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Opinion

The Impact of ICT-Enabled Healthcare Technologies in Managing Chronic Diseases

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Abstract

Lately, research has publicized the big potential that Information Communication Technology has to improve healthcare systems, particularly the management of chronic illnesses. Several countries have invested highly in ICTs for healthcare such as Telemedicine and mobile health applications among others to enhance patient care and self-management of chronic diseases. Nevertheless, a research gap still exists in investigating the exact impact of ICT developments on chronic illness management since most of the existing studies focus on the broader effects of ICT on healthcare, moreover in the contexts of Western countries. This study will provide useful insights that will help curb the strain on healthcare systems by evaluating the extent to which ICT-enabled technologies can contribute to improving chronic disease management. Additionally, this study will extend the Activity Theory framework, offering an all-inclusive understanding of how ICT-enabled healthcare technologies influence chronic disease management practices. The findings of the study will have significant theoretical, methodological, and policy implications.

Keywords: ICT enabled technologies, Healthcare, Chronic disease

Introduction

Lately, there has been an outstanding increase in the occurrence of chronic diseases, leading to a decline in overall health and quality of life on a global scale (*Miller, Monga & Wilkins, 2019*; [1,2]). Chronic disease or condition refers to long-lasting physical or mental health issues that result in functional limitations or necessitate ongoing monitoring and treatment. Frequently occurring chronic conditions such as diabetes, hypertension, stroke, heart disease, respiratory disorders, and arthritis are not only common but also present significant health and financial burdens, often leading to hospitalization, permanent disability, reduced quality of life, and mortality [3,4]. Even though these conditions are commonly linked to older age groups, research indicates that a significant portion of deaths from chronic diseases, roughly-17 million occur before individuals reach the age of 70 [5]. It is concerning to note that low- and middle-income nations account for 86% of these premature deaths. Chronic ailments distress individuals across all age groups, regions, and nations. Remarkably, healthcare for chronic diseases is not limited to particular settings like hospitals but rather offers flexibility that improves access to information for both patients and healthcare providers, thus improving healthcare outcomes.

Moreso, people of all age groups, including children, adults, and the elderly, are prone to the risk factors linked with chronic diseases. Several of these illnesses come from behavioral factors such as inactive lifestyles, extreme alcohol consumption, tobacco use, and poor dietary habits among others [4]. Thus, patients must intentionally take care of their health by adjusting their lifestyles and effectively managing chronic conditions. Early detection, screening, treatment, and palliative care play vital roles in managing chronic diseases [6-8]. Undesirably, people in resource-constrained and developing nations face substantial challenges in accessing healthcare services due to limited financial resources, inadequate infrastructure, and other barriers.

There is a shift from conventional healthcare delivery methods to more modern approaches that prioritize efficient information sharing and improved medical infrastructure through the use of ICT [9-12]. The advanced use of ICT in healthcare has led to new chances for self-management, which has been widely accepted as a means of improving the quality of life and general well-being of people with long-term conditions. Moreover, with the development of ICT-powered healthcare technologies like wearable devices and electronic health records healthcare providers can easily get real-time data and communication tools that empower competent and customized care for patients with chronic diseases (*Thaikakara, et al.,2020*).

These technologies have wireless connections to the network allowing for remote patient monitoring without being limited by geographical location. By leveraging ICT-powered tools, healthcare value is improved through enhanced communication between healthcare facilities and individuals. Furthermore, accepting such technologies can help in the self-management of chronic diseases [1].

However, some studies indicate that current ICT applications often fail to consider the collaborative partnership between patients and healthcare providers/professionals, instead focusing merely on one party without putting into consideration the needs and perspectives of both [13]. This leads to concerns that these ICT interventions may not be as effective and might hinder patients' ability to be involved in self-care, making them more defenseless. Additionally, a key limitation in the utilization of ICT is the lack of knowledge among patients, particularly the elderly, in using these tools, as well as challenges in accessing them [13]. Thus, this study aims to evaluate the impact of ICT-powered healthcare technologies in the management of chronic illnesses. It will broadly examine the clinical effects of ICT-enabled healthcare technologies and their influence on healthcare service utilization for persons with chronic conditions. Additionally, this study will extend the Activity Theory framework, offering an all-inclusive understanding of how ICT-enabled healthcare technologies influence chronic disease management practices. The question the research will seek to answer is "How does the utilization of ICT-powered healthcare technologies impact the management of chronic diseases?"

ICT-enabled technologies have the potential to aid in the management of chronic diseases, however, the extent to which ICT-enabled technologies can contribute towards managing chronic diseases needs to be evaluated. Many studies have focused on the impact of ICT on health systems in general, without emphasizing the Impact of ICT in managing chronic diseases [14-20]. Moreover, there is a need for ICT applications to consider a collaborative partnership between patients and healthcare professionals, instead of focusing solely on one party without taking into account the needs and perspectives of both [13]. Chronic diseases are the leading cause of death worldwide with increasing prevalence in all age groups, genders, and ethnicities, it is therefore important to devise improved ways of managing such diseases to relieve the strain on healthcare.

Background

Chronic Diseases

The Centers for Disease Control and Prevention [21] defines chronic diseases as conditions that last one year or more and that require ongoing medical attention or limit activities of daily living or even both [22]. Chronic diseases such as heart disease, cancer, and diabetes are the leading causes of death and disability globally. They are also the leading drivers of the nation's USD 4.1 trillion in annual health costs [5]. These diseases exert a significant negative impact on the health and economies of developing countries. Furthermore, extensive research in the last decades has revealed that the major risk factors for most chronic diseases are infections, obesity, alcohol, lack of physical activities, tobacco, radiation, diet, and environmental pollutants among others [5] (*Ajaikumar et al*., 2018). Measures have been put in place to prevent these harmful diseases. For example, the World Health Assembly recently extended the WHO Global Action Plan for the prevention and control of chronic diseases from 2013 to 2020 to 2030 and called for the development of an Implementation Roadmap from 2023 to 2030 to accelerate progress on preventing and controlling noncommunicable diseases/chronic diseases. However, Individuals in developing countries and resource-constrained areas have the least access to health services due to low financial resources, lack of infrastructure, and other barriers to accessing the needed services [9].

ICT and Chronic Diseases Management

In the 21st century, where everyone is connected through digital technologies, ICT plays a critical role in improving health care for individuals and larger communities. ICT in health is generally known as telemedicine and medical informatics. Telemedicine is formally defined as the use of ICTs to provide healthcare when distance separates the participants. ICT carries potential in many different clinical situations including the transmission of radiological images, interactive video visits, and analysis of self-monitored data [14].

ICT has currently been severely incorporated in a variety of application domains which signifies its importance as a major technological paradigm, and it has drawn higher attention for its potential to alleviate the burden on healthcare systems caused by a rise in chronic diseases, aging, and increased population and pandemic situations [15]. Furthermore, mobile applications (apps) for health-related purposes have been increasingly used to support chronic disease management through mechanisms such as digital education, self-monitoring, and feedback [23,24]. There is a positive significant impact of mobile communication services on health system performance (*Mimbi & Bankole, 2015*). Several apps are being increasingly incorporated into healthcare services due to their portability, instantaneous access, and direct communication (*Meskol, et al., 2017*). This has inspired new models of remote healthcare delivery and cost-effective solutions for chronic diseases whose long-term nature and need for continuous monitoring can be positively impacted. MHealth apps may be particularly effective in self-management.

Self-management refers to the individual's ability to manage the symptoms, treatment, physical and psychosocial consequences, and lifestyle changes inherent in living with chronic diseases [25-27]. Apps could also improve patient empowerment, the process of gaining knowledge of one's health, and the ability and motivation to influence it. Most of these apps are highly used in developed countries. For example, there is a cloud-based Internet of things app that offers various medical services like continuous live monitoring and providing notifications to the health care providers [10] (*Alazab, et al. 2022*). Additionally, there are modern measurement devices for medical treatment, such as blood pressure, blood glucose level, heart rate, and body temperature, and various wearable incorporate communication capabilities [28].

ICT in managing chronic diseases in the United States of America is steadily increasing. Many healthcare providers and organizations are adopting various ICT-powered solutions to improve the management of chronic conditions, enhance patient care, and facilitate remote monitoring and telehealth services [22]. Health information technology shows promise in improving care processes and some clinical outcomes, but its effectiveness is limited by various challenges [13]. Research shows that 75% of adults with chronic diseases sought health information on the Web, with higher rates of patient portal access and use (*Madrigal, 2019*). ICT technologies used include Electronic Health Records (EHRs), telemedicine, mobile health applications, remote monitoring devices, and patient portals among others. These technologies help healthcare providers track patient data, communicate with patients remotely, monitor their health status, and provide personalized care for chronic conditions at the Centers for Diseases [22].

In Europe, the utilization of technological solutions has the potential to enhance diagnosis and treatment decisions, leading to improved treatment adaptation, reduced duration, and cost (*Wojtas, Dorota & Kurpas ,2022*). The most commonly used ICTs in managing chronic diseases in Europe are; Electronic Health Records, Telemedicine (video calls, phone calls, or messaging), Mobile Health (Smartphone applications), Wearable devices (like smartwatches or fitness trackers that collect real-time health data, such as heart rate, activity levels, and sleep patterns, to help patients and healthcare providers monitor and manage chronic conditions) and Remote monitoring systems (like IoT (Internet of Things) devices that allow healthcare providers to remotely monitor patients' vital signs, medication adherence, and overall health status). These technologies play a crucial role in improving the management of chronic diseases by enhancing communication between patients and healthcare providers, facilitating remote monitoring, and promoting self-management of health conditions [29,30].

There is the utilization of digital technologies for various chronic conditions in sub-Saharan Africa Achieng & Ogundain (2022). For instance, individuals with diabetes make use of medical mobile applications, digital glucose monitors, and sensors to monitor blood sugar levels and other vital signs. These technologies also provide prompts for patients to adjust their lifestyle behaviors, such as engaging in physical activities, regulating glucose levels, and ensuring adequate sleep. Patients with cardiovascular issues utilize fitness tracking apps and portable handheld digital Electrocardiogram monitors, which offer cost-effective solutions, reduce hospital visits, and enhance convenience and comfort. Cancer patients, on the other hand, rely on smartphone medical apps, wearables, and sensors to monitor comorbidities, track recovery or remission of cancer cells, and ensure comprehensive care. Those dealing with mental health conditions like anxiety, stress, and depression benefit from telemedicine, smartwatches, and smartphone medical apps, enabling remote consultations, enhancing mobility, and monitoring stress symptoms. Lastly, individuals with dementia and Alzheimer's disease use portable digital health devices, digital hearing aids, and wearables as noninvasive tools to assist and monitor the elderly in real time, promoting independent living and overall well-being.

Furthermore, research done in Uganda adapted a mHealth application and tailored it to the Ugandan setting, and integrated it into a government mHealth platform (*Schwartz, et al., 2022*). Through the utilization of Medly Uganda, patients can report symptoms related to heart failure and receive personalized, automated self-care guidance, along with direct communication with healthcare providers in case of severe symptoms. To assess the clinical effectiveness of Medly Uganda, a 6-month prospective study was conducted at the Uganda Heart Institute in Kampala. The findings indicated that the application has the potential to enhance self-calculator care practices, improve Health-Related Quality of Life (HRQoL), increase exercise tolerance, alleviate symptoms, and reduce hospitalizations among patients in Uganda diagnosed with heart failure.

A telemedicine system Mobil Diab for diabetes management was utilized over two months in African countries. This included receiving coaching and support from medical staff based on the analysis of data transmitted through the system (*Takenga, et al*., 2014). The study revealed a positive impact of the Mobil Diab system on enhancing diabetes management in underserved communities, highlighting its effectiveness in areas with limited healthcare resources and its ability to improve clinical outcomes. Key outcomes measured in the study included a reduction in HbA1c levels (from 8.67% to 6.89%) and an improvement in the mean amplitude of glycemic excursions, characterized by the mean blood glucose and its standard deviation. However, these studies still suggest that while ICT holds promise for improving chronic disease management in Africa, significant obstacles must be overcome. It is emphasized that unreliable Internet connectivity in Sub-Saharan Africa, with mobile devices being the most dependable technology for healthcare providers [31-33]. Additionally, studies indicate limited Internet access and the need for additional ICT training among health information professionals in sub-Saharan Africa [34-36].

Research on the use of ICT in managing chronic diseases in Africa reveals a mixed picture. Some studies show that health information professionals in sub-Saharan Africa have limited access to the Internet and require further ICT training. Recent research emphasizes that there is unreliable Internet connectivity in Sub-Saharan Africa, with mobile devices being the most reliable technology for healthcare providers [37]. These studies collectively suggest that while there is potential for ICT to improve chronic disease management in Africa, significant barriers need to be addressed.

Recent research on the utilization of digital technologies for managing chronic conditions in sub-Saharan Africa shows that individuals with diabetes are leveraging medical mobile applications, digital glucose monitors, and sensors to monitor blood sugar levels and other vital signs Achieng & Ogundain (2022). These technologies not only provide real-time data but also offer prompts for patients to adjust their lifestyle behaviors, such as engaging in physical activities, regulating glucose levels, and ensuring adequate sleep. Patients with cardiovascular issues are utilizing fitness tracking apps and portable handheld digital Electrocardiogram monitors, which provide cost-effective solutions, reduce hospital visits, and enhance convenience and comfort. Similarly, cancer patients are relying on smartphone medical apps, wearables, and sensors to monitor comorbidities, track recovery or remission of cancer cells, and ensure comprehensive care. Individuals dealing with mental health conditions like anxiety, stress, and depression are benefiting from telemedicine, smartwatches, and smartphone medical apps, enabling remote consultations, enhancing mobility, and monitoring stress symptoms. Moreover, individuals with dementia and Alzheimer's disease are using portable digital health devices, digital hearing aids, and wearables as noninvasive tools to assist and monitor the elderly in real-time, promoting independent living and overall well-being (*Achieng & Ogundain, 2022*).

Furthermore, a mHealth application was adapted, tailored to the Ugandan setting and integrated it into a government mHealth platform. Through the utilization of Medly Uganda, patients can report symptoms related to heart failure and receive personalized, automated self-care guidance, along with direct communication with healthcare providers in case of severe symptoms (*Schwartz, et al., 2022*). A 6-month prospective study conducted at the Uganda Heart Institute in Kampala indicated that the application has the potential to enhance self-care practices, improve Health-Related Quality of Life (HRQoL), increase exercise tolerance, alleviate symptoms, and reduce hospitalizations among patients diagnosed with heart failure in Uganda.

Additionally, a telemedicine system Mobil Diab for diabetes management was implemented over two months in the Democratic Republic of Congo. This system involved receiving coaching and support from medical staff based on the analysis of transmitted data. The study demonstrated a positive impact of the Mobil Diab system on enhancing diabetes management in underserved communities, emphasizing its effectiveness in areas with limited healthcare resources and its ability to improve clinical outcomes (*Takenga, et al., 2014*). Key outcomes measured in the study included a reduction in HbA1c levels (from 8.67% to 6.89%) and an improvement in the mean amplitude of glycemic excursions, characterized by the mean blood glucose and its standard deviation. These studies collectively suggest that there is potential for ICT to improve chronic disease management. In this opinion paper, we propose Activity Theory following the interpretive paradigm to help understand the impact of ICT enabled healthcare technologies in managing chronic diseases.

Activity Theory is a qualitative approach; therefore, it will help us understand better the impact of ICT-enabled healthcare technologies in managing patients with chronic diseases such as Diabetes, Hypertension and Heart failure. It was Originally based on the work of Vygotsky (1980) and expanded by Engestrom (1987). It originated in psychology and was later extended to different fields including human computer interaction, Education and Organizational studies (*Kuutti, 1996*). Activity Theory (AT), has subjects, objects, and tools as the key concepts situated in an activity. The activity also referred to as the unit of analysis, is viewed as a form of tool-mediated human existence, which is object-oriented [37-41] extends AT by adding rules and norms and division of labor.

Activity Theory has been used by researchers to study the impact of ICT in different sectors, AT gives a valuable platform to study how technology influences human activities (*Kuutti, et al. 1996*). ICT has become part of modern society influencing the way people work and interact with each other it is therefore important to study how ICT tools and systems mediate human activities, transform work practices, and impact individual and collective behavior, and AT explains this better.

In the context of managing patients with chronic diseases, ICT-enabled healthcare technologies play a vital role in supporting self-management activities and the exchange of information between patients and caregivers among others, since Activity Theory provides a framework for understanding how individuals interact with their environment, tools, and other people it is appropriate to help bring forth our opinion. The theory helped the researchers gain insights into how ICT-enabled healthcare technologies impact the various aspects of the activity system including user behavior, workflow, communication, and health outcomes.

In this opinion paper, we have sourced our initial data using a systematic review of the literature (*Lame, 2019*). A systematic review of literature research design is particularly appropriate for this study as its purpose suits the central aim of this research – that is to examine literature review on ICT and chronic diseases management. Peer-reviewed studies that evaluated ICT-powered/ digital technologies and chronic disease management have been collected from PubMed and Web of Science because they are trusted databases since they reference from a wide range of journals.

Conclusion

In the 21st century, ICT has emerged as a critical tool in improving healthcare delivery, particularly in the management of chronic diseases. Telemedicine, medical informatics, and mobile health applications have shown promise in enhancing patient care, remote monitoring, and self-management of chronic conditions. ICT-enabled technologies, such as wearable devices and remote monitoring systems, offer new models of healthcare delivery and cost-effective solutions for chronic disease management. Despite the potential benefits of ICT in managing chronic diseases, there are challenges to its effective implementation, particularly in low-resource settings. Many studies have focused on the impact of ICT on health systems in general ([14,15,20,42] *Mimbi & Bankole, 2015*), without emphasizing the Impact of ICT powered healthcare technologies in managing chronic diseases in low developed countries. Additionally, some studies have highlighted the need for further research on the impact of ICT-powered healthcare technologies in

managing chronic diseases. By evaluating the extent to which ICT can contribute to improving chronic disease management, this study aims to provide valuable insights to reduce the strain on healthcare systems and enhance patient outcomes.

Future Research

We shall extend Activity Theory to help explain the Impact ICT-enabled healthcare technologies have on managing patients with chronic diseases.

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Conflict of Intertest

None.

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