International Journal of Emerging Trends & Technology in Computer Science (IJETTCS)
Web Site: www.ijettcs.org Email: editor@ijettcs.org, editorijettcs@gmail.com
Volume 2, Issue 4, July – August 2013 ISSN 2278-6856

Evaluating the effectiveness of m-health based Diabetes Self-Management and community based networking

Prudence M.Mavhemwa[1], Obert Muzurura[2]

[1,2]Bindura University of Science Education , Computer Science Department
Trojan Road, Bindura, Zimbabwe

Abstract: ***Health has been a topical issue for years as it affects development of societies in various ways. As a result , several countries world over signed to the Millenium Development Goal in which health delivery is also part. However, several diseases have affected families, communities and nations at large and although governments are making efforts to control them, they are still a challenge. One such disease is Diabetes. Several mechanisms have been put in place to help control as well as monitor Diabetes as it is affecting a lot of people these days. This research was conducted to assess the effectiveness of internet enabled mobile phones as a tool for self management as well as community support platform for those suffering from Diabetes. The research was carried out on twenty patients and Harare . Diabetic patients read their blood sugar levels using Glucometers at some intervals and fed these readings on their profiles on the website created for them. If some dangerous levels were reached, an alert message was sent from the system to the patient with a list of probable causes of the high blood sugar level. Upon request, a graph could be drawn showing the changes in the patient's blood sugar level so that a patient would be always knowing his or her status. There was also a social networking part where patients could interact and share their experiences and tips on how to stay healthy.The mobile website was tested for response time, availability and speed among other factors and together with patient's responses it was concluded that a smartphone can go a long way in helping Diabetic patients stay healthy. The authors however noted some areas that need improvement and gave recommendation form what was learnt during the research.***

KEYWORDS: M-HEALTH, MDGS, SELF-MANAGEMENT, COMMUNITY SUPPORT

INTRODUCTION

Millennium Development Goals (MDGs) touch on several aspects that have to do with the well being of the populace and several governments world wide signed to them (undp, 2010). The MDGs are eradication of extreme poverty and hunger, achieving universal primary education, promote gender equality and empower women, reduce child mortality, improve maternal health, combat HIV/AIDS, malaria and other diseases, ensure environmental sustainability and develop a global partnership for development. Goal Number six which says by 2015 there should be a reverse to the spread of HIV/AIDS and the incidence of malaria and other diseases is the basis for the current research. In developing countries, m-health projects focus on HIV/AIDS, Malaria, and TB using SMS texting (Pujari, 2011). As for today, people are healthier, wealthier and live longer than 30 years ago. However, while the progress achieved over the years in health sector has remained highly concentrated in the developed countries, many developing and least-developed countries are still seriously lagging behind. This is particularly true in the regions of South Asia and Sub-Saharan Africa where health care coverage and health services remained significantly poor in many countries. (sesric, 2011) Sub-Sahara African nations are lagging behind in working towards the fulfilment of the health related Millennium development goals (Disease control priorities project, 2007). As a means to counter that, several countries in Africa and other continents have adopted m-health as a means of facilitating fast reaching the people who are in need of health services and interesting results have been yielded. m-health is a great mechanism to save significant funds in the health sector. (Pujari, 2011)

(Mujera, 2009) says information availability enhances the quality of patient care as physicians make better use of evidence and apply appropriate current tools and practices at the point of care. He further goes to say the development of information and communication technologies (ICT) such as internet makes relevant, reliable, current and affordable information can be universally accessed. m-health is a subclass of e-health which is defined by (Eysenbach, 2001)) as cited by (Mujera, 2009) as "the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies". The definition also defines e-health as a state-of-mind, a way of thinking, an attitude and a commitment for networked, global thinking, to improve health care locally.

M-health

m-health according to (WHO, 2011) is a medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices. m-health according to Royal Tropical Institute stands for the

provision of health-related services using mobile communication technology.

1.0 Background

Often people who are diagnosed with diabetes need to make major changes to their lifestyle. This is not easily done as diabetics can be de-motivated by the lack of social support (Tod, 2005). It is assumed that any desirable healthcare system ensures the continuity of care through all the stages of care delivery. Some of these stages include prevention, diagnoses, treatment, and rehabilitation (Iakovidis, 1998). On the other hand there are commercial available products which have to be purchased and are not affordable by the average person. Additionally, there are no publicly available online social support structures for diabetics in Zimbabwe and patients prefer to remain anonymous. In this project we hope to develop a system that is accessible and available at low cost. The system will aim to assist in the self-management of diabetes, method of record and data keeping, which is an essential part of a diabetic`s daily life.

Previous research has shown that diabetes is increasing at an alarming rate in society due to social factors such as obesity and the lack of exercise(Demand Media,2011). Diabetes is one of the better known chronic illnesses which can have debilitating effects on those affected both mentally and physically (Demand Media 2011). As a chronic disease marked at times by high sugar levels in the blood, the body`s inability to either produce or respond to insulin often results in health complications for the individual concerned if the correct treatment is not administered (A.D.A.M. 2011;Swan 2009). For some individuals, limited access to healthcare and information on the disease could lead to more severe consequences such as paralysis or blindness (Demand Media 2011). Individuals affected by both a chronic illness and a disability may struggle to find and maintain work placing a financial load on their families (Demand Media 2011). Systems have been developed to ease the lifestyle of a diabetic individual. The Freestyle Navigator helps with the monitoring of glucose levels by using a special strip to read the sugar levels in the blood (Heller and Feldman 2010). Other systems act to manage the disease such as the Diabetes Pilot which helps to record measurements, tracks dietary information in food, helps see trends through a graph and sends data for inspection to a medical physician for further analysis (Digital Altitudes, 2010). Sometimes family support and management systems are not enough. Patients often look to the internet to find other people with similar illnesses to aid and advise them where their medical condition is concerned (Greene et al. 2010,;Pearson 2010,Swan 2009). Patients like these rely on online social media such as Facebook, Twitter, TuDiabetes and PatientsLikeMe to find social support (Swan 2009).The social networking sites are powerful and cost effective communication tools (Hawn 2009).

1.1 Problem Statement

With the increasing number of cases of this and other related there aren't any publicly available m-health applications or systems that can assist in the self-management of diabetes in Zimbabwe. However, there are a variety of commercially available products, like the Diabetes Pilot software, which have to be purchased and are not affordable by an average person (Digital Altitudes, 2010). The core aspects of this investigation are diabetes self-management, social support and social networking, and the applicability of m-health.

The motivation behind the development of the m-Health field arises from two factors. The first factor concerns the myriad constraints felt by healthcare systems of developing nations like Zimbabwe. These constraints include high population growth, a high burden of disease prevalence, low health care workforce, large numbers of rural inhabitants, and limited financial resources to support healthcare infrastructure and health information systems. The second factor is the recent rapid rise in mobile phone penetration in developing countries to large segments of the healthcare workforce, as well as the population of a country as a whole. With greater access to mobile phones to all segments of a country, including rural areas, the potential of lowering information and transaction costs in order to deliver healthcare improves.

The system aims to assist in the self-management of diabetes, method of record and data keeping, which is an essential part of a patient's daily life. The proposed system should be easily accessible and available at a low cost. In addition, it would also provide social support for diabetic patients in areas where there is scarcity of support groups through the use of social networking (Smith and Christakis 2008). Moreover, the combination of social networking with mobile applications could provide significant social support to patients and possibly transform the diabetic healthcare system as well as the outlook of online networking

1.2 Objectives of the study

The aim of the research is:

- To design and implement an integrated m-health system for use by a group of diabetic patients that's assists users in self management of the disease. To access the impact of implementing the system on users, who are patients.
- To access the impact of implementing the system on a group of patients.
- To measure the effectiveness of the system on health delivery.

1.3 Research Questions

1) Does implementation of m-health improve health delivery in management of diabetes?

2) Will patients find the implemented system useful to them?

3) Will patients trust the m-health system as technology that can be used to help them in fighting whatever ailments that will be afflicting them

1.4 Hypotheses

In this research we hypothesize that the health of users will or is bound to change as they are fully exposed to the concept of self-management and community based networking.

1. Does implementation of m-health in Zimbabwe improve health delivery in monitoring and controlling diseases?

Null Hypothesis (H_0) : There is no significant difference in monitoring, reporting and controlling diabetes by the introduction of an m-health diabetic system.

Alternative Hypothesis (H_1): There is a significant difference in monitoring, reporting and controlling diabetes by the introduction of an m-health diabetic system.

2. Will patients workers find the implemented system useful to them?

Null Hypothesis (H_0) : The patients will not find the implemented m-health system useful to them

Alternative Hypothesis (H_1) : The patients will find the implemented m-health system useful to them.

3. Will patients trust the m-health system as technology that can be used to help them in fighting whatever ailments that will be afflicting them?

Null Hypothesis (H_0) : Patients will not trust the m-health system as a technology that can help them fight whatever ailments that will be afflicting them.

Alterative Hypothesis (H_1) : Patients will trust the m-health system as a technology that can help them fight whatever ailments that will be afflicting them.

1.5 Justification of the study

The m-Health diabetes management project deals with creating a mobile system allowing patients to better manage their diabetes. This project comes from the fact that diabetes is a disease affecting a large population group and that it's primarily managed with lifestyle choices. The system will therefore help users better understand and manage their disease. The use of mobile phone technology should allow the system to be used by a large proportion of diabetes sufferers.The system aims to assist in the self-management of diabetes, method of record and data keeping, which is an essential part of a patient's daily life. The proposed system should be easily accessible and available at a low cost. Moreover, the combination of social networking with mobile applications could provide significant social support to patients and possibly transform the diabetic healthcare system as well as the outlook of online networking. Justification

The research on m-health in diabetes management is worth carrying out due to several reasons. Some countries like Kenya, Burkina Faso and Zambia have tried some episurveyor software to use on mobile phones and it helped control Measles (Blynn, 2009). Rwanda (Compendium of mhealth projects, n.d.) implemented TRAC net in monitoring and controlling HIV/AIDS. In South Africa, Dokoza (Mishra, 2008), Cell-Life (Compendium of mhealth projects, n.d.) was tried to monitor and control HIV/AIDS and it was successful. These are just a few examples of successful implementation of m-health but there is a vast array of areas where it has been successfully implemented. However, in all these software products that were used, it's either its sms based only or web based only and where specific for the projects they were designed (Blynn, 2009). Mobile Health is one aspect of e-health that is pushing the limits of how to acquire, transport, store, process, and secure the raw and processed data to deliver meaningful results. m-Health offers the ability of remote individuals to participate in the health care value matrix, which may not have been possible in the past. Participation does not imply just consumption of health care services. In many cases remote users are valuable contributors to gather data regarding disease and public health concerns such as outdoor pollution, drugs and violence It is therefore worth researching on so that at the end of the day we may improve the health delivery in the monitoring and control of diseases so that by 2015 we will have made strides in meeting the Millennium Development Goals. Therefore there is need to research on this because timely delivery of service is an important factor in health delivery.

1.6 Definition of terms

Evaluation:This is a term used to judge or calculate the quality or importance, amount or value of something. It can also be defined as the comparison of actual project impacts against the agreed strategic plans. It looks at what you set out to do, and what you have accomplished, and how you accomplished it. It is the act of judging or determining the significance, worth, or quality of something.

Effectiveness:The Cambridge International Dictionary of English defines the term effectiveness as the result of a particular influence. It is also a measure of adequacy to accomplish a purpose by producing the intended or expected result. It also means the capability of producing an effect, and is most frequently used in connection with the degree to which something is capable of producing a specific or the desired effect

LITERATURE REVIEW

2.0 Definitions

1. m health

According to (Vital Wave Consulting, 2008) as cited by (Kallander, 2010) , there is no widely agreed –to

definition but the public health community came to these working definitions:

eHealth : Using information and communication technology (ICT) – such as computers, mobile phones, and satellite communications for health services and information

m-health : Using mobile communications such as PDAs and mobile phones for health services and information.

Closely analysing these definitions we can see that m-health is a subset of eHealth since it is an application of eHealth only with the use of mobile communication. This is further supported by Vital Wave consulting 2009 as cited by (Vital Wave Consulting, 2011) on m-health report Ethiopia. Also according to the report, m-health ranges from simple mobile –phone based applications for the transfer of health information on basic handsets to via short messages to sophisticated diagnostic applications that rely on advanced equipment and back-end data systems. The field of m-health is relatively young but has great potential and has had promising results and lessons from the pilot programs that have been conducted in a variety of geographic and health system settings. It should also be noted that m-health is not a solution to all the health related problems affecting all countries both developed and developing, but has the potential to greatly improve the efficiency of communication, reduce life threatening delays in the delivery of care and extend the reach of the health system to underserved communities (Vital Wave Consulting, 2011).

Both m-health and e-health have the same goals of improving health outcomes and at the end fulfilling the health related Millennium Development Goals.

2.1 Study on Diabetes

For some individuals limited access to healthcare and information on the disease could lead to more severe consequences such as paralysis or blindness (Diabetes, 2011). Individuals affected by both a chronic illness and a disability may struggle to find and maintain work placing a financial load on their families (Diabetes, 2011). Systems have been developed to ease the lifestyle of a diabetic individual. The Freestyle Navigator helps with the monitoring of glucose levels by using a special strip to read the sugar levels in the blood (Heller, A. and Feldman, 2010). Other systems act to manage the disease such as the Diabetes Pilot which helps to record measurements, tracks dietary information in food, helps see trends through a graph and sends data for inspection to a medical physician for further analysis. Sometimes family support and management systems are not enough. Patients often look to the internet to find other people with similar illnesses to aid and advise them where their medical condition is concerned (Greene JA, 2011. Patients like these rely on online social media such as Facebook, Twitter, TuDiabetes and PatientsLikeMe to find social support (Swan, 2009). It is assumed that any desirable healthcare system ensures the continuity of care through all the stages of care delivery. Some of these stages include prevention, diagnoses, treatment, and rehabilitation (Iakovidis ,1998). In order to investigate m-Health further and provide a sustainable conclusion, it is necessary to select a particular area to investigate rather than to provide a broad overview. The following section will focus on the rehabilitation of patients by utilizing social networking.

2.2 Social networks

A social network is a social structure that is made up of individuals or groups that are connected by a set of relationships such as friendship, affiliation or Information Exchange (Park, 2003). The formation of a social network is a complex process whereby many individuals simultaneously try to satisfy their goals under multiple constraints that are possibly conflicting. An example is when individuals interact with other people who are similar to them while attempting to avoid conflicting relationships (Watts K. a., 2006). According to (Griffin, 2009) social networking has brought about an essential change in how people use technology in their daily lives in the past few years. Modern computing has been brought into the lives of many people due to changes in attitudes, social interactions and general expectations. This has also allowed the definition of a social network to describe the online communities that people create and are centred on common interests, and are a means of staying in touch with the group members (Griffin, 2009). One of the most popular social networking sites is Facebook (Griffin, 2009). Anyone can register onto Facebook and create a profile. Once a profile has been created, the user can then start to connect to other people directly, and post comments on their profile pages. Users can also join groups that already have members (Ellison, 2007). In addition to joining existing online groups on Facebook, users can also create their own tailor-made groups whereby they can set the rules of accepting new members. Social websites like Bebo, Facebook and Twitter with millions of users have mushroomed across the globe. Email and online chat are no longer the only ways that people use the internet. Blogging and Wikipedia have recently emerged as popular uses of the internet for people to express themselves; learning, sharing and interacting with people from all walks of life across the world. It has certainly changed the way we acquire knowledge.

2.3 The use of Social Networks in healthcare

As computing devices became smaller, faster, more powerful and portable and broadband networks connected people across major cities, it was inevitable that healthcare would also offer online solutions (Griffin, 2009). However, according to (Berkman LF, 2000), substantial research was undertaken on social networks but little work has integrated the social networks research

with healthcare issues in a way that could guide the development of policies or intervention to improve the health of the public. (Griffin, 2009) proposed an architecture that can be used to develop a healthcare site that involves an instant messaging client that provides near real time communication with other users of the system, a web browser which provides an interface to the web enabled services, an RSS web feed that would allow for blogs and updates from other services and applications to be viewed on the device and a file storage server that allows users to store files privately and publicly as needed. They propose that further investigations into the inner workings of social networks are needed before this proposed architecture can become a reality. One shortfall of Griffin's research was that they did not take into account the existing social networks in order to integrate with a proposed new solution. (McKay , 2001) analyzed a short term social network that was created to supplement the usual social support structures that would have been in place for patients suffering with diabetes. 78 diabetics were surveyed on this Diabetes network. The network had 2 sections. One section only provided useful information to patients, and the other section provided intervention tools. The information-only section allowed access to diabetes-specific articles in the website's library as well as real-time blood glucose tracking with graphic feedback for the 8 week duration of the study for eachuser. The intervention section included goal setting and personalized feedback, and the ability of receiving and posting messages to an online coach. The participants were divided into two groups, with one group having access to the information-only section and the other group having access to the intervention section. According to the results, there was increased usage of this support structure for the patients who used this resource regularly. There was however an overall decline in the use of this resource by the patients involved in the study. There were fewer logins on average to the information-only section as compared to the intervention section throughout the 8 week period. (Mckay, 2001)proposed that future research be based on enhancing ongoing use, and propose approaches that include logging in for a minimum number of times in a week.A possible solution to boost usage of such a system would be to use existing social networks to create an internet based support structure. For example, since many people log into Facebook on a daily basis, it would be easier for the patients to remember to post or check their messages from their online coach without having to log into a different website. The graphic feedback could also be posted on the patient's Facebook wall, or sent to the patient's Facebook email address for anonymity. In order to understand the scope of the possible implementation of a diabetes social support system, it is necessary to understand the fundamentals of the chronic disease. The next section outlines the definition, treatment and available systems that aid in the treatment of the disease.

2.4 Electronic systems that aid in treatment

There are a variety of electronic systems that are available that aid in the treatment of diabetes. Some of these electronic systems are targeted at the patients. They range from devices that actually monitor or read values from the patient to systems that aid in structuring the day to day plan for the patient. Blood glucose meters are used by diabetics to check level of glucose in the blood. There are a variety of commercially available blood glucose meters. According to a comparison performed by (Thomas, 2008), the devices tested all produced clinically acceptable accuracy when producing readings of glucose levels (Thomas ,2008).

1) *Social support and Interactions of Diabetics*

In addition self-management of diabetes, diabetics also require social support. Due to the fact that there are competing priorities when it comes to diabetes treatment, physical activity is rarely tackled in a consistent way in both primary care and diabetes education (McKay , 2001). Patients may not want to join a network whereby they do not already have social capital. Social capital is defined as the resources that are gained through the relationships among people they interact with (Ellison, 2007).

2.4.1 Quantified self tracking

Another service that healthcare social networks provide is the ability to allow the user to manage and track their health condition (Pearson, J.F., Brownstein, C. a, and Brownstein, J.S,2010) . CureTogether, MedHelp and PatientsLikeMe provide a quantified self-tracking option(Swan,2009). This functionality gives patients easy to use data entry screens for condition, symptom, treatment and other biological information. The information can be seen on a graphical display and can be viewed by individual or by groups . This service helps patients to view their status in an analytical format. The website PatientsLikeMe allows the user to have a statistical view on their condition and track their prescription drug usage. Patients who have a chronic disease like diabetes can use this service to monitor their glucose levels and will be able to evaluate a trend in the graph to decide when to increase or decrease sugar levels in the blood(Pearson, J.F., Brownstein, C. a, and Brownstein, J.S,2010).

2.4.2 Interview with Physicians

A service that a few m-health social networks provide is the ability to ask questions to a medical expert (Swan,2009). A site like Facebook is not a place to seek professional advice due to the absence of forums administrated by trained professionals. A well known social networking site that provides this service is MedHelp which connects regular people with medical experts to give patients aid and support (Yang,2010). As an interactive social network as well as an informative healthcare forum, patients are allowed to view a physician's credentials. One of the draw backs of this

service is that many of the doctors are only willing to answer questions once paid (Swan,2009)

2.5 Emotional support and Information sharing

The most basic service provided by most healthcare social networks is emotional support and information sharing (Swan,2009). CureTogether allows patients to anonymously compare and track conditions with one another focusing more on information sharing than emotional support (Dhillion, 2010) as cited by (Dalton, 2010). Conversely, members of PatientsLikeMe offer one another support based on their own experience and advise each other on medical issues and how to improve day-to-day life (Massagli MP, 2009). Websites such as PatientsLike and CureTogether offer emotional support at an implicit or an explicit level(Swan,2009). Emotional support is received implicitly through the observation of other patient's conditions and explicitly through user interactions where members of the site can reply to forums, send public or private messages, give advice and give a social greeting .

2.6 Types of Diabetes

'Type 1' diabetes is primarily caused by the destruction of pancreatic islet beta-cells of which no specific causes can be assigned, and also includes the cases that are caused by an autoimmune process. The end result is usually a total insulin deficiency which leads to insulin being required for survival(WHO, 1999). 'Type 2' diabetes is the most common form of diabetes which results due to low insulin secretion . Type 2 diabetes accounts for 85 to 90 percent of all diabetes cases (Butler, 2009). A major cause of the deficiency is increased resistance to insulin that is attained (WHO, 1999).

2.7 Treatment of Diabetes

Successful management of diabetes requires close teamwork between the patients and their health care providers. The Health care providers need to prescribe optimal medications and counsel patients on treatment plans, and the patients need to sustain this often-complicated treatment plan consisting of medication, diet and exercise plan (Heisler, 2003) . Diabetic patients have to maintain their blood glucose levels by keeping up a healthy lifestyle that includes eating a healthy diet and exercising. It is usually necessary to record the details of the blood glucose levels regularly in order to determine whether the blood glucose levels are staying at an optimal level or if adjustments need to be made to their diet, exercise and insulin intake. The art of maintaining this treatment plan is called Self-Management (Heisler, 2003). The American Diabetes Association propose that patients should perform self-monitoring of blood glucose (SMBG) at least 3 times a day for type 1 patients and as clinically necessary as possible for type 2 (Thomas et al. 2008).

2.8 Why the mobile phone and not other devices?

(Heather-Cole Lewis, 2010) cites (Rowling, 2009) and (Mishra, 2008) as saying communication by mobile phone is less expensive than alternative options such as landline telephones or standard Internet. She also quotes the Pew Internet and American Life Project which says the mobile phone use will be the case for the entire world by 2020 because it is currently the primary mode of accessing the internet and the trend is expected to grow according to (Adler, 2007) and (Rainie, 2009) and supported by (Horrigan, 2009) . The (International Telecommunications Union, 2009) saw the need to use the mobile phones as they have the potential to act as catalysts to the fulfilment of the Millennium Development Goals which should have been achieved by 2015.

(Mark Tomlinson, 2009) *say* Low and middle-income countries lack the infrastructure in many research field settings to accommodate adequate fixed line internet access, whereas wireless networks allow access to telecommunications in a region where fixed lines remain limited. The researchers go on to say the use of mobile technology as a research instrument is still in its infancy. The authors quote (Cho JH et-al,2009), (Shapiro JR et-al, 2008) ,(Anhoj J et-al, 2004), (Cocosila M et al, 2009), (Rodgers A et-al,2005), (Leong KC et-al,2006) and (Koshy E et-al, 2008) who say studies conducted in developed country settings have investigated the use of cell phones on the patient end to generate feedback for improved chronic illness care and monitoring, increased medication compliance and smoking cessation, or reduced missed clinic visits. The researchers also say, few studies have investigated the use of mobile phones as a data collection tool in low income countries and that, there are numerous anecdotal reports but few published studies exist quoting (Kinkade S, Verclas K:2008).With the rapid expansion of mobile technology all over the world ,including in developing countries like ours, the issue of reduced costs in setting the network and maintaining it, speed and simplicity in resource constrained environments and also the low cost of short messages in most countries really makes the mobile phone most ideal to use in m-health (Blynn, 2009).

The graph below adapted from (Pujari, 2011), illustrates the growing potential of mobile phones which make them the tool for the moment.

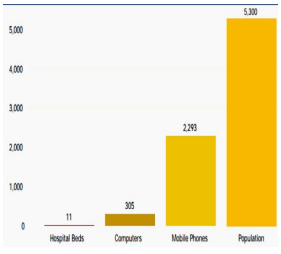

Figure 1 : Technology and health-related statistics for developing countries (millions) : Source : "m-health for Development : the Opportunity of Mobile Technology for Healthcare in the Developing World", 2009 cited by (Pujari, 2010).

As can be seen from the graph, Mobile phones have a high figure compared to computers and hospital beds and this shows that mobile phones' availability can be used to bridge the health gaps that exist. (Pujari, 2011) further says Mobile phones reach further into developing countries than other technology and health infrastructures. (Schuster C, 2011) says while research to evaluate mobile interventions has been growing, there are relatively few studies of the use of mobile technology itself as a research instrument in developing countries. They also argue saying mobile data collection projects to capture outcomes are abundant, but there are far fewer large-scale and complex surveys using mobile phones. This shows the need to fully exploit mobile phones in support of what other researchers have postulated.

Other advantages of mobile phones are access to accurate information in a timely manner (Angelidis,2008) as cited by (Chib, 2009) ,pre-treatment of primary healthcare problems (Bali and Singh, 2007) cited by (Chib, 2009), improving communication within the complexities of the healthcare system itself (Malkary, 2006) cited by (Chib, 2009) and with the patient community (Harper, 2006) cited by (Chib, 2009), integrating data into a central database for efficient tracking (Anantraman, Mikkelsen, Khilnani, Kumar, Machiraju, Pentland et al 2002, Chetley, 2006) cited by (Chib, 2009) and finally improving the administrative efficiency of healthcare providers (Baker, 2006) cited by (Chib, 2009).
According to (UNDES, 2007) there are four main areas where m-health is being applied which are:
1. Health administration
2. Healthcare Delivery Systems
3. Health Information
4. Patient Care

This is in agreement with (Caroline Free, 2010) and (Car,2008) as cited by (Vlasta Vodopivec-Jamsek, 2008).

2.9 Work done by other researchers

(Laugesen J, 2010) researched on a continuance model for a mobile/web based self management system for adolescent diabetes. This was based on loyalties. The researcher focused on controlling Juvenile Diabetes as it is known not to have cure. The researcher also noted that several researches have been made with software solutions made to help patients manage their chronic diseases but the problem was that often the systems suffer from under usage or being completely abandoned. It was also noted that limited research had been done in the issue of continual usage of a solution and then proposed to build and evaluate a mobile/web based system that incorporated rewarding a patient just to increase usage of medication. This was developed combining the IS Model by Bhattacherjee(2001) with DeLone and McLean(2003)'s IS success model.

(Noordam CA, 2011) noted that few project actually exist with little evidence available to tell the impact of mobile phones on the quality of maternal health services. It was noted that common researches were simply made to reduce the delay in provision of care and ongoing projects are focusing on empowering women to seek health care. However, this research was mainly centred on scientific and grey literature on improving maternal health in Low and Middle Income countries. Michael et al (2010) as cited by (Noordam CA, 2011) saw great potential for m-health, the only problem noted being that there is no much evidence of actual and widespread impact yet. He also went on to say that most documentation referred to pilot studies that often lacked baseline data, a control group and clear outcome indicators. The research findings however were mainly based on grey literature which is sometimes unreliable. With the potential that was seen in the mobile phone the researcher recommended further researches in how mobile phones can benefit maternal health services taking into consideration privacy and confidentiality.
(Barclay, 2009) as reported in the Lancet identified a mobile phone as a tool that can be used to fight tuberculosis. She noted the lengthy period of taking medication as well as the pain and agony involved as the reasons that people drop the medication mid way through or when they begin to feel better. She said connection between patients and caregivers using short massage services (sms) hold potential to help in improving adherence to taking the medication. Mario Raviglone, director of WHO's Stop TB Department(2009) was quoted in the Lancet as having encouraged the use of anything, including smss to prevent patients from defaulting which poses a high chance of disease relapse.
(Kamanga A, 2010) did a research on Malaria control in Zambia and realised that effective malaria control depends on timely acquisition of information on new cases, their location and their frequency so as to deploy supplies , plan interventions or focus attention on specific locations appropriately to intervene and prevent an upsurge in transmission in a process called active case detection. Data from each of the health centres were mapped using geographical positioning system coordinates to plot the patterns of malaria case detection in the vicinity of each location. The seasonal patterns of malaria transmission associated with local ecological conditions were seen in the distribution of cases diagnosed. Adequate supplies of RDT were made available and malaria was controlled.
(Kollmann, 2011) also researched on healthcare delivery specifically looking at the control of Type 1 Diabetes Mellitus. In his research he used a mobile phone–based, patient-centred diabetes management system that was built using Internet technology and comprised the following:

1. Patient terminal: At this terminal a mobile phone was used to record patient data ,who would have made self-measurements and then trigger data transmission to the

control centre, The control centre could then give feedback using text messages.

2. Monitoring centre: This was a 24-hour server which received, stored and processed data sent to it. Security was considered in it to ensure security, integrity, and traceability of data. The system had user control which means that only authorized users were able to view, edit, or enter data.
3. Graphical data representations and reminder: This was an automated process that analysed all incoming data in order to generate statistics, trends, and graphical representations of the data. In response to the incoming data, reminder messages were generated and sent to patients' mobile phones using text messaging.
4. Web portal: Data were accessible by patients and health care professionals using a standard Web browser.

The patients were given Nokia 7650 mobile phones loaded with Diab-Memory software application pre-installed as well as a user manual. Using this mobile phone, the patients tracked their daily blood glucose measurements and to registered their recordings. In the events of patients taking less than three successful data transmissions per day, an automatic reminder message was sent to the patient's phone via SMS. During the study , a help desk was established at the monitoring centre and skilled personnel handled questions from users and were responsible for training. The study period was three months and at its end, the patients were reviewed in the diabetes clinic and some tests were made. Questionnaires were used to check patients' satisfaction. The results from the pilot study paved way for the need to improve the diabetes management system in relation to data acquisition, automatic feedback and alerts and communication between patient and health care professional.

(Katherine de Tolly, 2009) researched on the innovative use of cell phone technology for HIV/AIDS behaviour change communications in South Africa with 3 pilot surveys. (Kaplan, 2006) was quoted as having said that there was at that time no literature on using mobile telephones as a healthcare intervention for HIV, TB, Malaria and chronic conditions in developing countries. These sentiments were also echoed by (Cristian Pop-Eleches, 2011) who said that there is limited evidence on whether growing mobile phone availability in sub-Saharan Africa can be used to promote high adherence to antiretroviral therapy (ARV). This concern is however not limited to these diseases only, but apply to a wide range of diseases.

Cell-Life initiated a research project titled "Cellphones4HIV" whose aim was to look at how mobile technology can be used in the prevention, treatment and care of HIV and AIDS, and to support the HIV sector in general. It uses SMS to send reminders and HIV related information such as side effects of some drugs and the importance of adherence. According to Vital Wave Consulting (2009) cited by (Katherine de Tolly, 2009), studies have shown that reminding people to take their medication can increase their adherence and that people with higher levels of health literacy adhere better to medication according to Kalichman S et al (2008) as quoted by (Katherine de Tolly, 2009). What was examined in the evaluation was whether the content and timing of the SMSs is helpful and also whether receiving them makes recipients feel like they belong to something.

(Lester RT, 2009) compared the effectiveness of SMS messaging to standard care of adherence, quality of life, retention, and mortality in a group of people receiving antiretroviral therapy in Nairobi, Kenya. A Random sample was collected at three clinics to receive either a structure weekly SMS slogan or received the current standard care support mechanisms as the control group. He cited Karanja S (2008) who feels that structures mobile phones communication can substantially improve clinical management of HIV patients in resource- limited settings because, despite other economic factors that may hinder human development, cellular phones are in high use.

2.10 Evaluation

(Kaplan, 2006) evaluated the use of mobile phones to improve adherence if the systems are dynamic and sustainable over time as patients' lives and circumstances change. He also said that for interventions to be effective messages have to be sent in a way that they become an integral part of the recipient's life. It was also concluded that the overall lack of well designed, randomized clinical trials with economic evaluation to confirm or refute clinical and economic benefits with mobile phone/healthcare interventions is an evidence gap that should be addressed in a systematic way.

(Noordam CA, 2011) suggested that few projects exist in this field and little evidence is available as yet on the impact of mobile phones on the quality of maternal health services and noted the need for robust evidence on constraints and impacts, especially when financial and human resources will be invested. This research was based on literature but can also be used as a measuring stick on other diseases.

In India (Shet A, 2010) designed a Mobile Phone-Based Intervention to Promote Adherence to Antiretroviral Therapy in South India. In this research automated voice reminders were sent to patients reminding them to take their medication. Respondents preferred weekly reminders although the reason was not explained in the research but a possibility was that more frequent calls could be seen as an intrusion. The authors highlighted the need for larger randomized controlled prospective studies assessing the role of the mobile phone influencing adherence and health outcomes among HIV affected populations.

Despite some potential of m-health noted by some researchers, others think the use of mobile phones SMSs cannot replace face to face health monitoring. (Barclay,

2009) in her work on use of mobile phones to fight tuberculosis cited Partners in Health (PIH), of Boston, USA as having developed one of the most effective programmes for tuberculosis treatment using community health workers. Every day, the workers visited patients in their homes to supervise treatment. PIH also developed Directly Observed Treatment Short Course (DOTS) Plus, a type of treatment for treating multidrug-resistant tuberculosis, where patients received daily nutritional support as a supplement and incentive for treatment.

2.11 Designing a solution

(Loudon M, 2009) says in designing a solution it is important to involve all stakeholders, including those who will collect the data, those who will use or analyse it, and those who will manage the process. She also says the points to consider include:

- Knowledge of the data to be collected
- How the solution will best fit with the work flow of data capturers
- How the data will be analysed
- How the data collection process will be managed

2.12 Summary

Diabetic individuals who do not have access to proper treatment or information systems often experience an overall reduction in their quality of life. The research conducted on the m-health social networks was to provide a more efficient framework upon which a website/database could be developed for people with Diabetes. Quantified self-tracking, emotional support and information sharing need to become more accessible and affordable to most people suffering from this disease.

In this review, it has been outlined that electronic healthcare needs to be patient-centred so that the patients can have access to their electronic health records since they may have to utilize multiple healthcare providers. The patients need to access the electronic health records at any given time. When it comes to patients suffering with diabetes, there are a number of competent commercial software systems available that can aid in self-management but a low cost system is required that can assist in tracking their daily progress which may include their diet and exercise routines. The use of an online social network as a social support structure to this proposed low-cost system can be advantageous as it may encourage the patients to interact with other patients and online medical professionals. This chapter gave an outline of what other researchers discovered about m-Health as a field and then zeroed to what has been learnt and researched as far social networks and community based management are concerned. In view of the literature obtained from the various researchers including those of online learning, the general view that was discovered by the researcher was that m-Health is a promising field with a brighter idea that can turn around the health process. The next chapter highlights the research methodology.

References

Number citations consecutively in square brackets [1]. The sentence punctuation follows the brackets [2]. Multiple references [2], [3] are each numbered with separate brackets [1]–[3]. Please note that the references at the end of this document are in the preferred referencing style. Please ensure that the provided references are complete with all the details and also cited inside the manuscript (example: page numbers, year of publication, publisher's name etc.).

RESEARCH DESIGN AND METHODOLOGY

3.0 Introduction

In this chapter we will give a detailed description of how this research was carried out. It is meant to discuss the research design and the various approaches that were employed in this research study. This chapter will also explain how the data collection was done in order to meet the overall objectives of the research study. We are going to explain the sampling techniques used, the types of data and the sample size. The research involves experiments meant to provide answer the research questions and also to fulfil the aim and objectives of the research.

3.1 Research Design

3.1.1 Group characteristics and population size

The researcher opted for experimental design due to the fact that the test was centred on a platform that had to be used first and then results and conclusions deduced from experiences with the system from users, intended beneficiaries, i.e. patients and system evaluators .Therefore the test was scientific and it is a fact that science is all about performing real experiments rather than basing on literature. The researcher combined some quantitative and qualitative components in the experiment, each covering a section that the other could not.

a) Sample and Population Size

The researcher targeted a population of nineteen people with ages ranging from eighteen and above. The number of patients was low as a result of some patients not willing to be part of the research and preferred privacy. Those people who participated contributed to the rating of the system. Patients used the system in managing their health , networking and then rated it according to their views and perception in the line with the content that was anticipated? Patients where given the URL of the website and were required to register where they were to enter their usernames and passwords.

b) Choice of mobile phones

The choice of mobile phone was some Nokia X2 phones some which were owned by the participants and others supplied by the researcher. This was because previous researches by the researcher had shown the cost of a Nokia X2 favourable together with its screen size A mobile component was installed on the website to allow mobile phones to access the content of the website in a way compatible to the phones.

Participants logged on to the platform and accessed their inbox to see if they had any messages. They could also use the chat facility to communicate with fellow patients and health workers. This is where the social networking part was. They could share their experiences as well as recommendations from physicians. A patient would use a glucometer to test their sugar levels and record the readings three times a day. After a day or two, a graph could be produced and an alert message sent if the sugar levels were above or below normal. Possible causes would also be shown such as diet, stress among other factors. With this information a patient would be in a position to decide how to get his/her health back on track. At the server side, a component to record statistic was installed so that every visit was recorded for use in the evaluation.

A t-test and comparisons of means was used to test the effectiveness of mhealth as a tool in improving monitoring and control of diabetes. The research design would allow us to measure the productivity in terms of performance (reliability and effectiveness) of mobile phones. The control group gave us light on whether using mobile phones can contribute in the improvement health delivery.

c) Data transfer method

Once data had been captured on the phone, the completed form was submitted to a central back-end server. This mobile phone data collection system was used and the GSM network for remote data collection, transmitting completed forms and other information was done via both SMS and GPRS. SMS is available on almost all phones while GPRS has the advantage on cost and data size. GPRS has no realistic limit to the size of the form and it is fairly cheaper. At the same time, it is not all communication that will require the web, so SMS was also used when the web was not necessary.

3.2 Reporting Tools

3.2.1 Programming Language

After an exhaustive analysis of existing SMS based reporting tools, researcher developed a web based disease reporting system using Joomla and a database using WampServer.

Ozeki SMS Module was integrated into the system to enable the SMS functionality and below is the Ozeki structure and requirements.

The review of related literature revealed that most of the m-health systems that have been implemented were costly and inaccessible to the majority of patients.

Figure 3 below illustrates what the researcher was trying to achieve in his research. The individual profiles, personal diary, messages and forums.

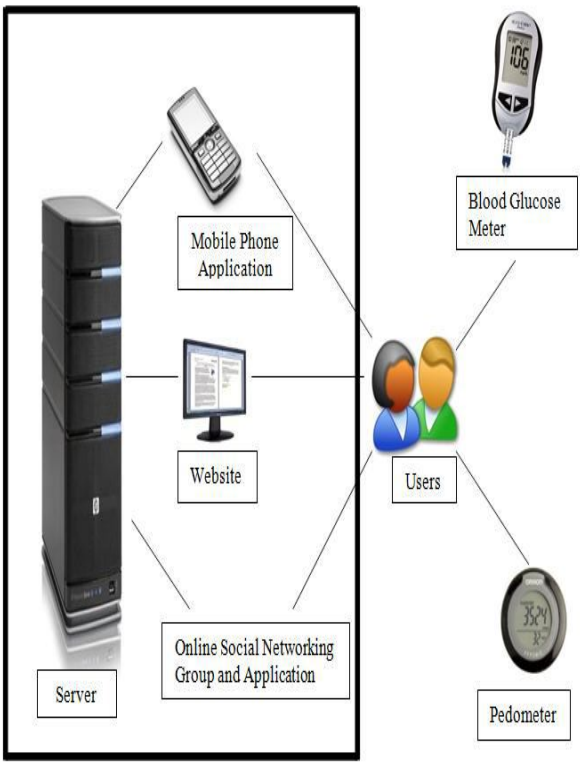

Figure 2: Proposed layout

3.3 Research Instruments

The researcher used questionnaires and system performance as data gathering instruments. Both primary and secondary data were used.

Questionnaires

The researcher used questionnaires from patients who are members of the Diabetes association of Zimbabwe.

Figure 3 below shows how the final users' referred to in figure 3 would access the m-Health platform. The platform was used by both patients and administrators to deliver or maintain content respectively.

1) Interface Design

Considering that the main users are mobile users, the web application should have the minimum requirements of a lightweight application. With that in mind, a mobile plug-in was downloaded and plugged in to the website so that the website can be viewed from mobile phones. The website had to have minimum graphic, low memory

requirement as well as to fit on the small mobile phone screen showing all the important details.

Input Design

Data was to be entered in fields which would be aided by check boxes and radio buttons so that navigating the forms through the mobile phone would be easy as mobile phones do not have keyboards.

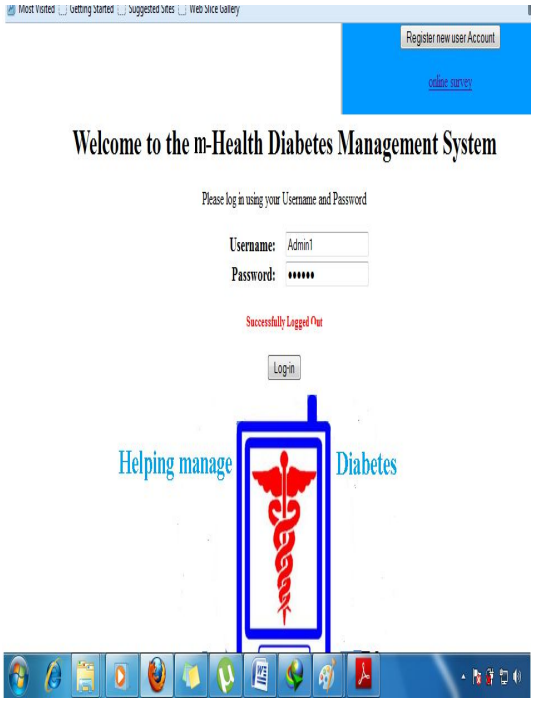

Figure 3: Login to the m-health platform

3.4 Research Questions

The research design was in such a way that it has to address the following questions which are on Chapter 1. Without answering the following questions, the research would be meaningless

1. Does implementation of m-health in Zimbabwe improve health delivery in management of diabetes?

The research question scrutinised the application of mhealth technology on the changes in data collection , speed of processing data, decision time and communication with fellow patients as well as caregivers to determine whether there was an advantage or disadvantage to Diabetic patients when compared to a scenario where there are no social support or communication structures. In order to provide a reasonable grounds for experimenting, the traditional system was to be observed and followed for some time prior to the implementation. Below is a summary of activities involved in the traditional diabetes management. There are two cases of patients, one case is of those who inject themselves and the other less severe where patients take tablets. The researcher will generalise the steps

1. A patient pricks his/ her finger with a sharp sterilized needle so that some blood appears.
2. After the blood has come out, it is smeared on the glucometer and a reading is made.
3. It is the reading that tells the patient that blood sugar lever is normal or not and nothing else.
4. If there is need for help, the patient goes to a health centre or to the Diabetic Association of Zimbabwe for support and help.

Still on time there is another Metric that needed to be measured to find the effectiveness of web based approaches which is :

- Reliability and Uptime

Availability

The availability of a website is measured by the percentage of a year in which the website is publicly accessible and reachable via the internet. :

Total time = 365 days per year * 24 hours per day * 60 minutes per hour = 525,600 minutes per year. To calculate how many minutes of downtime the system may experience per year, we take the uptime guarantee and multiply it by total time in a year.

In this example we'll use 99.99%: (1 - .9999) * 525,600 = allowable minutes down per year.

2. Will patients find the implemented system useful to them?

Basing on the procedure above, comparisons were made in terms of the general response time of the system on the part the people who will use the system daily, i.e. patients. Questionnaires were be supplied to patients who would later evaluate the system. A comparison of the time it takes to get response or help from the system or other users would be made with the existing systems. Challenges where also to be noted. The table below shows the data collection and analysis techniques for use to answer the question.

Table 3 : Data collection and analysis for patients

Question	Data Collection	Analysis
Will patients find the implemented system useful to them?	Pre-implementation views Post-implementation views Latency	t-test comparison of means

3) Will patients trust the m-health system as technology that can be used to help them in fighting whatever ailments that will be afflicting them?

The intended beneficiaries of the research are patients, since our aim is to improve health delivery and control diabetes as well as other diseases and work towards achieving the millennium development goals of 2015. It is therefore that patients evaluate the system. They would fill in questionnaires that would later be analysed for results. A comparison would also be made on the patients' views relating the intervention in terms of convenience to them. A table below shows the data collection and analysis.

Table 4 : Data collection and analysis for patients

Question	Data Collection	Analysis
Will patients trust the m-health system as technology that can be used to help them in fighting whatever ailments that will be afflicting them?	Pre-implementation views Post-implementation views	t-test Comparison of means

3.5 Rate of access and time spend online

Effectiveness was measured by the rate of access to the system on part of the final users. The ONLINE section was used to view which people were using the system at a particular time and the time they spend in the system till they log out was calculated using the LAST LOGOUT section . The later was also used to view when last the person used the system. This type of assessment was useful to the researcher for he could quantify how many logged onto the system and at what times? This tool was however; in-adequate to measure effect due to facts like some people can just log in to the system and stay logged but will not be basically using the system and the fact that some might not be directly benefiting from the system but will have visited the site to tour it. The researcher tried to minimize this type of behavior from patients by creating an automatic logout after five minutes idleness. Below is the user profile of a logged on user.

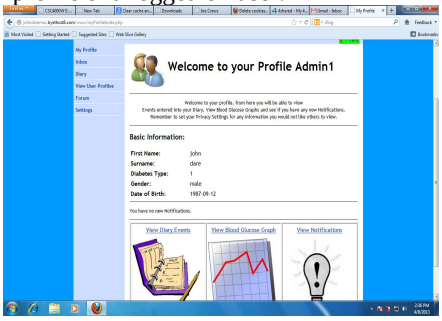

Figure 4: User profile

Figure 5 below indicates the type of instant messaging programs that the users will be using to access the server on the section INBOX. The screenshot shown below in figure 6 can also be used to monitor the clients currently logged on to the system.

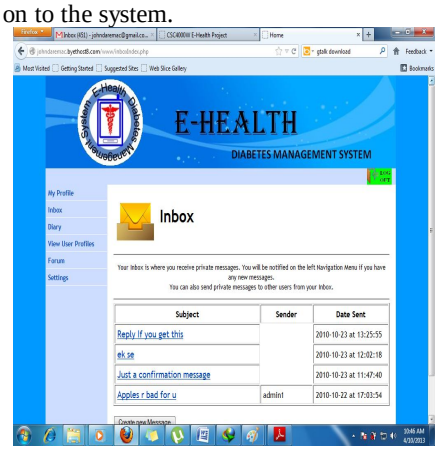

Figure 5: Inbox

3.6 Data Analysis Procedures

Data collected was to be used to produce statistics at the control centre for analysis and response to diabetic patients. With this, appropriate action could then be taken without delay. A Graphic User Interface (GUI) was to be developed for the administrator to view the cases and usage of the system.

The researcher used SPSS software to analyze statistics obtained from the data collected.
By analyzing data of pre-test and post test we will be able to qualitatively conclude the research or come up with a better understanding of the research

3.7 Summary

The successful design and then implementation made it possible for results to be collected which are in the next chapter.

RESULTS AND FINDINGS

4.0 Introduction

After successfully implementing the system and collecting data there is need to analyse the data collected in order to derive meaningful conclusion. This chapter is going to examine the results obtained from the research and try to present them in a more meaning way. Various forms of data presentation will be done in this chapter.

4.1 Analysis of patients reports.

A sample of 19 patients was used in the research for data collection. They were supposed to be 20 but one respondent did not return the questionnaire.
The reliability of the tool with the set of dependent variables making up the questionnaire was measured using Cronobach`s alpha at 0.820 .Patients' questionnaire's reliability was also tested and questions were grouped into variables as shown in table 3.

Table 5 : Reliability analysis of Patients Questionnaire

Variable Name	Reliability Analysis Scale
Patient history of treatment at health centres	0.563
Patients relatives treatment history	0.677
m-health helps and implement it locally	0.568

As can be seen from the table, the lowest response was 0.563 with the highest 0.677 which shows that the questionnaire was reliable as the values are greater than 0.5.
The research tried to answer the following research questions using the following hypotheses:

1. Does implementation of m-health in Zimbabwe improve health delivery in monitoring and controlling diabetes?

Null Hypothesis (H_0) : There is no significant difference in monitoring and managing diabetes by the introduction of an m-health system.
Alternative Hypothesis (H_1): There is a significant difference in monitoring and managing diabetes by the introduction of an m-health system.

Table 4 shows patients responses to the m-health platform by smartphone ownership.

Table 6 : Means of responses on mhealth platform by smartphone ownership

Smartphone ownership	Ease of access	Always available	Ease of use	Navigation and data entry easy	Data sending easy	System is reliable	Phone compatibility	Network a challenge	Period to send a request	Preferred reporting	Where to implement m-health	Will drug acquisition improve
No (N=5)	4.20	3.40	4.20	4.20	5.00	3.60	2.20	3.40	1.00	2.40	3.00	2.00
Yes (N=14)	4.14	3.64	3.86	3.64	4.36	3.86	2.21	3.93	1.36	2.93	2.86	1.86
Total Mean	4.16	3.58	3.95	3.79	4.53	3.79	2.21	3.79	1.26	2.79	2.89	1.89

Table 5 below shows means on patients responses by prior internet knowledge.

Table 7 : Means on response on mhealth platform by prior internet knowledge

Ever used internet before	Ease of access	Always available	Ease of use	Navigation and entry easy	Data sending easy	System is reliable	Phone compatibility	Is network a challenge	Where can mhealth be implemented	Will drug acquisition improve
Disagree	4.00	3.00	3.50	3.00	4.50	3.00	1.00	3.50	3.00	1.50
Somewhat Agree somewhat	4.33	3.67	4.33	4.00	5.00	4.00	2.00	3.00	3.00	2.00
Strongly agree	4.14	3.64	3.93	3.86	4.43	3.86	2.43	4.00	2.86	1.93
Total	4.16	3.58	3.95	3.79	4.93	3.79	2.21	3.79	2.89	1.89

From the table, those in agreement with the statements constituted 76.5% while those not in agreement contributed 24.5% . The general overview of the responses looking at the total means is that regardless of prior internet knowledge, the patients saw significance in the mhealth platform and accepted it as a monitoring and managing tool.
This shows that patients found the implemented m-health platform helpful in as a tool that can significantly improve monitoring and managing.

a) Patients cross tabulation by sex

Table 8 : Cross tabulation of Navigation and Data Entry Easy by sex

Count		NavigationAndEntryEasy				
		DisagreeSomewhat	Unsure	AgreeSomewhat	StronglyAgree	Total
Sex Of Respondant	Male	0	3	2	2	7
	Female	1	2	8	1	12
Total		1	5	10	3	19

From table 6 above 13 (68%) are in agreement against 6 (32%) who are against the statement which says "Navigation and Data Entry is Easy". The bar chart below explains the table above.

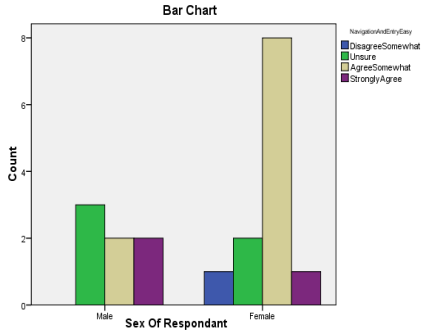

Figure 6 : Bar chart for navigation and data entry easy by sex.

Table 9 : cross tabulation of system reliability with sex

Count		System is reliable				
		DisagreeSomewhat	Unsure	AgreeSomewhat	StronglyAgree	Total
Sex Of Respondant	Male	1	0	4	2	7
	Female	0	5	6	1	12
Total		1	5	10	3	19

Out of the 19 respondents, 13 (68%) concurred that the system is reliable against 6 (32%) who where either unsure or disagreed. This shows that the majority said mhealth has a significance in monitoring and managing.

Table 10 : Phone compatibility with sex

Count		Phone compatibility with site			
		Not Compatible	Compatible	Very Compatible	Total
Sex Of Respondant	Male	0	4	3	7
	Female	2	7	3	12
Total		2	11	6	19

On the issue of compatibility 100 % of the males said the site was compatible to their phones while 83 % of the females agreed with compatibility. However ,there were some concerns over compatibility when the site was loaded for the first time. This might have attributed to the 83% of the females.

Table 11 : Navigation and data sending response by SmartPhone Ownership

Count		NavigationAndEntryEasy				
		DisagreeSomewhat	Unsure	AgreeSomewhat	StronglyAgree	Total
Smartphone Ownership	No	0	0	4	1	5
	yes	1	5	6	2	14
Total		1	5	10	3	19

All the 5 patients who did not have smartphones before concurred that navigation and data entry into the platform was easy. This shows positive response regardless of smartphone ownership.

Table 12 : Independent samples t-test by Phone internet knowledge

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Easy of Access	Equal variances assumed	2.856	.109	-.071	17	.944	-.024	.337	-.734	.687
	Equal variances not assumed			-.063	8.947	.951	-.024	.379	-.881	.834
EaseOfUse	Equal variances assumed	.556	.466	-1.108	17	.283	-.369	.333	-1.072	.334
	Equal variances not assumed			-1.070	11.427	.307	-.369	.345	-1.124	.386
NavigationAndEntryEasy	Equal variances assumed	.735	.403	.279	17	.784	.107	.384	-.704	.918
	Equal variances not assumed			.265	10.920	.796	.107	.404	-.782	.997
AlwaysAvailable	Equal variances assumed	2.289	.149	2.238	17	.039	.667	.298	.038	1.295
	Equal variances not assumed			2.314	14.005	.036	.667	.288	.049	1.284
DataSendingEasy	Equal variances assumed	.569	.461	-2.329	17	.032	-.607	.261	-1.157	-.057
	Equal variances not assumed			-2.082	9.073	.067	-.607	.292	-1.266	.052
System is reliable	Equal variances assumed	.004	.950	.885	17	.389	.333	.377	-.461	1.128
	Equal variances not assumed			.790	9.035	.450	.333	.422	-.621	1.288
Phone compatibility with site	Equal variances assumed	.031	.863	1.162	17	.261	.345	.297	-.281	.972
	Equal variances not assumed			1.236	15.092	.235	.345	.279	-.250	.940
Is Network a challenge	Equal variances assumed	.185	.673	.212	17	.834	.107	.504	-.957	1.171
	Equal variances not assumed			.189	8.966	.854	.107	.567	-1.175	1.390
Where can m-health be implemented	Equal variances assumed	47.719	.000	-2.072	17	.054	-.286	.138	-.577	.005
	Equal variances not assumed			-1.549	6.000	.172	-.286	.184	-.737	.166
Will drug acquisition improve with mhe	Equal variances assumed	.594	.451	-.307	17	.763	-.060	.194	-.384	.265
	Equal variances not assumed			-.360	10.136	.726	-.060	.165	-.427	.308

Analysis of table 10 will again be done in the discussion section of this chapter.

2. Will patients trust the m-health system as technology that can be used to help them in fighting whatever ailments that will be afflicting them?

Null Hypothesis (H_0): Patients will not trust the m-health system as a technology that can help them fight whatever ailments that will be afflicting them.

Alterative Hypothesis (H_1): Patients will trust the m-health system as a technology that can help them fight whatever ailments that will be afflicting them.

The table below shows the means of patients' perception of the currently used method of monitoring and managing.

Table 13 : Mhealth helps statistics

Mhealth helps

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsure	3	16.0	16.0	16.0
	AgreeSomewhat	3	16.0	16.0	32.0
	StronglyAgree	13	68.0	68.0	100.0
	Total	19	100.0	100.0	

From the table 11, 85% of the respondents agreed that mHealth helps which shows confidents in the platform from patients.

3. Will patients trust the m-health system as technology that can be used to help them in fighting whatever ailments that will be afflicting them?

Null Hypothesis (H_0): Patients will not trust the m-health system as a technology that can help them fight whatever ailments that will be afflicting them.

Alternative Hypothesis (H_1): Patients will trust the m-health system as a technology that can help them fight whatever ailments that will be afflicting them.

The table below shows the means of patients' perception of the currently used method of monitoring and managing. Table 12 shows some means on patients responses.

Table 14 : Independent samples t-test

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Mhealth helps	1.721	.206	.878	18	.391	.300	.342	-.418	1.018
			.878	17.176	.392	.300	.342	-.420	1.020
implement mhealth locally	3.415	.081	.849	18	.407	.200	.236	-.295	.695
			.849	12.770	.412	.200	.236	-.310	.710
Diagnosed of Diabetes	1.880	.187	1.070	18	.299	.700	.654	-.674	2.074
			1.070	16.926	.300	.700	.654	-.680	2.080
Drugs readily available	7.205	.015	-1.283	18	.216	-.800	.624	-2.110	.510
			-1.283	15.270	.219	-.800	.624	-2.127	.527
Referals prepared for a patient	2.342	.143	.983	18	.339	.500	.509	-.569	1.569
			.983	16.700	.340	.500	.509	-.575	1.575
sought counselling	.820	.377	.423	18	.677	.300	.709	-1.191	1.791
			.423	17.924	.677	.300	.709	-1.192	1.754

Table 12 will be analysed in the discussion section of this chapter.

4.2 Analysis of variables on gender

The following table shows summaries of patients repsonses to the following questions by gender

1) You were treated of diagnosed of diabetes
2) m-health helps
3) Implement m-health locally

4.3 Speed of the website

The following URL http://analyze.websiteoptimization.com/wso was used to test the response time and speed of the website.

http://www.websiteoptimization.com/speed/1/ says waiting time is dependant upon several factors, which the researcher is not going to explore in this research, but the general load time should be under **8.6** seconds and load times should be decreased by 0.5 to 1.5 seconds but there is no universally agreed time as the relationship between expectation and user experience is what matters most. (http://www.webperformancematters.com/journal/2007/7/10/acceptable-response-times.html)

4.4 Discussion

Response towards m-health platform by sex

Responses from table 4, table 9 and table 10 show that the respondents had words of praise to the m-health diabetes management platform that they had been exposed to showing that they appreciated it. There were slight variations in the means from either sex but the overall mean was in agreement with appreciation of the m-health platform

m-health by prior internet knowledge

From the table 5 which had responses by prior internet knowledge, those in agreement with the statements or dependent variables constituted 76.5% while those not in agreement contributed 24.5% . The general overview of the responses looking at the total means is that regardless of prior internet knowledge, the patients saw significance in the m-health platform and accepted it as a monitoring and managing tool. The 24.5% may be attributed to the fact there were some reservations on always available maybe due to the network challenge.

Easy of access by smartphone ownership

From table 4 and table 9 we can see that respondents without smart phones were five and those with them were fourteen. From the table there was insignificant difference on responses for instance on ease of access ,they had a difference of 0.06. Generally speaking, the responses were not affected by smart phone ownership and both respondents so the significance of m-health platform. We can conclude that factors like smartphone ownership did not have any significant contribution to patients responses who said the platform had several advantages.

Availability of m-health platform

From table 4 and table 5 all responses ,with the exception of "Always Available" which has 0.039 have two tailed means of greater than 0.05 which can help us reject the null hypotheses that the patients will not find the implemented m-health system useful to them and that there is no significant difference in monitoring and controlling diseases by the introduction of an m-health system. We can then accept the alternative hypotheses that The patients will find the implanted m-health system useful to them and there is a significant difference in monitoring and controlling diseases by the introduction of an m-health system. There are no significant difference in patients responses by gender which shows that the acceptance of the platform was independent of gender.

Navigation and Data Entry

From table 6 , 68% of the respondents were in agreement against 32% who are against the statement which says "Navigation and Data Entry is Easy". As depicted by the table, those with and without prior phone internet knowledge concurred that navigation and data entry is easy with the platform with the highest number coming from those with prior internet knowledge.

As depicted by the table 9 which shows responses by smartphone ownership ,26 % of the respondents had no smartphones but agreed that navigation and data entry was easy.42 % of the respondents had smartphones and agreed that navigation and data entry was easy .26% was unsure with 6% disagreeing. This shows that whether respondents had smartphones or not before, they saw navigation and data entry being easy.

Site Compatibility with mobile phones

On the issue of compatibility 100 % of the males said the site was compatible to their phones while 83 % of the females agreed with compatibility. However ,there were some concerns over compatibility when the site was loaded for the first time. This might have attributed to the 83% of the females.

T –distribution of patients

On the t-test by patients sex in table 10 Sig > 0.05 means there is no significant difference in the patients responses. This shows that there were no significant differences in their responses by sex. This can help reject null hypothesis that patients will not find the mhealth platform as a tool that can be useful for monitoring and managing and accept the alternative that patients will find mhealth a a technology that can be useful in monitoring and managing and thereby improve service delivery.

Figure 8: Rate of execution

The rate of execution was also tested against well known benchmarks and showed positive results.When two request where sent on a page size of 10.8KB ,page load time was recorded at 0.44s.

Complexity of the system:

The system is not so complicated and restarting does not take time.

However, despite the praises and rejection of the null hypotheses in support of the alternative hypothesis, the research also has its weaknesses which might have played a role in affecting the outcome. The sample size is not ideally representative of the population. It might have been appropriate if the sample was taken from very geographically spaced samples. The choice of the network provider may have been a challenge again because at times the favourite network may at times be conjested. But generally speaking, the results that were obtained were positive.

The main finding from the data collection was that patients using the m-Health system to manage their health where better off than those that relied on traditional methods of management. Hence from the information we can conclude that it is effective to use the diabetes self management system with community based management to monitor a patients` health.

All the users felt that the details stored on the system were not too personal ,they felt that recording their blood glucose readings was quick and efficient. Most of the users felt that the display of their blood glucose history was helpful and the graph of their blood glucose history was helpful as well. Users agreed that entering food consumptions allowed them to monitor their diet

Results from Interview sessions confirmed that the viewing of the blood glucose history as the best feature of the system. The user felt that viewing a history that spans the last 2 days instead of the last 5 readings would be more beneficial. They also felt that the graph for viewing blood glucose history could be improved by adding multiple lines that compare multiple days on the same graph

4.5 Conclusion

This chapter presented the results that were found during the research from both the participants and the system testing. The results were discussed and used to derive conclusions that the m-health platform is helpful and useful in the delivery of health and management of diabetes.

SUMMARY AND CONCLUSION

5.0 Introduction

After successfully collecting and analysing results as has been shown in the previous chapter, this chapter will now summarise and give a conclusion to the research.

5.1 Summary

The main thrust of the research was to establish whether an internet enabled mobile phone can be used as a monitoring and managing diabetes tool for use by patients. This came from the documented facts that Zimbabwe, like other developing countries is lagging behind in the race to meet the MDGs of 2015. As a result, some countries, still developing, like Zimbabwe started on m-health which was meant to help in timely delivery of health services and the researcher saw, after literature surveys, the potential that mobile phones have as they are just designed wit features almost similar to those on computers.

Objectives were set, research questions formulated and hypotheses defined, which were to guide the researcher throughout the research. A mobile website was designed and developed which was then put online for viewing and use by a group of patients who where strategically sampled. Daily management of blood sugar level was done with the help of some recording instruments and decisions were made based on the readings.

Users where then given questionnaires which they completed basing on their experiences with the system.

The website was also put under several tests to measure response time, availability and speed among other metrics and results where compared with known average values. Analysis of data collected during implementation was then made to come up with a conclusion.

5.2 Conclusion

The research was successfully conducted with everything working well and awesome results where produced. Responses from users showed that they were satisfied with the mobile platform and expressed keen in having the system widely used. Users where not affected by any background factor like prior phone internet knowledge or Smart phone ownership. However, they had variation on whether the system was reliable or not and whether drug acquisition would improve with the majority giving a response of unsure. Some users raised concern on the compatibility of the website to their mobile phones. On loading the website for the second time, it would not show the images but just show the simplified menus and the necessary items. However patients expressed satisfaction with the speed, efficiency and ease of use of the platform. Analysing their responses we can reject the null hypothesis that they will not trust the m-health platform as a technology that can be used to help manage diabetes. Analysing their responses again led to the rejection of the null hypothesis which said they would not accept the new system thereby accepting the alternative hypothesis which said they would accept the platform as a technology that can help them fight ailments that may affect them

In a nutshell, the research was successful, and showed that m-health is helpful and if fully implemented can go a long way in facilitating timely delivery of life saving data or information, can enhance communication, can reduce

travel costs and facilitate in-house refresher training among other advantages and therefore should be implemented on a large scale.

RECOMMENDATIONS AND FUTURE WORK

6.0 Recommendations

With the positive results realised from the implementation of m-health, it can be seen and concluded that m-health can effectively monitor and manage diabetes and timely delivery of information for decision making purposes. However, the researcher noted some areas that need to be addressed for m-health to fully realise its potential

- The ministry of health and child welfare should play a leading role in these researches as it is the mother body that can facilitate selection of strategic research sites and participants and the researcher noted that he had problems in convincing the participants to participate without the full knowledge of the authorities due to a large number of protocols that needed to be observed.
- The researcher also recommends funding for the research to be implemented at full scale

6.1 Future Work

The researcher proposes to include development of surveillance features that can be used to improve real-time communication between users and administrators. There is also need to see if geographical locations have a bearing on the effectiveness of an m-health platform. There is also need to analyse the patients responses by their ages to see if it has an effect on people's responses.

6.2 Conclusion

The research was successfully carried out and the mobile phone was seen to be an effective tool in the monitoring and management of diabetes. The aim of the project was to design and or develop a system that enables diabetes patients to manage their health ,socialize with other patients and communicate with the community of other diabetes in real time.

The researcher implemented a m-health basing on open source softwarewhich was capable of delivering the content in real time to the patients. It was also tested to the final users where the majority of the end users liked the system as they were familiarising with it. The process of exposing end users to the m-health environment helped the researcher to discover a lot of things that the respondents as end users were highlighting as they used the system.

If projects are implemented at large scale, with support from the parent ministry, the mobile phone can go a long way in helping improve health delivery, not on diabetes only but on other diseases as well. On the suggested future work, if it is researched on, the mobile phone has the potential to help us as a country move towards fulfilling the health related Millennium development goals

References

[1] A.D.A.M. (2011). Diabetes :PubMed Health .

[2] Adler.R. (2007). *Health Care Unplugged: The Evolving Role of Wireless Technology.* Oakland,CA: Carlifonia HealthCare Foundation.

[3] al, H. e. (2003). When do patients and their physicians agree on diabetes treatment goals and strategiesand what difference does it make? *Journal of Medical inernet research* , 893-902.

[4] ALTITUDES, D. (2010). diabetes Pilot:Software for Diabetes.

[5] Atun RA, Sittampalam SR. (2006). The Role of Mobile Phones in Increasing Accessibility and Efficiency in Healthcare. A review of the characteristics and benefits of SMS in delivering health care. *The Vodafone policy paper series 4, no.4* , 18-28.

[6] Banks. (2008). *Mobile phones and the digital divide.* San Fransisco,CA: PCWorld Communications Inc.

[7] Barclay, E. (2009). Text messages could hasten tuberculosis drug compliance. *The Lancet, Volume 373, Issue 9657* , 15-16.

[8] Berkman LF, G. T. (2000). From social integration to health:Durkheim in the new Millenium. *Soc Sci Med* , 843-57.

[9] Blaya J. (2010). *Barriers and Gaps affecting mHealth in Low and Middle Income Countries: Policy White Paper Release.* The Earth Institute, Columbia University.

[10]Blynn, E. (2009). *Piloting mHealth : A Research Scan.* Georgetown University , Georgetown.

[11]Butler. (2009). Type 2 Diabetes Mellitus . 32-35,43.

[12]c, H. (2009). Take two aspirin and tweet me in the morning: how Twitter, Facebook, and other social media are reshaping health care. Health affairs (Project Hope). 28,2,361-8..

[13]Chib, A. (2009). The Aceh Besar midwives with mobile phones program: Design and evaluation perspectives using the information and communication technologies for healthcare model. *Mobile 2.0 : Beyond Voice* .

[14]*Compendium of mhealth projects.*

[15]Consulting, V. (2011). mHealth in Ethiopia, Strategies for a new framework.

[16]Consulting, V. W. (2009).

[17]Dalton. (2010). *The use of social networks for E-Health : Literature synthesis.* Cape Town: University of Cape Town.

[18]de Tolly K, A. H. (2009). *Innovative use of cellphone technology for HIV/AIDS behaviour change communications : 3 pilot projects.* Cape Town.

[19]Dhillion, J. (2010). Leveraging Web 2.0 and consumer Devices for Improving Elderlies" health. *Knowledge Management* .

[20]Diabetes. (2011). Type2 diabetes.

[21]Ellison. (2007). The use of Facebook in mhealth.

[22]Feldman, H. A. (2010). Blood glucose monitoring using Frestyle Navigator.

[23]Fjedsoe BS,Marshall AL,Miller YD. (2009). Behavior change intervetions delivered by mobile telephone short-message service. *Am J Prev Med 2009* , 165-173.

[24]Free C,Gemma P,Louise W,Leandro G,Lambert F,Phil E,Vikram P,Andy H. (2010). The effectiveness of M-health technologies for improving health and health services : a systematic review protocol. *BioMedCentral Research Notes* .

[25]Garrett L, C. M.-M. (2009). All for universal health coverage (viewpoint). *Lancet* , 374:1294–99.

[26]government, C. o. (2007). *Volume 1 : Mobile Applications on Health and Learning.* New York: UN Department of Economic and Social Affairs.

[27]Greene JA, C. N. (2011). Online social networking by patients with diabetes: A qualitative evaluation of communication with Facebook. *Journal of General Internal Medicine* , 287-292.

[28]Griffin, D. a. (2009). Social Networking Healthcare. *6th International Workshop on wearable and nanosystems for personalised health.* Oslo.

[29]HASKELL, M. B. (2011). The Compendium of Physical Activities Tracking Guide.

[30]Heisler, M. (2003). when do Patients and their Physicians Agree on Diabetes Treatment Goals and Strategies. *Journal of Medical internet researhc* , 893-902.

[31]Horrigan.J. (2009). *Wireless Internet use.* Washington DC: Pew Research Center.

[32]Iakovidis. (1998). utilizing electronic processes and communication.

[33]International Telecomminication Union. (2009). *Press Release: Worldwide mobile cellular subscribers to reach 4 billion mark late 2009.* Geneva: International Telecomminication Union.

[34]Kallander. (2010). Landscape analysis of mHealth approaches which can increase performance and retention for community based agents. *inSCALE publication* , 6-43.

[35]Kaplan, W. (2006). Can the ubiquitous power of mobile phones be used to improve health outcomes in developing countries?

[36]Keller.M. (2011). Still a Nestling. *For The Record, Volume 23* , 20.

[37]Kollmann A,Reidel M,Kastner P,Schreier G,Ludvik B. (2011). Feasibility of a mobile phone-based Data Service for Functional Insulin Treatment of Type 1 Diabetes Mellitus Patients. *Journal of medical internet research* .

[38]Laugesen, J., Hassanein. (2010). A Continuance Model for a Mobile/Web Based Self-Management System for Adolescent Diabetics: The Role of Loyalty Incentives". *European Conference on Information Systems (ECIS).* Pretoria.

[39]Leastar, G. a. (2009). The impact oftechnology on social networking.

[40]Loudon, M. (2009, February). Mobile phones for data collection.

[41]Massagli MP, F. J. (2009). Social Uses of Personal Health Information within PatientsLikeMe. *Journal Of Medical Internet Research* .

[42]Mckay. (2001).

[43]Mechael P, K. N. (2010). *mHealth:New Horizon for Health Through Mobile Technologies.* World Health Organization, New York.

[44]MEDIA, D. (2011). Diabetes Effects on Society . *eHow* .

[45]Mishra S and Singh IP. (2008). mHealth: a developing country perspective. Making the eHealth Connection. *Local solutions Conference.* Bellagio: Global Partnerships.

[46]Mujera ET, S. T. (2009). *eHealth in Zimbabwe:the role and capacity of the University OfZimbabwe College of Health Sciences Library.* University of Zimbabwe, Harare.

[47]Noordam, A. C., Kuepper, B. M., Stekelenburg, J. and Milen, A. (2011). Improvement of maternal health services through the use of mobile phones. *Tropical Medicine and International Health, 16* , 622-626.

[48]Park. (2003). effects of social networks on electronic health.

[49]PEARSON, J. B. (2010). Potential for Electronic Health Records and Online Social Networking to Redefine Medical Research. *Clinical chemistry 204* .

[50]pujari. (2010).

[51]Pujari. (2011). *Tobacco control and mHealth, A new initiative.* Tobacco Free Initiative.

[52]. Guatemala.

[53]sesric. (2011, december 10). Retrieved february 16, 2012, from Statistical ,Economic and Social Research and Training Centre: www.sesric.org/activities-achievements.php

[54]Shet A, A. k. (2010). *Designing a Mobile phone based intervention to promote adherence to antiretroviral therapy in india.* Bangalore.

[55]SMITH, V. (2008). Social Networks and Health. Annual Review of Sociology. *Social Networks and Health. Annual Review of Sociology* , 34,405-429.

[56]SWAN, M. 2. (2009). Emerging patient-driven health care models: an examination of health . *International journal of environmental research and public health* , 492-525.

[57]THOMAS, K. P. (2008). A Glucose Meter Accuracy and Precision Comparison: The Freestyle Flash Versus the Accu-Chek Advantage, AccuChek

Compact Plus, Ascensia Contour, and the BD Logic. Diabetes Technology and Therapeutics . 10,2,102-110.

[58]Tod. (2005). Patient education and counselling. 1-12.

[59]Tomlison M,Solomon W,Sigh Y,Doherty T,Chopra M,Ijumba P, Tsai AC,Jackson D. (2009). The use of mobile phones as a data collection tool: A report from a household survey in South Africa. *BMC Medical Informatics and Decision Making* , 9-51.

[60]UNDP. (2010, 6 15). *Millenium development Goals Report*. Retrieved 12 11, 2011, from Millenium goals: www.un.org/milleniumgoals

[61]Vodopivec-Jamsek, de Jongh T, Gurol-Urganci, Atun R,Car J. (2008). Mobile phone messaging for preventive health care(Protocol). *Cochrane Database of Systematic Reviews* .

[62]Waidyanatha, N. *Real-Time Biosurveillance Program : a research proposal.* Learning Initiatives on Reforms for Network Economics.

[63]Watts, K. (2006). Empirical analysis of an Evolving social Network. *Science* , 88-90.

[64]WHO. (1999). Definition, Diagnosis and Classification of Diabetes Mellitus and its Complications. Report of a WHO Consultation .

[65]WHO. (2011). mHealth :New horizons for health through mobile technologies. *Global Observatory for eHealth series - Volume 3* .

[66]WHO. (2008). *The World Health Report*. Geneva: World Health Organisation .

[67]YANG. (2010). Identifying influential users in an online healthcare social network. *2010 IEEE International Conference on Intelligence and Security Informatics* , 43-48.