. The end result is still the same: To provide quality health care services to all in the same manner and at any geographical or economic environment.

6. Building Sustainable Telehealth Models in Low-Resource Settings

The sustainability of telehealth in the management of chronic diseases as a way of improving the healthcare delivery system in low-resource settings will depend on the ability of the systems put in place to address the existing challenges. Sustainability is not only about the continuity of operations but also about the ability of the system to be strategy economical, that accessible, looks culturally into sensitive the and social, adaptable economic, to and the technological dynamic relations nature can of make health telehealth care a system which is a vital part proactive of the public health in the areas with limited access to health care facilities.

One of the key principles of sustainability is the emphasis on the use of context-appropriate strategies. Such systems including SMS-powered be areas offline health developed that mode reminders in have to or a spotty enable simple manner internet communication. hotlines that connection, Instead attended suits telehealth of by the programs complex health conditions can high-tech workers, of use approaches, can the mobile low-tech be people data solutions, used that or to it is targeting. overcome the digital divide (29,30). This can be done by making sure that the telehealth platforms are also translated in different languages and are culturally appropriate to increase their adoption and utilization.

The financial viability is one of the most important factors that determine the sustainability of telehealth initiatives in the long run. There are patients in low-resource settings who cannot afford initial costs of devices or the recurring costs of consultations. Some of the strategies that can help include subsidized programs, low-cost device manufacturing partnerships, and other innovative payment models such as microinsurance (31). Such collaborations with the governments and international aid organizations can also help in developing and maintaining the telehealth infrastructure without putting an extra load on the local community. Thus, integrating telehealth services into the existing public healthcare structures may also help to decrease the costs and increase the accessibility.

Another role crucial of element the that healthcare cannot providers. be Thus, left even out the in most the sophisticated development systems of will a approval not sustainable of work telehealth the without model healthcare the is professionals. participation the Therefore, and it is imperative that providers are trained regularly to make them familiar with the technology and equipped to deal with the patient's requirements virtually. This should not only target the enhancement of the technical knowledge but also the communication techniques that should be employed during the virtual visits and management of patients with chronic diseases that need a long term relationship (32). In addition, there should be policies that encourage the providers to embrace telehealth by associating their performance in these programs with career growth or financial gains.

Sustainability Some on patients the still other have hand concerns needs about a relying change on in telehealth, public for perception the and perception patient that engagement it in may the knot use of be the as tangible useful benefits as through the physical awareness visit campaigns to and the hospital. users' To testimonies. gain Success the stories confidence, of the program's

patients must who prove have managed their chronic diseases with the help of telehealth can be effective in changing the perception of the patients. Moreover, having the community leaders promote the use of telehealth will also help in breaking the stigma that surrounds the use of the system.

Partnerships across the globe have been critical in the development of telehealth especially in the implementation of the programs in the resource limited settings. The paper reviewed in this assignment identified these partnerships as the collaboration between the government, non-governmental organizations, private technology companies, and academic institutions. For instance, the telecommunications companies can be very useful in enhancing the connectivity in the hard-to-reach areas while the academic institutions can bring in ideas on This how also to means enhance that the while efficiency developing and the effectiveness funding of mechanisms, the its telehealth is solutions. important that multiple stakeholders are involved such that none of the parties bears the costs solely. Environmental concerns are now a part of the healthcare delivery and telehealth cannot be excluded from it.

Telemedicine is one of the greatest strategies that have been put in place to reduce the patient's transport needs thus decreasing the carbon foot print of health care. Nevertheless, there are some concerns with the infrastructure used in telehealth for example the digital devices and data centers. The programs should also consider energy conserving technologies and green energy sources including the establishment of solar powered telehealth facilities in areas that are not connected to the grid to ensure that the environment is not adversely affected.

7. Discussion

Telehealth is a revolutionary model in the management of chronic diseases especially in the regions with limited access to health care facilities. Through the use of telehealth, it is possible to provide remote consultations, telemonitoring, and patient education thus closing the gap between the health care givers and the patients and hence enhancing health outcomes and increasing access to primary health care services.

Telehealth can be defined as the delivery of health care services via remote means, which enables patients to consult with their doctors and receive follow-up care without the need to travel to the healthcare facility. It helps in lightening the burden on the health care facilities and also

helps the patient by saving his time and money. Telemonitoring helps in the tracking of various health parameters on a regular basis thus enabling the health care givers to identify the possibilities of complications and manage them before the condition of the patient gets worse (33). Patient education through telehealth platforms empowers individuals to manage their conditions effectively and make informed decisions about their health.

However, there are several barriers that hinder the adoption of telehealth in the low-resource settings such as technological, literacy and regulatory concerns. These challenges have to be addressed so that telehealth can be properly incorporated into the public health systems and the potential that it offers can be achieved (20).

Investing in technology infrastructure is crucial for the successful implementation of telehealth. This includes expanding internet access, providing digital devices, and developing telehealth platforms that are compatible with the available technology. Public-private partnerships can play a key role in this effort, leveraging resources from both the public and private sectors to improve technology infrastructure in underserved areas (30).

Education and training programs are also important in enhancing the digital literacy of the patients and healthcare practitioners and hence effectiveness of telehealth. Some of the areas that should be given attention include; teaching individuals on how to use digital devices, how to navigate through telehealth platforms and how to comprehend the information given during the telehealth sessions. Through enhancing digital literacy, these programs can assist in making sure that telehealth services are accessible to all people in the society regardless of their technology literacy. Therefore, the formation of supportive regulatory frameworks is key to the integration of telehealth in low resource settings. Some of the areas that should be considered in these frameworks include data privacy, practice licenses for the providers and payment for telehealth services. Through putting down some guidelines, the policy makers can enable a system where telehealth can be embraced and integrated in the care of chronic diseases

8. Conclusion

Telehealth has the capacity to change the face of chronic disease management especially in the areas of poor resources by enabling the delivery of essential health care services. By virtue of remote consultations, telemonitoring and patient education, telehealth can help to overcome the

barriers between the health care givers and the patients, enhance health outcomes and increase utilization of the public health care facilities. Thus, to implement telehealth effectively, there are various barriers that need to be solved in the aspects of technology, digital skills, and legal requirements. opportunities With that such come investment, with the telehealth public and health enhance systems the can care be of able chronic to diseases maximize on in the the communities that have been neglected.

Declarations

Ethical approval

Not applicable

Consent for publication

Not Applicable.

Availability of data and materials

Not Applicable

Competing interests

The authors declare that they have no competing interests.

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