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Mobile Health Technology in Developing Countries: The Case of Tanzania

Shruti Modi

Introduction

Mobile technology is redesigning the way the world functions and thinks. It is now being used

in healthcare, and is becoming a huge contributor in delivering healthcare information to

impoverished people in developing countries. Mobile phones are cheap, portable, easy to use,

and are becoming easily available, even in remote parts of the world. Mobile Health, or m-

Health, is the use of mobile phones to improve the quality of care and improve efficiency of

health services. The Global Observatory for eHealth (GOe) (2011) defined m-Health as "medical

and public health practice supported by mobile devices, such as mobile phones, patient

monitoring devices, personal digital assistants (PDAs), and other wireless devices" (p.6).

Specifically, m-Health can have a profoundly positive impact on the country of Tanzania in East

Africa, which has a high prevalence of diseases that are both chronic and communicable. With

improved health, Tanzania can focus on developing economically, and its workers can be more

productive in the labor force, and Tanzania can focus on developing economically.

Tanzania Today

Tanzania can greatly benefit from increased usage of m-health. People in Tanzania, who

are in desperate need of healthcare face major obstacles such as poverty, lack of infrastructure,

and government corruption. These people cannot pay for healthcare and are unable to travel to

locations where adequate healthcare is available. Illness and disease severely affect people's

occupations and economic productivity. As a result from the lack of healthcare, diseases like HIV/AIDS and malaria spread quickly and easily.

Tanzania has a high prevalence of both HIV/AIDS and malaria. It was estimated by the World Health Organization (WHO) (2008) that 1.5 million children and adults in Tanzania were living with symptoms of AIDS (p.4). According to the WHO, there were 110,000 deaths due to HIV/AIDS in 2007 (p.5). There are 1.1 million orphaned children because their parents died from the disease (p.6). The WHO study estimated that 530,000 people were in need of antiretroviral therapy (ART) in Tanzania (p.11).

In terms of malaria, a large majority of the population is at risk of incurring a malaria infection. According to the Roll Back Malaria Initiative from the WHO (2012), 40 million people of Tanzania's estimated 43.2 million people live in areas where malaria is transmitted (p.12). The National Malaria Control Program (NMCP) (2009) estimated that 60,000 to 80,000 deaths due to malaria occur every year (p.12). As malaria is so widespread, the disease impacts people's economic capacity greatly, action as a major factor furthering poverty and underdevelopment within the country. According to Mboera, Makundi and Kitua (2007), expenditures on malaria represent 1.1% of Tanzania's Gross Domestic Product (p.112). While eradicating these diseases will be a long process, prevention and treatment can have an enormous impact on preventing the spread of these diseases and reducing their severity. This is why usage of mobile health technology in Tanzania has potential to alleviate the problems of these diseases, as well as bolster the economy.

Economic Effect of Poor Health

According to Cole and Neumayer (2006), poor health and disease have a negative impact on an individual's ability to work and provide for a family (p. 918). Poor health and a high

disease burden also negatively affect the economic productivity and development of a country (p.918). Specifically, developing countries with limited or poor healthcare systems are hindered even more by a high incidence of disease (p.918). Bloom, Canning, and Sevilla (2001) also provide evidence that health is an important factor in the productivity of human capital. They state that workers who are physically healthier are more productive and miss fewer days of work, therefore earning higher wages (p.3). They go on further to argue that this fact is even more important in developing countries because there are more workers who perform manual labor (p.3). Bloom, Canning, and Sevilla performed a study in which they explored the effect of health and work experience on economic growth (p.4). They produced an aggregate production function where physical capital, labor and human capital were the inputs, and the function determined a nation's output and the total factor productivity of these inputs (p. 4). They concluded, "health has a positive and statistically significant effect on economic growth. It suggests that a one year improvement in a population's life expectancy contributes to a 4 percent increase in output." (Bloom, Canning, and Sevilla, 2001, p. 5) This knowledge provides support for studying and improving healthcare in Tanzania, as improved health has the potential to help the country's economy.

Benefits of M-Health

M-Health makes it possible for people to receive healthcare information in real time, allowing them to address health issues much earlier and in a more timely fashion. Health concerns are prevented from becoming more severe, and people can maintain their lives and occupations more easily. M-Health can also help global and public health officials track the prevalence of diseases, and the rates at which they spread. With more information, health officials can be more proactive in how they address concerns, rather than reactive. M-Health can

feasibly address the gaps in healthcare in remote and impoverished areas. The International

Telecommunication Union (ITU) (2010) stated that 80% of rural communities around the globe

have access to a mobile network (p.1). Furthermore, mobile phone networks surpass basic

infrastructure like roads, electricity and sanitation, because there is a high demand for mobile

phones. As disease spreads rapidly in Tanzania and mobile phones become more easily

available, the appeal and desire to research and study m-Health also increases. M-Health is

becoming a likely vehicle to create positive change. In a study conducted by

PricewaterhouseCoopers and the Economist Intelligence Unit (2012), patient expectations for m-

Health were high. Fifty-two percent of patients believe m-Health will make healthcare more

convenient for them (p.7). Additionally, 6 in 10 doctors and payers believe the usage of m-

Health technology is inevitable (p.3). However, research into m-Health programs to understand

both their effectiveness and sustainability is necessary for the advancement of m-Health.

According to the Royal Tropic Institute (2012), there is an abundance of m-Health

programs that are testing their success and sustainability. While there are many m-Health

programs that can be made possible in Tanzania, there are four programs in particular that have

the potential to help a large number of people in Tanzania: "Phones for Health", "SMS for Life",

e-IMCI, and Project Mwana. "Phones for Health" and "SMS for Life" are both supported by

government partnerships with private organizations, while e-IMCI and Project Mwana are

supported by non-profit and research organizations. These programs have the potential to help in

a variety of ways.

M-Health Increases Education and Awareness

One of the most important ways that m-Health benefits people is by providing educating

about diseases they have or could have. Typically, this is achieved by texting information to

people, such as relaying test results, how to take medicine, and warning signs of disease. Kahn, Yang, and Kahn (2010) emphasize the steady growth of disease in developing countries and that using m-Health to combat this growth shows promise. These researchers emphasize the rise in prevalence of both chronic and communicable diseases, known as a "dual burden" (Kahn, Yang, & Kahn, 2010, p. 252). They believe m-Health has a positive effect for both types of diseases, as well as improving public health. While they found positive examples of m-Health programs, they conclude that there is still not enough assessment or valuation of these programs. They conclude that performance, both clinically and economically, of m-Health programs needs to be measured. They cite a researched named Santosh Krishna, who studied the use of mobile calls and text messages in twelve clinical areas. Krishna found "significant improvements in compliance with medicine taking, asthma symptoms, HbA1C, stress levels, smoking quit rates, and self-efficacy" (Kahn, Yang, & Kahn, 2010, p.253). However, the limitation with Krishna's study was that it was conducted in wealthier countries. In order to understand possible m-Health potential in Tanzania, examination of m-Health programs conducted in developing countries needs to be done.

One such program is "Phones for Health," which is supported by the m-Health Tanzania Public Private Partnership with the United States Center for Disease Control (CDC). "Phones for Health" uses mobile phones both to relay information to patients, as well as collect information from them. This program aims to achieve its goal of increasing information flow between different health system levels in two ways. First, by texting or calling patients and local health workers of disease status, directions for taking medicine, or local health issues to be aware of, the program will create an education channel. Generally, notifications will elicit a response from the patient or local worker, creating a two-way communication system. By maintaining this

channel, "Phones for Health" will create a reliable and easily accessible educational resource that will strengthen as patients refer other patients. Second, "Phones for Health" aims to create a "culture of information seeking" (PEPFAR, 2007, p.2) where information will be gathered in an easy fashion that is organized and manageable. If information is organized, it will be easier to distribute it to all levels of health systems. The easy management of information received will encourage health workers to promote usage of these phones, increasing the amount of data available. Not only will patients have more information, health care workers will as well. Health care workers and public health officials will be able to make more data-driven decisions that will be beneficial to all parties.

M-Health Raises Treatment Support and Medication Compliance

In addition to being educated about disease and notified of test results, patients need treatment support. Patients must understand how to take their medications, including frequency. They also need to know that the required medication they need is available, and where they can easily obtain the medication. Finally, they need emotional support from someone, who understands their disease, and that person is generally a health care worker. Overall, Kahn, Yang and Kahn (2010) cited a study done by Krishna that saw improved compliance with medication taking through the usage of an m-Health program.

"SMS for Life" is one initiative that maintains the availability of malaria medication through the usage of an m-Health program. This initiative falls under the Roll Back Malaria Partnership. It is led by Novartis, and supported by the Tanzanian Ministry of Health and Social Welfare, IBM, Medicines for Malaria Venture (MMV), the Swiss Agency for Development and Cooperation (SDC), Vodacom and Vodafone. "SMS for Life" uses mobile phones, SMS messages and electronic mapping technology to track stock levels of medication at health

facilities to increase access to malaria treatment medication and reduce the number of deaths due to malaria (Roll Back Malaria, 2010, p.2). "SMS for Life" works by checking stock levels every Thursday and sending a stock request message to health facilities that dispense antimalarial medication (p.2). On Monday, the system sends information to the district management officer who monitors stock levels, orders medication and redistributes medicine between sites accordingly (p.2). If information is not sent on time, the system sends reminder text messages asking for information to make sure there are no critical time gaps or delays (p.2).

To test the impact of the system, "SMS for Life" ran as a pilot program for six months in three districts in Tanzania. According to the Roll Back Malaria Initiative (2010), the results of the pilot were positive. It covered 129 villages within three districts, and a total of 1.2 million people (p.3). At the beginning of the pilot, the three districts had high stock-out percentages for anti-malarial medications, at 57%, 93%, and 87%. As a result of "SMS for Life," these percentages were reduced to 0%, 47% and 30% (p.2). Additionally, 26% of the facilities within these three districts had no dose form of the ACT antimalarial drug made by Novartis, and by the end of the pilot, this number was cut to less than 1% (p.2). Because of these successful and positive results, "SMS for Life" has expanded to all districts within the United Republic of Tanzania. There are over 5,000 facilities trained and reporting data on a weekly basis.

M-Health Success through Improved Healthcare Worker Performance

Education, awareness, treatment support and medication compliance can only be realized if healthcare workers use m-Health technologies. Healthcare worker performance is critical to the success of m-Health programs. A study performed by researchers at the University of Antioquia, Medellín in Colombia, and the School of Health Information Sciences at the University of Texas analyzed the benefits of m-Health to the performance of community health

workers (Florez-Arango, Dunn, Iyengar, Zhang, 2011). This study had two groups, the intervention group that used m-Health technology, and a control group, which did not (p.131). The researchers studied two areas: error rates per case and task and measured compliance of protocols (p.131). They evaluated 1394 cases and found that the usage of m-Health technology reduced errors by an average of 33.15% and increased protocol compliance by about 30.18% (p.131). Researchers concluded that there are encouraging prospects for m-Health technologies for the improvement of community health worker performance.

Dr. Marc Mitchell, a researcher at the National Institute of Health, conducted research on the potential of electronic protocols, and firmly believes m-Health can greatly improve child health in Tanzania. He states that "the survival of a sick child can hinge on something as simple as a health worker going through the pages of a manual" (National Institute of Health: Fogarty International Center, 2012, p.9). Mitchell is the president of D-Tree, a non-profit organization that uses decision trees and algorithms to promote evidence-based medical practices. The WHO (1999) developed Integrated Management of Childhood Illness (IMCI) protocols that healthcare workers around the world are supposed to follow. Dr. Mitchell's research has focused on using electronic versions of these protocols to improve healthcare worker performance (National Institute of Health: Fogarty International Center, 2012, p.9). These protocols advise healthcare workers as to how to properly diagnose and treat patients (p.9). Mitchell argues that paper versions of IMCI protocols are not always followed, and sometimes are completely neglected (p.9). He believes one reason for this is that patients become uncomfortable when they see a health worker flip through the pages of a book (p.9). This makes patients uneasy and causes them to doubt the expertise of their health worker (p.9). As a result, patients are less likely to follow treatments and comply with required medication dosages. Furthermore, IMCI protocols can

easily be misinterpreted. The electronic versions of these protocols that Mitchell is developing

are less expensive, less time-consuming, and easy to learn and follow.

In addition to developing IMCI protocols, Dr. Mitchell's organization, D-Tree, partnered

with Dimagi, a private software consultancy, to test mobile e-IMCI in Tanzania (Dimagi, 2008).

Dimagi is dedicated to integrating innovative technology into global public and private services

in order to improve human health and well-being. The team tested whether the use of an

electronic job aid would improve adherence to IMCI protocols. E-IMCI is a program that

provides a step-by-step guide for health workers in IMCI treatment. This was field-tested at a

dispensary in Mtwara, Tanzania (DeRenzi, Lesh, Parikh, Sims, Mitchell, Maokola, Chemba,

Hamisi, Schellenberg, and Borriello, 2008, p.2). The test consisted of structured interviews with

clinicians, and observations of patient visits with and without e-IMCI. The team performing the

investigation observed 24 patient encounters without e-IMCI, and 28 with e-IMCI (Dimagi,

2008). Using the e-IMCI program, clinicians performed 84.7% of examinations required by

IMCI, a significant improvement over the 61% of examinations observed using previous

practices (DeRenzi,, Lesh, Parikh, Sims, Mitchell, Maokola, Chemba, Hamisi, Schellenberg, and

Borriello.et al, 2008, p.2). The team also performed an evaluation of 18 patient visits in which

they compared the time clinicians spent with each patient using e-IMCI and when they did not

use it. The average for both uses was about 12.5 minutes (p.2). However, the time it took to train

clinicians in using e-IMCI was 20 minutes, after which clinicians were easily able to train each

other in how to use it, and the four clinicians in the trial unanimously preferred using e-IMCI

(p.2). They stated it was faster and easier to use than the chart book they used to reference

previously. The team concluded that their results and experience suggested that e-IMCI was

quick, improved adherence and thus the quality of care, and allowed health workers flexibility in applying their skills on a case-by-case basis (p.2).

M-Health used for Disease Surveillance

In addition to supporting improved healthcare of patients, m-Health has the ability to help larger groups of people by tracking diseases and alerting public health officials. The m-Health Tanzania Public-Private Partnership connects the Tanzanian Ministry of Health and Social Welfare with the U.S. Center for Disease Control and Prevention, which is funded by the U.S. President's Emergency Plan for AIDS Relief (PEPFAR). One of the goals of the partnership is to increase information flow between different health system levels in order to reduce response time for critical services and enhance meticulous, evidence-based planning and decision-making. This partnership uses the "Phones for Health" initiative to achieve these goals.

Also supporting the goals of the public-private partnership is a letter by Chhanabhai and Holt (2009), two prominent figures in the m-health field. The authors argue that spreading the availability of mobile phones is an attainable goal. Furthermore, they encourage the usage of m-Health technologies in developing countries.

Analysis

While m-Health technology can possibly revolutionize healthcare in developing countries, there are several issues and concerns that need to be addressed in conjunction with more quantifiable research. First, chronic diseases require long periods of time to diagnose and treat. They require community-wide interventions if they are to be significantly reduced. This in turn requires whole communities to be amenable to the usage of m-Health technologies, as well as diligent and consistent with its usage.

Second, communities need to also be diligent in following directions from text messages or calls. Using m-health reliably not only means checking and responding to phone calls and text messages, it also means following directions as to how and when to take medication, and when to visit health facilities for check-ups. This is not an easy task when people have to worry about so many other parts of their lives, such as making money and taking care of their families. Too often, taking care of one's own health falls to the bottom of a person's list of priorities.

Third, there is always the possibility for errors (Kahn, Yang, & Kahn, 2010, p. 254). Incorrect information may cause alarm, or create havoc within small communities (Kahn, Yang, & Kahn, 2010, p. 254). This type of alarm may cause people to lose trust in m-Health technology. Fourth, there is a loss of confidentiality, human interaction, empathy and support (Kahn, Yang, & Kahn, 2010, p. 254). Upon receiving bad news, patients had health workers to talk to where they could receive reassurance. While this is possible through phones, a facet of the truly personal connection is lost.

Fifth, text messages are open to misinterpretation. With m-Health, there is no person to physically explain the messages. Ideally, messages will be simple, clear and exact. However, there are differing levels of education within large communities. Sixth, m-Health adds another channel of communication that health workers must use, which can be seen as another burden (Kahn, Yang, & Kahn, 2010, p. 254).

Seventh, there is no official organized list of m-Health programs, clinical trials, and research studies. The field currently lacks coordination. Eighth, associated with coordination is regulation. The field of m-health is not clearly regulated (Sandhu, 2011). For example, the United States has not clearly regulated m-health, which is leading to a loss of innovation as m-Health creators use their programs in other countries where regulation is not a concern (mHealth

Regulatory Coalition, 2010). However, the United States is very involved in supporting m-Health programs around the world, both in developed and developing countries. The potential for disputes over the intellectual property of m-Health program reduces motivation and interest in developing these programs, and interest in forming partnerships with U.S. innovators.

Finally, poorly designed campaigns may have unintended consequences (Kahn, Yang, & Kahn, 2010, p.254). These are all incredibly important factors that proponents of m-Health technology need to take into account and address if they want m-Health to be sustainable and successful.

Responses to Negative Consequences of M-Health

These issues need time and careful research before they can be eliminated. However, these issues can be organized into three areas that can be individually addressed. First, researchers must get to know and work with communities. It is not enough to simply work with patients. In order to spread and sustain m-Health technology, whole communities need to accept and support it. Whole communities need to understand that they need to work together to improve overall health; and that they will not be able to improve their economy if members of their communities are sick and unable to contribute. Second, vast amounts of careful and thorough research, studies and tests need to be done in order, to limit errors and misinterpretations. Specifically, e-IMCI should be studied even more, as it affects both health care worker performance, and the health and lives of children. Taking surveys of patients and health care workers who have used m-Health technology, and asking them how it can better serve them will be useful in limiting confusion. Third, proponents and developers of m-Health programs need to form partnerships, like the Tanzanian public-private partnership that sponsors "Phones for Health." This partnership combines powerful entities that have the resources to

affect positive change. "Phones for Health" also appears to be one of the most promising m-Health programs. Partnerships will organize the m-Health movement, share resources, and benefit all entities involved.

In addition to addressing these issues, m-Health in other developing countries should be assessed to gain further insight into the situation in Tanzania. Project Mwana is one such program that currently operates in Zambia (World Health Organization, 2011-2012). Project Mwana's mission is to achieve earlier infant diagnosis of HIV infections through mobile texting of blood test results (World Health Organization, 2011-2012). Project Mwana also assists health worker performance, and helps contain the spread of HIV/AIDS (World Health Organization, 2011-2012). Essentially, Project Mwana has the ability to support all four potential targets of m-Health cited previously.

In Zambia, the estimated prevalence of HIV infection is 14.3%, and mother-to-child transmission accounts for 21% of these infections (World Health Organization, 2011-2012). Early infant diagnosis is necessary when prevention of mother-to-child transmission fails. There is a great deal of evidence that beginning anti-retroviral therapy (ART) at an early age in HIV-infected children can significantly reduce HIV-related morbidity and mortality (World Health Organization, 2011-2012). In 2010, the WHO recommended the immediate initiation of ART upon diagnosis of HIV infection in infants and older children. However, Zambia, as well as other African countries, is unable to initiate ART in a timely fashion because of delays in notifying patients of their diagnosis (World Health Organization, 2011-2012). The limited resources in Zambia make the process between testing, laboratory analysis, and reception of diagnosis disorganized and filled with gaps (World Health Organization, 2011-2012). This is where m-Health technology fits in. It saves time of health care workers by eliminating their travel to

distant laboratories to receive test results. This allows health care workers to focus on patient care and support. M-Health technology also saves time of patients from having to travel to receive results. Furthermore, mobile phones can be used to improve ART adherence through reminder calls and test messages to patients (World Health Organization, 2011-2012). In a similar program and study performed in Kenya, weekly messages from a health worker significantly improved ART adherence and rates of viral suppression (World Health Organization, 2011-2012). Project Mwana has been a success in the short-term in Zambia, but needs to be studied further to see the potential for long-term success. Tanzania is an ideal place to conduct a research study of Project Mwana.

Conclusion

In undertaking m-Health programs, it is necessary to learn the effects on improving health, and how these effects will affect overall worker productivity, economic growth, and economic development. For m-Health to compete with other possible health interventions, the costs it saves a person with a disease or health concern need to be measurable. This is increasingly being used as a possible measurement of performance, and should continue to be. Any and all programs need to measure results, outcomes and performance. The framework for evaluating m-Health interventions should include their costs, intended health results, and possible consequences. In terms of the global economy, m-Health interventions can increase economic development of developing countries, creating more jobs and introducing new industries to developing countries. Outside of healthcare jobs, m-Health can encourage jobs in the fields of software, communications, and public relations. M-Health can also promote more partnerships between non-profit organizations, businesses, governments, and communities. M-

Health has the potential to revolutionize healthcare around the world; however, it needs rigorous

evaluation and research.

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