MOBILE TECHNOLOGY TO IMPROVE ADHERENCE IN PATIENTS WITH DIABETES:

A SYSTEMATIC REVIEW

Wilfredo Portillo

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Master's Thesis Committee

Hadi Kharrazi, MD. Ph.D., Chair
Assistant Professor

Josette Jones, Ph.D.
Associate Professor, Health Informatics

John T. Finnell, M.D., M.Sc.
Director and Associate Professor,
Health Informatics

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Dedicated

To myself, for all the hard work and life struggles during this journey and to my colleagues who have given their support and shared their knowledge.

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LIST OF ABBREVIATIONS

- DM: Diabetes management
- DM-I: Type 1 Diabetes
- DM-II: Type 2 Diabetes
- SMS: [Telephone] Short Message System
- PDA: Personal Digital Assistants
- HIPAA: The Health Insurance Portability and Accountability Act

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ABSTRACT

Wilfredo Portillo

MOBILE TECHNOLOGY TO IMPROVE ADHERENCE IN PATIENTS WITH DIABETES: A SYSTEMATIC REVIEW

BACKGROUD: The pathophysiology of diabetes mellitus and the need for vigilant monitoring of serum glucose levels lends itself well to prompt medical intervention by healthcare providers that can significantly reduce morbidity and mortality and improve patient quality of life. The effect of intervention in diabetes can be assessed by following objective laboratory measurements such as hemoglobin A1C, which is abnormal with poorly controlled diabetes and returns to normal with proper management. There are mobile technologies now available that allow for self-monitoring and intervention in this patient population. Using a systematic approach this paper will assess the benefits of Short Message Services and mobile technology in managing patients with diabetes and improving adherence and other outcomes.

OBJECTIVE: To assess the benefits and disadvantages the use of mobile technology could have in the management of diabetes.

METHODOLOGY: A systematic review of articles on this topic was performed. A total of 759 articles were initially identified by searching various search engines, from which only 39 articles met all of the inclusion/exclusion criteria of this systematic review.

FINDINGS: The initial review of literature indicated that the use of mobile technology in patients with diabetes resulted in improved disease outcomes as indicated by parameters such as a decrease in hemoglobin A1C, and an increase in sustainable blood glucose levels.

CONCLUSION: Mobile technology is found to be a promising tool in the management of diabetes, but further research is needed because there is a lack of reliable studies, trials, and

systematic reviews. Physicians and other healthcare professionals are rapidly adopting mobile technology for use in clinical practice because they understand the rising phenomenon of mobile technology.

CHAPTER ONE: INTRODUCTION & BACKGROUND

Introduction

Diabetes mellitus (DM) is a chronic disease that occurs secondary to the body's inability to maintain glucose homeostasis as a result of either a lack of insulin or insulin resistance that results in elevated serum glucose levels. If poorly controlled, it can result in extensive organ damage that can result in significant morbidity and mortality. Complications that result from DM are both short- and long-term (Faridi, et al 2008). Short-term complications can occur day to day and include hypoglycemia, hyperglycemia and hyperglycemic hyperosmolar ketoacidosis, which all can be fatal if left untreated. Long-term complications are the result of uncontrolled hyperglycemia that causes end organ damage and can present itself as peripheral or autonomic neuropathy, micro- or macro-vascular disease, and kidney dysfunction that can progress into end stage renal disease or even poor wound healing. The side effects of an uncontrolled or poorly controlled glucose level by a patient diagnosed with DM, can be detrimental to their quality of life and even life threatening, which is why the study of mobile technology is so important.

As of 2000, there were almost 171 million people who suffered from either form of DM worldwide (Jaana & Paré, 2007). In the United States of America, DM is the sixth leading cause of death (Jaana & Paré, 2007). In addition, almost fifty percent of patients do not adhere to the lifestyle changes needed to reach a sustainable healthy lifestyle, concluding that research and studies are required to improve the number of patients who adhere to their physicians' prescription of regimen adherence (Delamater, 2006).

The recent advancements in technology and the rise in the availability of the internet, mobile phones, and mobile devices has shown that mobile technologies have earned their spot in healthcare research, studies, and trials. The need for a new way of patient physician communication is shown by the number of DM patients that do not adhere to the recommendations of their physicians and who are not knowledgeable enough on the facts of their disease and the recommendations and advice of supporting groups of the disease. There are many different mobile technologies being tested and evaluated that have received positive reviews by both physicians and patients (Preuveneers & Berbers 2008).

In the past, self-management tools consisted of pamphlets and monitoring devices that relied on the patients' knowledge and personal adherence to the regimen of monitoring their serum glucose levels. Now, after many years of advancements in technology, we have seen a change in self-management tools and a new variety of them be tested and reviewed to explore which ones provide the patients with the best chance of disease self-managing. Some of these new self-management tools focus on improving the patients' knowledge of their disease, while others focus on physician-patient communication and the stabilization of patients' serum glucose levels. The focal point of web-assisted interventions is on physician-patient communication and to bring patients up-to-date on information pertaining to their disease. Web-sites and web portals give the patients a place to find answer to their questions and review current information concerning their disease and the recommended treatments. Electronic medical records, videoconferencing, and interactive voice response services give the patient and the physician a way of speedy communication and responses to questions, which is beneficial for patients diagnosed with DM as changes in serum glucose levels

need to be monitored with the utmost vigilance due to the complications that can occur when the levels are not attentively monitored.

One of the most integrated technology interventions is the mobile telephone short message system (SMS), which can help with physician-patient communication, monitoring of serum glucose levels, and improving the knowledge of the patients. Short messaging system is a suitable technology intervention as it encompasses various factors to improve patients' self-management of their disease. Technologies such as Personal Digital Assistants (PDA) and Smart Phones provide patients with various dietary self-management modules such as libraries of foods and their nutritional facts and how they affect their serum glucose levels. The integration of SMS and the PDA/Smart-Phone based dietary self-monitoring system could be used in tandem to create a regimen that all patients would adhere to. This is mainly due to SMS accessibility, convenience, and relative ease of use. Traditional medical records previously existed as a single paper document maintained by the physician or the hospital to record all the patient's healthcare encounters and procedures. The integration of SMS with actual health records can be a major step forward to share data that were traditionally accessible exclusively by physicians, hospitals, and other healthcare organizations.

The pathophysiology of DM and the need for vigilant monitoring of serum glucose levels prompts medical intervention by healthcare providers that can result in the significant reduction of both morbidity and mortality and an improved quality of life for patients. Several landmark Randomized Control Trials (RCTs) have shown that early intervention and glycemic control reduces the risk of the dreadful complications of DM (Prospective Diabetes Study, 1998). These RCTs include the United

Kingdom's Prospective Diabetes Study (UKPDS), which was set up to determine whether improved blood glucose control in people with type II diabetes DM-II would prevent the complications of the disease. This study included 5,102 subjects with newly diagnosed DM-II and it showed that glycemic control decreases the risk of complications in patients with DM-II with the greatest effect being on micro-vascular complications (Prospective Diabetes Study, 1998).

With these studies in mind, it can be hypothesized that a technology that allows for early intervention in patients with DM, outside of the traditional intervention performed during physician-patient clinic encounters, would result in an improved outcome and standard of living for patients. Many mobile technologies are now available that could potentially assist in the healthcare process by allowing patients to become more involved in the management of their disease and by allowing physicians to better document the progress their patients are making toward therapeutic goals and also intervene when indicated. Therefore, a number of studies have been conducted hypothesizing that the use of mobile technologies can improve medication adherence and disease-related outcomes.

To evaluate the above hypothesis a comprehensive overview of literature on research about this topic was carried out. A systematic review was used as the tool to evaluate this hypothesis because it gives the best possible estimate of any true effect and is reproducible in its conclusions. Additionally, the systematic review allows for the summarization of research based information and overcomes some of the biases associated with small single trials. The systematic review of this research also should allow clinicians to better determine the place of mobile technology for DM patients and patient care in general.

Background

A few systematic reviews have been completed in the past that evaluate the use of mobile technology in the management of chronic diseases, such as DM. A summary of these reviews is provided in table 1. These reviews, however, are older and advances have been made in the field of mobile technology since they were published. Besides, the use of mobile technology is now even more widespread and accepted.

This systematic review is an update on the advances and current knowledge based on research focusing on the application of mobile technology in the self-management of DM. The systematic review is necessary to bring together up-to-date information on two subjects that are continuously changing and advancing, healthcare and technology. This systematic review synthesizes the information on mobile technologies used to manage disorders, specifically, both types of DM, because DM is a disease that can be managed and controlled with the proper management tools.

Past systematic reviews have concentrated on the usage of the technology and how it works toward medication adherence and disease management, but little has been done to get patients and physicians involved in the process to receive better results. In this systematic review many factors have been taken into consideration based on past studies, such as, whether the patient and physician have been involved in the study. Notably there were few studies that incorporated physicians and patients along an integrated mobile technology enabled automated SMS system. The patient is needed in the study to see if they will benefit from the system, but the physician is also needed in the study because if they are involved then the patient will be more likely to adhere to the feedback they receive from the automated SMS systems. Indeed, if the

patient does not feel like the system has any personal thought towards the patient, then the patient will never fully adhere to the regimen and their health will be at risk. This systematic review looks at past systematic reviews and how much, if any, are the patients and physicians involved in technology interventions.

Followed is a background review of these (see Table 1):

"A Review of Web-Assisted Intervention for Diabetes Management: Maximizing the Potential for Improving Health Outcomes" (Brown, et al 2007) reviews web-based interventions for managing DM II. Web-based interventions include, but are not limited to, short messaging systems, interactive voice response, videoconference, electronic medical records, web portals, and websites. These web-based interventions help patients track blood glucose levels, receive electronic reminders, schedule physician visits, email their health team, and interact with other diabetic patients. In the conclusion of the review, the authors encourage further study of web-based interventions to explore which technology is the best for which person, during which time, and why. This review does not address DM-I, nor does it try to answer the question posed by the review.

The article, "Behavior Change Interventions Delivered by Mobile Telephone Short-Message Service" (Fjeldsoe, et al 2009), reviews the behavior changes of patients who have received intervention by mobile telephone SMS. The review covers 14 studies that were conducted using SMS as an intervention. The authors found that few studies existed that focused on the promotion of preventive health behaviors in healthy individuals. The authors also found that future research is needed to explore SMS as a main form of intervention. This review does not discuss SMS intervention

specifically for diabetic patients and the amount of studies used for the review does not seem adequate for a quality review.

In the debate, "Can the Ubiquitous Power of Mobile Phones be Used to Improve Health Outcomes on Developing Countries?" (Kaplan, et al 2006) the authors present a literature review of studies and list the pros and cons to mobile telephones as a healthcare intervention. The authors found that there was a lack of quality RCTs that had economic evaluations incorporated within them, which made it difficult for them to create a definitive answer to their title question. This debate focuses more on HIV, TB, and malaria rather than DM. The debate also solely focuses on developing countries and categorically excludes developed countries.

The article, "Computerized Knowledge Management in Diabetes Care" (Balas, et al 2004), was created to identify the impact of computerized information intervention on patients' outcome and diabetes care, and to use this knowledge to improve diabetes care. The authors reviewed and created a meta-analysis of RCTs that showed recording and analysis of DM control-guidelines can lower the glycated hemoglobin levels in most patients. The review also found that the long-term effects of computerized intervention cannot be seen in the RCTs because they did not follow-up with the patients long enough to gain this insight. This review was relatively outdated, not focused on mobile technology, and found to not be comprehensive enough in its discussion of its results on cost effectiveness of computerized interventions.

The "Computerized Learning Technologies for Diabetes: A systematic Review" (Boren, et al 2008), reviews computerized learning technology as interventions that can improve the self-management of DM for patients. The review also looked at the use for the technology to support education and learning when the

patient is at a distance from their healthcare physician. The authors concluded that of the trials they choose for their systematic review there was no consensus of an outcome. They believe further study of DM self-management education by computerized learning technologies is needed to find out if patients' self-management of their DM improves. This systematic review focuses on both types of DM and utilized a sound methodology on its review of trials, but the discussion of the results of the systematic review showed that the review did not yield conclusive results. In addition, these articles review a broad range of learning technologies and do not concentrate on SMS mobile-enabled technologies.

The "Diabetes Self-Management Care via Cell Phone: A Systematic Review" (Krishna, et al 2008), is a study that evaluated evidence of the impact of cell phone intervention for patients with either type of DM. The authors found that cell phone and SMS interventions can increase knowledge and self-efficacy to bring about better self-management behavior. The systematic review included studies that covered obesity, which is not discussed in this systematic review, as well as both types of DM. They also included studies that provided face-to-face communication during routine clinic visits, which does not help to show clear results of improvement in health outcomes from cell phone intervention.

The "Home Tele-monitoring of Patients with Diabetes: a Systematic Assessment of Observed Effects" (Jaana, et al 2007), is a review of the behavioral, structural, informational, clinical, and economic effects of home Tele-monitoring for patients with DM. The systematic review found that Tele-monitoring systems reduced complications for diabetic patients, maintained blood glucose control, the patients became more educated on the subject of their disease, and they also became more

empowered to manage their disease independently. It also found that the time savings of home Tele-monitoring is an attractive feature for patients. The authors only reviewed 17 studies. The study is relatively outdated, with a focus on Tele-monitoring and not necessarily mobile technology. In the conclusion, the authors call for more studies with large sample sizes that vary in demographic characteristics, because at the present time most studies do not represent the entire population.

The "Text Messaging as a Tool for Behavior Change in Disease Prevention and Management" (Cole-Lewis, et al 2010), is a systematic review of peer reviewed studies that shows that text messaging interventions can increase behavior change in patients with chronic diseases. The systematic review reviewed 17 articles that covered 12 different studies, whose main focus was on text messaging intervention. The studies chosen by the authors were mainly completed in developed countries, but one of them was conducted in a developing country. The studies looked at many different age groups, such as, adolescents, young adults, and adults. The authors found that text message intervention helped to decrease hemoglobin A1C levels in adolescent and adult diabetic patients, which was due to the fact that patients increased the frequency of their blood glucose monitoring. The 12 studies featured in the systematic review did not include long-term follow-ups, which are needed to know that the results of the trial will continue to benefit patients throughout their lifetime.

The "Measures of Physical Activity Using Cell Phones: Validation Using Criterion Methods"

(Bexelius, et al 2010), is a study of the collection of physical activity levels (PAL) by means of a Java-based questionnaire that was downloaded onto patient's cell phones. PAL's are important to patients with DM, cardiovascular diseases, and certain

cancers because the energy they expend can affect their diseases. The authors believe that telecommunication technologies can create an accurate real-time approach to collect data and reduce the risk of bias because paper questionnaires rely on patients' memory. The study found that cell phone data collection of PDA's would be useful for a large-scale epidemiological study. The study only focused on females, which does not give us an accurate analysis of the total population and the study does not focus on a specific disease that would benefit from PDA data collection.

The article "Improving Patient Adherence" (Delamater, et al 2006), reviews studies that relate to adherence problems for patients with DM and makes recommendations for improving those patients adherence to behavioral change strategies. The authors discuss many factors that can affect patient adherence, such as, social, psychological, demographic, and health care providers. The authors learned that DMs for the most part is a self-managed disease that requires patients to be responsible and self-motivated to see optimal results in treatment. The authors believe that physicians undermine their patients' self-motivation and management of their disease by telling them what needs to be done without explaining or talking with the patient to create a treatment that patients will adhere to. The study finds that physicians need to engage in active listening techniques to create a patient-physician relationship that is beneficial to both parties and the overall health of the patient. This study did not discuss technology as a way to benefit patients with DM, but it does show the need for a better way for patients and physicians to communicate in a healthy and routine way.

"Factors Associated with Probability of Personal Digital Assistant-based Dietary Self-monitoring in Those with Type 2 Diabetes" (Sevick, et al 2009), is a

study that examined the modifiable and non-modifiable factors linked to a PDA self-monitoring system. The authors believe that the old paper and pencil method of dietary self-monitoring is too tedious and time-consuming for patients to adhere to the achievement of their goals. This study created a randomized controlled trial for adults with DM-II to investigate if a PDA self-monitoring system would improve adherence to dietary goals. While the trial obtained sociodemographic information from the patients, their study did not find any correlation between the data and adherence or non-adherence to the PDA self-monitoring system. The trial found that one of the most powerful indicators of adherence is patients' prior adherence behaviors. The trial was specifically designed for on DM-II patients, but the authors discussed other chronic diseases in their introduction and conclusion.

In the paper "Evaluation of Accessibility and Use of New Communication Technologies in Patients with Type 1 Diabetes Mellitus" (Gimenez-Perez, et al 2002), the authors assess the accessibility of new communication technologies in patients with DM-I. The authors found that patients had more access to cell phones with SMS than they had for the internet. They also found that the patients who had sustainable access to the internet had higher education levels, but they did not show a decrease in hypoglycemia. The study showed that more study and exploration of mobile-phone technologies is needed to see if they would be a better use than the internet for health care delivery.

Table 1. Summary of Past Similar Systematic Reviews

Review Paper	*Focus*	*Deficiency*
Brown, et al 2007	The focus of this systematic review was to compare various web-based interventions utilizing web sites, web portals, electronic medical records, video conferencing systems, interactive voice response, and short-messaging systems for managing DM II.	This systematic review had an inability to determine which intervention features were most effective and did not give a good demonstration of their results due to the small sample sizes, which may not have been representative of the population in question. This systematic review is not adopted widely.
Fjeldsoe, et al 2009	The focus of this systematic review was on the use of mobile telephone short-message services (SMS) for delivering health behavior change intervention via text message systems.	This systematic review was not comprehensive enough in its review of studies to give an appropriate determination as to whether or not text message systems can promote health behavior change.
Kaplan, et al 2006	The focus of this systematic review was on developing countries and how mobile phones could improve healthcare for patients with chronic diseases.	This older study found that mobile phone usage in developing countries is still low and shared use of mobile phones is very prominent. The study also did not focus on any specific disease.

Balas, et al 2004	The focus of this systematic review was on computerized information interventions and how they could affect DM healthcare.	This study did not include any information on the usage of mobile technology for patients participating in the study and it did not include any discussion on the cost effectiveness of the computerized information interventions.
Boren, et al 2008	The focus of this systematic review was to evaluate computerized learning technology interventions that try to empower patients with their self-management of DM and support distance education of DM.	This study did not include any data entry from the end user, which is needed to form a conclusive conclusion.
Krishna, et al 2008	The focus of this systematic review was to evaluate the evidence on the impact of cell phone interventions for people diagnosed with DM and/or obesity.	The studies this systematic review reviewed did not provide an evaluation of the reliability and validity of the information that patients entered into the cell phones. The heterogeneity of the studies also prevented a meta-analysis, which would have allowed for a quantitative assessment
Gimenez-Perez, et al 2002	The focus of this systematic review was on the management and control of DM-I with the intervention of mobile phone short message systems and the internet.	This study included articles from before 2003 and was not current enough to show a true representation of the present time period.
Sevick, et	The focus of this systematic review was on	This systematic review had an inability to

al 2009	the modifiable and non-modifiable factors associated with technology-based self-monitoring and specifically PDA-based dietary self-monitoring.	determine to what extent patients back filled entries, which could skew the findings of the review because patient's memories were not always accurate.
Jaana, et al 2007	The focus of this systematic review was on the home Tele-monitoring of patients with DM.	This study did not provide any valuable information on the usage of mobile technology for disease management because the authors did not check the quality of their data, which means the information, should not be used to draw conclusions.
Delamater, et al 2006	The focus of this systematic review was on the factors that affect patient adherence and what can be done to improve patient adherence.	This study did not include any information on the usage of mobile technology for patients participating in the study.
Bexelius, et al 2010	The focus of this systematic review was on the measurement of physical activity by way of java-based questionnaire that was downloaded onto patients' mobile phones.	This studies sample size is much too small to be representative of the total population and only involved women. This study also did not focus on any specific disease.
Cole-Lewis, et al 2010	The focus of this study was on text messaging as a tool for behavior change in disease prevention and management.	This study found that all of the studies they reviewed did not do any long-term follow-up to see if the results of the study continued for many years after it was completed.

Mulcahy, et al 2003	The focus of this systematic review was on the application of core outcome measures of DM management in practice.	This study is an older study that was not included in this systematic review because it contained articles before 2003, which should be considered outdated in the fields of technology and healthcare.

Objectives

The objective of this systematic review is to assess the value of mobile technology in the self-management of diabetes mellitus as a tool to improve adherence to treatment regimens. This tool may also have an affinity for applications of the management of other chronic diseases. Mobile technology such as PDAs, are widely used among health care professionals across all major specialties (Dale, 2007). Mobile technology is also widely used by the general public for many purposes (e.g., gaming, communication) but not for tracking personal health records to allow patients to have control of their personal health care information. The purpose of this study is to assess the usability of mobile technology in patients with DM-I and DM-II and determine if quality of care can be improved by the collection and integration of patient-generated data into a more complete personal health record. Mobile technology is an integral part of everyday life, "although mobile technology is relatively new and innovative in the health care industry and still evolving" (Baumgart, 2005, Dale, 2007).

CHAPTER THREE: METHEDOLOGY

Methods

A comprehensive overview of literature on this topic was carried out. A systematic approach was selected to provide the best possible estimate of any true effect and produce reproducible conclusions. A systematic review allows for the summarization of research based information and overcomes some of the bias associated with small single trails. It also overcomes the lack of generalization inherent in studies conducted in one particular type of population by including many trials conducted in varying populations.

Data Collection and Analysis

A comprehensive search was performed of MEDLINE (1948-April 1, 2011), Embase (1947-March 2011), CINAHL (1982-March 2011), and the Cochrane Central Register of Controlled Trials (Issue 1, January 2011) to identify studies that used mobile technology to improve patient adherence in the management of diabetes. The Cochrane Database of Systematic Reviews (CDSR) and the Database of Abstracts of Reviews of Effects (DARE) were searched for systematic reviews as potential sources of additional primary studies, and Google Scholar and PubMed were searched for non-indexed and non-MEDLINE records. Reference lists of relevant studies were also scanned.

Detailed search strategies for MEDLINE, Embase, CINAHL, and the Cochrane Library are provided in Appendix A. Database-specific subject headings for diabetes mellitus (including hyperglycemia and glucose intolerance) were combined with subject headings and relevant keywords for handheld computers (including

cellular/mobile phones, personal digital assistants, iPhones, smartphones, and short message service). Adherence was not added as a search concept in an effort to maximize retrieval and avoid missing potentially relevant studies. Results were limited to the English language. Initial searches were performed in July 2010, and all results were updated in April 2011.

A total of 759 citations were retrieved when results from all databases were combined and duplicates removed. After scanning these articles a total of 69 articles were found to be related to the topic base on the following fields in the initial spreadsheet. Most articles were selected by heading where mobile technology was part of the title.

Initial articles review classification

- Title of article
- Year of publication
- Authors
- Abstract
- Database
- Diabetes type 2 and type 1
- Elderly
- Adherence
- Mobile technology/SMS
- Behavior

After the compilation of search results, these articles were selected by title for later revision to identify whether the full article met the initial scan. These articles where then ranked by two readers based on whether the abstract met the requirements needed to be included in the systematic review. Each article was read in its entirety to make sure that it correlated to the topic. The initial scan of the articles was performed by two readers and each article was included or excluded after carefully reading the abstract. If the article met all five of the initial search criterion, it was ranked as "OK" and five points were given for its evaluation, but if the article met half of the criterion, then it got less than five points based on how many of the criterion it met. The articles that were selected were ranked based on a five point scale, where "5" was completely related to the topic and "1" was only slightly related to the topic.

a) Types of studies

Studies should assess the use of mobile technology in the management of diabetes. Based on the results noted above, limited randomized control trials exist for this systematic review; thus nonrandomized trials that include a control group and other prospective studies may also be considered.

b) Types of participants

Patients of all ages with either DM-I or DM-II

c) Types of intervention

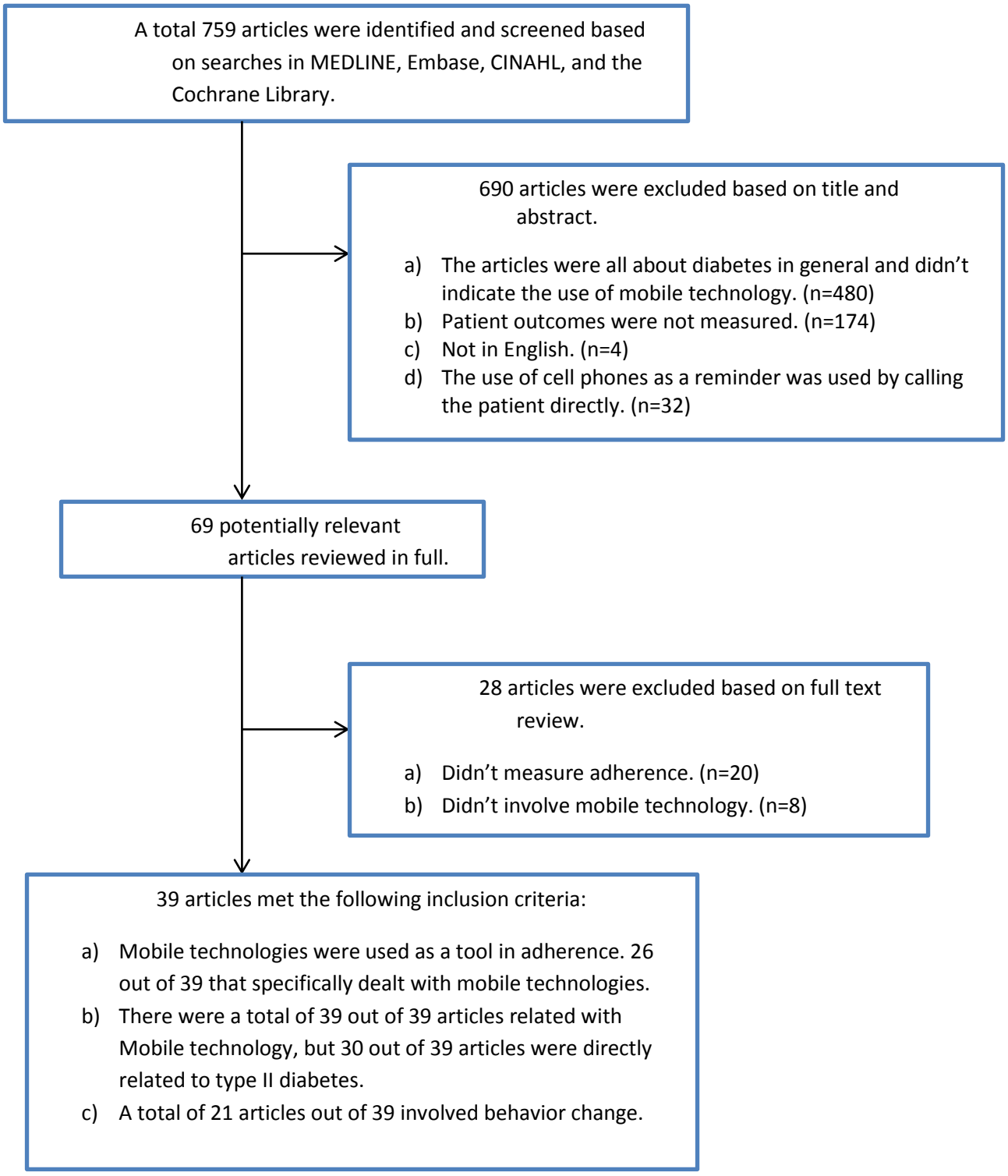
Any intervention using mobile technology including cell phones or handheld computers will be considered. These would include, but are not to be limited to, blood glucose tracking and feedback, dietary and lifestyle education, and e-mail reminders.

Studies that have used cell phones merely as a voice communication tool between the healthcare providers and patients are excluded from this review.

d) Type of outcome measures

Outcome measures will include, but are not to be limited to, improvement in hemoglobin A1C or mean glucose values, self-efficacy and quality of life scores, adverse events, and technological and other barriers encountered by both patients and providers. The paper has to provide information on clinical outcomes that could be assessed using objective data such as changes in hemoglobin A1C.

Figure 1. Steps Involved In Finding and Filtering the Final List of Articles in the Review



CHAPTER FOUR: RESULTS

Findings

After searching four different databases for articles related to the topic, a total of 759 were found to be actually associated with the topic. The next step was to scan the total articles initially accepted as related to the topic and choose the best articles that related to mobile technology and diabetes. A total of 69 articles matched the inclusion criteria after carefully analyzing each article. Of the 69 articles, 39 were chosen as critically related to the topic.

The individual findings of the 39 articles are outlined in the accompanying spreadsheet. Additionally, the schema to code the 39 final articles included the following criteria (see table 2):

- Type of Diabetes (e.g., DM I, DM II, both, include other chronic conditions)
- Co-morbidity (e.g., renal failure, diabetic foot)
- Age Range (e.g., 12 to 18 years, adults and elderly)
- Sample Size (e.g., 12 in control and 14 in treatment group)
- Gender (i.e., male, female, both genders)
- Type of Study (e.g., (un) controlled, (non) randomized, case-study, not specified)
- Duration (e.g., 2 months baseline, 6 months intervention and 1 month follow up)
- Technology (e.g., cell phones, PDA's, and other mobile technology)
- Intervention Treatment Group (e.g., medication adjustment, lifestyle recommendations)
- Intervention Control Group (e.g., no intervention, educational material)

- Target Measures (e.g., HbA1C, fasting plasma glucose)
- Results (e.g., improved HbA1C and self-efficacy)
- Behavioral Change Model (e.g., Self-efficacy, Theory of planned behavior, Stages of changes, Social cognitive theory)
- Reminder Frequency (e.g., SMS was received twice a day, email was sent once a day in the morning)
- Country (e.g., USA, Canada, Spain, S. Korean, UK, and Norway)
- Setting (e.g., Home, Lab, Hospitals, Outpatient clinic)
- Educational content (e.g., daily factoids about diabetes education/nutrition)

Based on the initial findings, patients who received intervention like education and medication management using mobile technology in addition to follow-up with their endocrinologist versus those that only had follow-up visits with their endocrinologist had improved glucose control as indicated by an improved hemoglobin A1C. Patients, who used a mobile technology system, were found to maintain blood glucose control much better that patients who did not use a mobile technology system. The analysis of articles also found that mobile technology increased patients' knowledge of self-efficacy and helped them become better at their self-management skills by means of education and have easier communication between them and their physician.

The 39 reviewed papers and publications (n = 6,465 participants assuming that all reviewed studies were mutually exckusive) have six distinctive study designs, namely: pilot, qualitative, randomized, RCT, quantitative and crossover study. For

ease of dissecting these papers, the crossover research study will be considered as RCT research. On the other hand, the rest of the other publications will be treated as non-RCT studies and research.

Upon careful examination of the peer-reviewed articles and publications, the technological communication that were used to take care and assist patients with diabetes include four different media of communications. These are SMS/text messaging, telephone-support, Internet/Web page, and voice-conferencing.

There are studies that used a combination of these modes of technological communications but this review found that the most familiar mode of communication as the choice of medical intervention in the study was SMS or text messaging. The highest rate of usage in terms of how to communicate with diabetic patients was through SMS or text messaging; the occurrence going as high as 21 times out of the 39 studies conducted.

The other medium of communications like Internet/Web page, telephone support and voice conferencing was used sparingly; and if used at all, they usually came as a secondary means to support SMS or text messaging. Telephone support came next and followed by Internet/Web page and finally, voice-conferencing which was used once. It must also be noted that there are many instances where technology communications used were a combination of any of these four communication technologies, though SMS and text messaging turned out to be the favorite choice of mode of communication.

Table 2: Summary of Reviewed Articles

Article	Type of Diabetes	Age Range	Sample Size	Type of Study	Duration
Wendel, et al 2003	T2D	>60	7	Pilot	12 weeks
Preuveneer, et al 2008	T1D	25-55	17	Pilot	N/A
Liberti, et al 2008	T2D	>18	30	Pilot	3 months
Kim, et al 2004	both	>15	185	no control	3 moths
Cardena, et al 2004	both	18-75	23	qualitative-no control	8 month
Song, 2008	T2D	>30	34	randomized	6 months
Kim, et al 2008	T2D	18-59	52	RCT	12 months
Tani, et al 2010	both	20-60	20	Pilot	12 months
Wentzell, et al 2009	T1D	18-59	22(sms) 18 (email) total 40	Quantitative(Pilot)	3 months

Kim, et al 2007	T2D	mean age 47.5 - 46.8	25(intervention), 26(control)	Quantitative(RCT)	6 months
Gruber-Baldini, et al 2009	T2D	18-64	N/A	Quantitaive (RCT)	1 year
Kim, 2007	T2D	18-59	25(intervention), 26(control)	Quantitative (RCT)	12 weeks
Kim, 2008	T2D		18(intervention); 16(control)	Quantitaive (RCT)	1 year
Cocosila, et al 2004	both	N/A	693	Quantititive	1 year
Gibson, et al 2005	T1D	N/A	N/A	Quantitative (RCT)	
Kim, 2005	both	N/A	16	randomized	3 month
Gerber, 2009	both	30-65	95	Quantitative (pilot)	4 months
Waller, et al 2003	T1D	N/A	N/A	randomized	N/A
Flanklin, et al 2006	T1D	9--15	30	randomized	4 months
Arsand, et al 2005	T1D	children 9-15	15 children, 15 parents (n=30)	Quantitative(pilot)	4 months

McPhee, et al 1999	T2D	>21	252 adults	Randomized	12 months
Kim, et al 2006	T2D	>30	45 patients	Randomized	12 Weeks
Flanklin, et al 2006	T1D	N/A	N/A	Randomized	N/A
Arsand, et al 2006	T1D	9-15 years old	11 boys and 4 girls	Qualitative	11 weeks
Park, et al 2009	T2D	30-70	123	Randomized	3 months
Kim, et al 2005	T2D	18-65	42 patients	Randomized	12 Weeks
Arcelloni, et al 2002	T2D	43+-16 12 men and 10 women	22 patients	Randomized	7 months
Melki, et al 2007	T1D	24+-13	13 patients	Crossover study	12 months
Kim, 2007	T2D	46-47	25 patients ITG and 26 patients ICG	Randomized	12 Weeks
Kollman, et	T1D	mean	3850 patients	Qualitative	3 months

al 2007		age 36.6 +-11			
Newton, et al 2009	T1D	14.4+-2.37	78 patients	Randomized	12 Weeks
Popow, et al 2006	T1D	15-19	36 patients	Randomized	6 months
Weinberger, et al 2001	T2D	60+-10	132 Intervention and 140 control	Randomized	12 months
Weinberger, et al 2000	T2D	> 21 <75	280 patients	Randomized	12 months
Lee, et al 2003	T2D	>42	37 Internet and 38 sms or phone	Randomized	3 months
Virtamo, et al 2004	T1D	43+-13	100 patients	Randomized	12 months
Carroll , et al 2007	T1D	13-18	10 patients	Qualitative/quantitative	3 months
De Leon, et al 2006	both	>18	18 patients	Pilot	12 Weeks
Mclaac, et al 2007	T2D	>58	31 patients	Pilot	4 months

Sample Characteristics

The total population that these studies and publications were able to include in the research was 6,465 patients. All of these participants were diagnosed as diabetic patients suffering from either DM-I or DM-II. The percentage of DM-I patients was 46.9 percent, while DM-II was 53.0 percent. This makes the ratio of DM-I patients in relation to DM-II patient 4:5.

The size of the population samples in the reviewed articles and publications ranged from 7 to 3850, with a median of 184 participants. On the other hand, these diabetic patients were aged from 9 to 70 years old, with the median to be at 39.5 years old. The percentage of males and females in the studies cannot be verified as some of the research in this review were not clear how many were males and females were included in some of the studies.

The RCT studies in this review comprised of 230 patients; their age ranged from 18 to 60 with median age of 39. Meanwhile non-RCT studies had a population number of 6,237. Their ages ranged from 9 to 70 years of age, with the median of 39.5 years old.

Study Characteristics

These studies took place in different countries, spanning as far as Asia – South Korea in particular – to Europe up to North America. For the RCT studies, they took place in Korea (n = 4), USA (n = 2) and United Kingdom (n = 1). On the other hand, the non-RCT studies that comprised the bulk of this review took place in countries in Asia, North America and mostly in Europe. These countries are specifically Korea (n = 12), USA (n = 10), Spain (n = 1), Canada (n = 1), United Kingdom (n = 4), Scotland (n = 1), Norway (n = 2), Italy (n = 1), Austria (n = 2), Japan (n = 1) and New Zealand (n = 1).

Most, if not all, of these studies and publications used as the primary outcome of measures the blood glucose and HbA1c levels of diabetic patients. This is true for both the RCT and non-RCT studies and experiments. Other outcomes were measured according to the FPG, cholesterol, ITG, ICG, and symptoms regarding glycemic control. There are also studies that took measure on the results according to the over-all health satisfaction and self-efficacy of the diabetic patient. On the other hand, the duration of the studies and experiments were varied. The studies for most of the experiments lasted for three month or twelve weeks, while some lasted up to twelve months or one year. The median of the duration of the studies is 5.9 months. The median can be estimated to run for about 23 weeks.

The terms of communication with endocrinologist also vary in each experiment. Most of the studies require the patients to report their glucose level and health situation once or twice every three months. This can be in the form of an actual

visit to the endocrinologist or logging on to a computer to record their health details remotely. There is also one study where the patient is required to log his/her glucose measurement daily on a computer or through cell phone.

Technology Characteristics

Four different media of communications are found in these peer-reviewed articles and publications. These are SMS/text messaging, telephone-support, Internet/Web page, and voice-conferencing. SMS/text messaging got the highest rate of usage in terms of how diabetic patients communicate and report their health status to their endocrinologist. While the other modes of communication technologies were used sparingly or in tandem with SMS or text messaging.

1. SMS/Text Messaging

Of the 39 studies and publication covered by this review, 21 studies used SMS or text as the underlying means to communicate with diabetic patients. The mobile phone text messaging was used primarily for diabetes management. In these studies, patients were instructed to use their cell phones to transmit data regarding the measurement of their glucose levels and body weight. In one study (Cardenas, 2004), the SMS messages sent to the health care professionals were recorded in a server. Upon the successful logging of health details, the patients received automatic reply from the server. In this similar study, patients were recorded as sending 33 SMS messages in a month (Wentzell, et al 2009).

In another study (Wendel, et al 2003), patients were the receiver of SMS text messages. In this particular study, 165 text messages were sent within a month. The content of these SMS text messages were tips and advices on how to maintain patients' health, like healthy eating habits and ideal physical activities. Text messages also contain messages such as reminders to drink water and encouragement for emotional and psychological support. In this study (Liberti, et al 2008), client-based software was used to transmit personal messages at least three times a week. There were about 4,500 text messages that were sent in the duration of the 4 month experiment. Usually, these studies encouraged diabetic patients to report their blood glucose and for it to be monitored. A regular reporting of glycosylated hemoglobin result was also sent by health providers to the patients. In these studies, the average reporting of glycosylated hemoglobin results happened in an interval of a month.

2. Telephone-support/telemedicine

There were 2 publications out of the 39 studies that focused primarily on the use of telephone and telemedicine in monitoring the health of diabetic patients (Popow , Horn, et al 2006). The requirement parameters used in the experiments were the glycaemia control, extensive analysis and interpretation of data, and the involvement of multidisciplinary team of health care volunteers with specialization in communication. In one of the telemedicine studies (Gibson, et al, 2005), the patients' mobile phone was installed with Java-based programs linked with blood glucose meter. Information also about insulin level, physical activities and eating patterns were also monitored and recorded. Feedbacks through phone were used, particularly,

through colored histogram over the level of glycaemia control. The telemedicine system also featured detailed graphical details of the data provided by the patients.

Meanwhile in the automated telephone health management study (McPhee, et al 1999), patients received automated telephone disease management (ATDM) calls through their touch-tone phone. The duration of the experiment lasted for one year. The patients used automated calls to log in their self-monitored blood glucose. Part of the health details that were monitored besides blood glucose measurement also included the patient's sense of glycaemia control, symptoms of poor control, chest pain, breathing problems, foot problems and other self-care issues. Healthcare professionals on the other hand, used the data sent through ADTM to create an assessment for each patient. This was done once every two weeks.

3. Internet/Web page

One study (Shim, 2005), out of the 39 experiments, used the Internet primarily as a means of recording the health status of the patients. In this study, the patients were instructed to record and log in their blood glucose level, diet, and exercise diary every day on a website. In this experiment, all participating patients were screened and required to have Internet access.

4. Voice-conferencing

One particular study (Weinberger, 2001), concentrated on the automated educated calls to patients, these so-called educated calls lasted up to 24 minutes of pre-recorded messages. The educated calls dealt on topics about knowledge and

prevention of diabetes, diet and physical activities, and management of their health problem. In this study, a total of 324 educated calls were made in the span of the three-month experiment.

5. Combination of Two Medium of Communications Technologies

As it has been seen that many studies conducted their experiments through the use of SMS/text messaging, Internet, telephone, and voice-conferencing, it must be noted that most of the studies involved the combination of these modes of communication. There were some studies where Internet-based was used as a mode of recording and monitoring the health of patients. However, health administrators did not at all rely exclusively on this means of communication.

Particularly in one study (Kim, 2007), patients were instructed to record their health details in a site and this was achieved through texting or direct access to the site through the Internet. There were also studies and experiments where the combination of SMS/text messaging was supplemented by the use of emails. Most of the experiments that used a combination of communication technologies used specialized software or programs to give optimal recording and monitoring of the health details of patients.

Interventions

Adherence to medication and self-care

A number of the studies and experiments that was conducted in these 39 publications were centered on self-care and medication. Through the use of communication technologies, the patients were all instructed to record and log in the measurement of their blood glucose and other pertinent health details. Eating patterns and physical activities were also recorded and monitored.

By regular assessment of results based on the health parameters recorded by patients, health administrators provide their suggestions for medication and advice on more efficient self-care programs. Based from all of the studies, self-care improved tremendously through regular remote correspondence with patients. It must be noted that the experiments and studies did not produce the expected result in all of the population of enrolled participants in the study. Based on the results of some of the studies, it was determined that there was only 77 percent success in the experiments that were conducted.

On the other hand, those participants who failed to achieve success, failed due to many factors. One of the common reasons was that they could not keep abreast with the daily or regular suggestions and advices given to them through the communication technologies used in their program. It was also reported that many just failed and stopped recording details of their health status due to other reasons.

and the majority of the experiments were conducted to record and monitor blood glucose or HbA1c. This included both RCT and non-RCT studies. Usually the participants comprised of diabetic patients suffering from either DM-I or DM-II. In several studies the main instruction was daily logging or reporting of self-monitored blood glucose. This was accomplished through various means using a variety of communication technologies like SMS or text messaging, telemedicine or phone support, Internet and voice conferencing. Some of the studies used a combination of these communication technologies for regular reporting and monitoring of the health status of the patients.

There were also studies that gave focus on monitoring fasting plasma glucose (FPG) and two-hour plasma glucose (2-h PG). Though, there were instances that these measurements were used as a pretest data for all the patients involved in the studies and experiments. In these studies, HbA1c, 2-h PG, AND FPG were measured after every 12 weeks during the duration of the experiment. This type of recording and monitoring usually was utilized in studies wherein the duration of the experiment lasted six months and longer. One non-RCT study (kim, 2008), however, used high-performance liquid chromatography technique through the use of Variant II to determine glycosylated hemoglobin. Part of the experiment included the measurement of total cholesterol, triglycerides, and high-density lipoprotein cholesterol. This experiment was used for DM-II patients.

Adherence to Diet

Fifteen non-RCT studies tried to give focus on monitoring the adherence to prescribed diet by participating diabetic patients. These studies typically used SMS or text messaging and pre-recorded phone messages to remind patients to log in their eating patterns. This information then was taken into consideration when healthcare professionals had the need to adjust or change the medication of these patients. One study also included the monitoring of liquid intake for its participating patients. Though, the monitoring most of the times came as a reminder for patients to drink water as frequent as possible. This reminder was passed through to the patients by the use of pre-recorded messages. The patients received these pre-recorded reminders through their touch-tone phone.

Adherence to Physical Activity

There were studies from the 39 publications that included a recording and monitoring of physical activity of the patients as part of their daily regiment for complete assessment of their health status. In these studies, patients were instructed to input the times they got involved in physical activities. This information then was taken into consideration in the over-all analysis of the patient's health status. In one study, getting into physical activity was encouraged by reminding the patients through SMS messages.

Clinical Outcome

The general clinical outcome of the reviewed studies and experiments on the intervention of both DM-I and DM-II in all the participants was positive. There was a marked decrease in the HbA1c or blood glucose of patients. Though, it must also be noted that the decrease in the measurement of blood glucose in all the patients varied. The clinical outcome depended, as seen by this author, on the duration of the experiment.

The level of decrease in blood glucose for example was not that remarkable for those patients who participated in studies that only lasted six months or shorter. On the other hand, those who participated in the program that lasted for as long as one year, showed tremendous decrease in their blood glucose. There are many reasons and factors as to the reason why there had been a remarkable decrease in the blood glucose of participating diabetic patients. One of these was the regular and constant frequency of contact with the health care researchers. As more data and information were recorded and help monitored the patients, this contributed well to the competent application of medical advice according to the recent data. The length of the experiment is also seen as a factor wherein it gave enthusiasm for the patients to control their glucose levels. Yet, in one of the studies concerning DM-II patients, the improvement was only seen on the decrease of HbA1C level and FGP. But there was no change or improvement in the level of total cholesterol, triglycerides, and high-density lipoprotein cholesterol.

Meanwhile, the over-all satisfaction of participating patients in these studies showed positive feedback; especially those regarding the self-care satisfaction that

came from the experiments. For example, in one non-RCT study (Flanklin, et al 2006), a survey was conducted among participating diabetic patients. The patients were asked how the experiments affected their view regarding their health condition, the health care provided for them, and the support that came from the use of communication technologies. The result of the survey showed an over-all satisfaction of patients in terms of health care that they received. The patients also expressed their gratitude that there were health care professionals that took time to take a look and address their medical needs through monitoring. Moreover, the patients showed intention to seek help with their diabetic condition in whatever way. What this shows was that patients wanted frequent contacts with health care professionals; something that they did not usually get from government health departments prior to the experiments conducted on them.

CHAPTER FIVE: DISCUSSION

DISCUSSION

The review of literature on diabetes unveiled a large number of articles that discussed several aspects of it including disease pathology and medical management. However, in comparison to this large bank of information only 39 articles have information that is relevant to the objective outlined above; an indicative of the novelty of the subject and/or the need for additional research.

The literature reviewed revealed that mobile and other communication technologies are a worldwide phenomenon as tools that does only serve for personal communication, but it can also be used for other purposes like the health care management of chronic diseases and for the education on various health-related topics. There are many countries and companies investing on the chronic disease population to promote this technology in the health care industry because they are the ones who would benefit the most from continued research, invention, and innovation of this system.

A good example in using technology to control chronic disease management is South Korea. Korean private companies and government agencies merged together and are seen working very hard together to push this technology to be used; though these institutions' aims and goals are for the purpose only of collecting patient medical information. These institutions see this method as a means by which it will benefit the general population but would not specifically help those with chronic diseases, such as those who are suffering from diabetes.

United Kingdom and the United States are also involved in doing research in mobile technology and how it can be used in the management of chronic diseases. Regarding United States' effort in this issue, there are some hindrances and challenges to this type of medical health management. One of these challenges is that HIPAA regulations hinder the use of mobile technology for healthcare because hospitals and healthcare providers are obligated to meet many privacy regulations (Knox, et al 2007). The reason for this privacy regulation is that many see communication technology as susceptible to outside infiltration and has the potential for the leaking of private health information of patients. The application of mobile technology in the healthcare field could then be hampered by these privacy regulations in the United States.

However, the new era of mobile technology will enhance its use as it becomes more secure, faster, and efficient. It is not farfetched to think that in the coming future hospitals will be forced to adopt the technology in their systems for regular recording and monitoring purposes pertaining to chronic illnesses and diseases of patients. Once hospitals and physicians catch the evolving trend concerning mobile technology in health management of people with chronic diseases, they will understand that this is the new direction healthcare is heading to; this will ensure that major strides will be made to make sure the technology is beneficial to everyone involved in the system.

Mobile technology does also have its downsides. One of these is because it relies on electricity and batteries that can shut down at any time and this 'black out' can last for indefinite duration of time. The effect of this is leaving the health care providers and physicians without electronic medical records and the means to

communicate with their patients. On the side of patients, this worst case scenario can leave them without their usual form of communication with their health care providers and doctors.

Yet even though mobile technology has its flaws, these disadvantages are overshadowed by the positive effects in the advancement in mobile technology would have for patients with chronic diseases. The advantages are many to mention but one of these is the self-health care abilities that can be imbibed by patients participating in this type of modern communication-technology-centered health system.

This is the most important effect of using communication technologies for health care management - diabetic patients will have the opportunity to practice self-health care. It is clear from the studies and publications included in this systematic review that patients are encouraged in taking care of themselves without traditional direct contact with their health care providers.

As several experiments showed, the way to promote self-health care to patients was through constant and regular transmission of messages whose content were about how to deal with their disease. Reminders through SMS and phone for example educate these patients in terms of eating patterns, physical activities, healthy habits and, of course, the daily self-monitoring of their blood glucose levels.

It is redundant to say that the use of Mobile technology systems in the healthcare field would be the first major change in how the health care providers and physicians and patient communicate. If there was once a need for a direct personal contact with health care providers and physicians, this will be lessened by the availability of communication technologies. Through a simple text message or email

or use of an Internet web page, patients now can have their medical advice concerning how to manage and maintain their health status.

This will also be the first time in medical history where the patient would feel confident in taking their healthcare into their own hands something that would make them feel more responsible for their own health. The effect of the promotion of self-health care through communication technologies on patient will be of better adherence to healthy lifestyles and/or at least the ability to be educated on the various regimens and interventions they can use for their disease, particularly diabetes.

Moreover, the use of communication technologies in disease management will give patients the ability to get answers to their questions without spending money for insurance fees on unnecessary doctor and hospital visits. This also will reduce the amount of time physicians would spend in face-to-face interactions since more time in health care management will be spent on the mobile technology systems.

As the management of chronic diseases, particularly diabetes, continues to evolve towards an emphasis on health care management wherein patients are actively involved in the management of their disease, mobile technology will allow for the advancement of preventive medicine. This is feasible by enabling patients to make follow-up communications regarding health statuses outside of the traditional clinic setting. This will allow for early intervention and education that will reduce patient morbidity and mortality. Not only would mobile technology have a positive effect on patients with diabetes, but everyone who needs education on any health concern can use the technology to reduce doctor and hospital visits including medical expenses.

Mobile technology is a promising tool in the management of diabetes and perhaps other chronic diseases; however, it needs more attention from academia and

the private sector for its full potential to be realized. More research is needed to find out if mobile technology would make a profound difference in the self-management of diabetes and other chronic diseases. Points to consider are: what mobile technology system would be the most beneficial for patients; if the systems would be cost effective; and, if it can be an alternative to much more costly and non-effective self-management tools.

As mobile technology advances and these devices become more widely available to the general public, these communication gadgets will play an increasingly valuable role in patient care. Moreover, their integration into Web-based applications and the recording of personal health record will ultimately contribute to improved health care management of patients with chronic diseases like diabetes. Researchers should know that mobile technology studies would not just be a benefit people with chronic diseases, but the technology would eventually become a major assistance to everyone with their healthcare needs.

Study on communication technology for its use in health care management should have an appeal to medical researchers because it can have a tremendous effect on everyone suffering from various chronic diseases, not just diabetes. Results of these studies will have an impact in the world and can revolutionize the healthcare management industry with a new form of communication, education, and intervention.

CHAPTER SIX: CONCLUSION

CONCLUSION

In this systematic review, 39 studies and publications are included and carefully analyzed according to the inherent value of them. These publications and studies were analyzed according to the criteria of Type of Diabetes, Co-morbidity, Age Range, Sample Size, Gender, Type of Study, Duration of the experiment, Communication Technology, Intervention Treatment Group, Intervention Control Group, Educational material, Target Measures, Results and Behavioral Change Model, Reminder Frequency, Country, Setting and Educational content of messages.

The results of the reviewed studies showed positive clinical outcomes in both DM-I and DM-II. There was a remarkable decrease in the HbA1c or blood glucose level of patients who participated in these studies and experiments. Yet, as it has been discussed in the section above about the clinical outcome of these studies, decrease in the measurement of blood glucose level depend on the duration of the experiment.

It was seen that decrease in blood glucose was not that remarkable for those patients who participated in experiments that were shorter than six months. Those patients who showed remarkable and positive decrease in their blood glucose level were those who participated in the program that had duration of as long as one year.

It was analyzed that there are many factors that brought this type of results to these patients. One major factor that was seen is that regular and constant frequency of contact with the health care researchers can bring a more positive decrease in blood glucose level. The reasoning behind this is that as more data and information are

recorded to help monitor the patients' health statuses; this assisted in a more competent formulation of medical advice coming from health care providers and endocrinologist.

It also showed that the duration of these experiments, the longer they are, contributed in encouraging the building up of enthusiasm for the patients to self-control their glucose levels. But it must be noted that the decrease in HbA1C or blood glucose level and FGP are the only positive results of the studies and experiments. Another positive outcome that was seen from the systematic review of these 39 studies and publication is that the over-all satisfaction of participating patients in these studies showed optimistic feedback. One of these optimistic impacts is about the overall self-care satisfaction that was brought to patient when they participated in these experiments.

As mentioned previously, in one non-RCT study (Kim, 2008), patients were surveyed how the experiments affected their perspective regarding their diabetic health condition. This survey also asked their experiences regarding the health care provided for them and the assistance that came along from the use of communication technologies like SMS/text messaging, Internet and phone-support. The product of the survey manifested an over-all satisfaction coming from patients in terms of health care that they received. It must be noted that the patients also expressed their gratitude about the conducted experiments and studies. These patients were thankful for the existence of health care professionals that took the time to address their diabetic health needs even through the simple means of monitoring and sending them messages through text.

Most of these studies and experiments involved the use of mobile

technology as means of communication between the patients and the health care providers and endocrinologists. There were studies that involved other means of communication technologies like Internet and phone, but many of these studies used them in combination with mobile technology.

We can conclude that mobile technology, specifically pertaining to giving medical assistance to patients diagnosed with either type of diabetes, could create a positive impact if utilized properly. Indeed, the use of mobile technology and other means of communication technologies, as the experiments showed, gave these patients a way to meet all of their needs.

The use of these communication technologies generated a better possibility of adherence to the treatment regimens prescribed by their endocrinologist and physicians. The regular and constant SMS messages that were sent to the patients by health care providers gave awareness and education to patients with DM to be educated about their health status.

Another remarkable observation is that the use of mobile communication, as means to monitor the health status of these diabetic patients, gave the opportunity to patients to learn better self-care health management skills. It has always been known that patients with diabetes need to rely on their own self-management skills because everything they eat and their serum glucose levels need to be monitored daily. It is given that physicians cannot control the diabetes patient's every day. Patients cannot see their physician every day because that would affect their daily activities and quality of life. But through the use of mobile communication, this necessary skill in self-care health management is even more reinforced.

It is the conclusion; mobile technology can create a reliable and efficient

self-management system that can considerably support diabetic patients, whether the patient is suffering from either of the two types of this disease. Moreover, the use of mobile technology has the potential and possibility of cutting down on physician visits and consultations.

Another benefit of mobile technology in the management of diabetes is patient adherence to healthy lifestyle. This can also result to an eventual lessening of cost of treatment.

Mobile technology is a way for patients and physicians to communicate in an effective and appropriate way. This systematic review shows that the stabilization of serum glucose levels in diabetes patients could be obtained from a mobile technology system. Medical management provided this way proved to be effective and can result to positive outcome for those who are suffering from disease.

In summary, mobile technology can create a reliable and efficient self-management system that would cut down on physician visits, diabetes patient non-adherence, and eventually cost of treatment because the technology would be improved over time and become more popular, which in turn would lower the price of the system. Mobile technology is a way for patients and physicians to communicate in an effective and appropriate way every day and at a distance.

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APPENDICES

Appendix A:

Search Strategies for MEDLINE, Embase, CINAHL, and the Cochrane Library

MEDLINE (Ovid):

---

1 exp Diabetes Mellitus/

2 exp Glycosuria/

3 exp Hyperglycemia/

4 exp Hyperinsulinism/

5 exp Hypoglycemia/

6 exp Hypoglycemic Agents/

7 diabet*.mp.

8 Computers, Handheld/

9 Cellular Phone/

10 (smartphone* or smart phone*).mp.

11 (iphone* or i phone*).mp.

12 (short message service or self management support).mp.

13 ((handheld or hand held) adj (comput* or device* or phone* or technolog*)).mp.

14 ((mobile or cell*) adj (comput* or device* or phone* or technolog*)).mp.

15 (personal digital or cellphone*).mp.

16 (text messag* or texting or messaging).mp.

17 (or/1-7) and (or/8-16)

18 limit 17 to english language

19 exp Animal/ not Human/

20 18 not 19

Embase (Embase.com):

#1. 'diabetes mellitus'/exp

#2. 'glucosuria'/exp

#3. 'hyperglycemia'/exp

#4. 'hyperinsulinism'/exp

#5. 'glucose intolerance'/exp

#6. 'glycemic control'/exp

#7. 'hypoglycemia'/exp

#8. 'antidiabetic agent'/exp

#9. diabetic OR diabetes

#10. 'microcomputer'/exp

#11. 'mobile phone'/exp

#12. 'personal digital assistant'/exp

#13. smartphone* OR 'smart phone' OR 'smart phones'

#14. iphone* OR 'i phone' OR 'i phones'

#15. 'short message service' OR 'self management support'

#16. hand*held OR mobile AND (computer* OR device* OR phone* OR technolog*)

#17. 'cell phone' OR 'cell phones' OR 'cellular phone' OR 'cellular phones'

#18. 'personal digital' OR cellphone*

#19. 'text messages' OR 'text message' OR messaging OR texting

#20. (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 or #9) AND (#10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19) AND [english]/lim

CINAHL (Ebsco):

S1 (MH "Diabetes Mellitus+")

S2 (MH "Diabetic Patients")

S3 (MH "Diabetes Education")

S4 (MH "Diabetes Educators")

S5 (MH "Hypoglycemic Agents+")

S6 (MH "Hyperglycemia+") OR (MH "Hyperinsulinism+") OR (MH "Hypoglycemia+")

S7 (MH "Glycemic Control")

S8 diabetic OR diabetes

S9 (MH "Computers, Hand-Held")

S10 (MH "Wireless Communications")

S11 smartphone* or "smart phone*"

S12 iphone* or "i phone*"

S13 "short message service" or "self management support"

S14 "personal digital" or cellphone*

S15 "cell* phone*"

S16 (handheld or "hand held" or mobile) AND (computer* or device* or phone* or technology*)

S17 "text message*" or messaging or texting

S18 (s1 or s2 or s3 or s4 or s5 or s6 or s7 or s8) and (s9 or s10 or s11 or s12 or s13 or s14 or s15 or s16 or s17) Limiters - English Language

Cochrane Library (Wiley):

#1 (diabetes or diabetic):ti,ab,kw

#2 (hypergly* or hypogly* or glucosur* or glycosur* or hyperinsulin* or insulin* or "glucose intolerance"):ti,ab,kw

#3 (handheld or "hand held" or "personal digital" or "cell phone" or "cell phones" or cellular):ti,ab,kw

#4 "short message service" or "self-management support":ti,ab,kw

#5 (mobile):ti,ab,kw

#6 (smartphone* or "smart phone" or "smart phones" or iphone* or "i phone" or "i phones"):ti,ab,kw

#7 (cellphone*):ti,ab,kw

#8 "text messages" or "text message" or messaging or texting:ti,ab,kw

#9 (#1 OR #2) AND (#3 OR #4 OR #5 OR #6 OR #7 OR #8)

Wilfredo Portillo

2029 Runaway Bay Ln Apt F
Indianapolis, in 46224
Cell 317-488-7339
pwportill@gmail.com

Objective

To obtain a full time position in Information Technology, specifically within the healthcare industry.

Education

Indiana University Purdue University Indianapolis
Master of Science in Health Informatics, 2012
Bachelor of Science in Computer Technology, 2004

Ivy Tech Community College, Columbus Indiana
Associate Degree in Computer Information Technology (Distinguished Alumnus), 1999

Certifications

CompTIA A+, CompTIA Net +

Computer Skills

Hardware – Repair computer desktop, rebuild computer system as requested by client, laptops, printer, and mobile technology/Smartphones

Software – Microsoft office, Photoshop, Word press, Concrete5, Virtualization tools, usability, Windows desktop support, Apple desktop support, CMS software, Relational Database tools, open source software, share point, angel learning, CERTTS software, Sakai open source, MySQL, MSSQL, PHP, Windows OS, Macintosh, Unix/Linux, Installed, configured, and managed servers, user workstations, network printers, and user accounts, forensic tool for data recovery and secure, windows OS mobile devices and palm os, iPhone, and droid platform, Symantec ghost imaging software,

Network – Wireless access point's configuration, manage networking devices. Manage file share server

Work Experience

IU School of Medicine, Indianapolis, IN, 2005- Present
Mobile Technology Support

- Provide high level support to Indiana University School of Medicine students and faculty for personal computer use.
- Serving as the primary contact for PDA support, laptop configurations and general computing questions for CERTTS, ANGEL, Sakai system and other IU systems.
- Build and repair computers.

IU School of Medicine (Department of Orthopedics Surgery), Indianapolis, IN, 2000-2005
PC Support

- Provided Help Desk support for the Orthopedic Department at all campus hospitals.
- Provided technical support for Orthopedic Research Scientific Group computer/software and hardware problems and stand-alone computer and networking devices.

Project Work

Video Game for children with autisms

- Setup the equipment for testing and interaction with participants
- Help with data collection

Sakai testing system for IU School of medicine

- Teach faculty and staff with the system
- Course design and manage

ANGEL Learning migration to oncourse management system

- Help faculty and staff with course migration
- Enroll new participant to the oncourse system
- Oncourse classes design for students and staff

CERTTs training

- Work with student with clinical tracking system
- Train medical student with mobile devices for clinical tracking

Activities

Member, National Institute for Fitness and Sport
Team Member, IUPUI Soccer League
Jaguars On The Street Volunteer, Wheeler Mission Ministry
Volunteer English/Spanish Translator, IU Health (Riley, Methodist, IU Hospital)

Languages

Fluent in English and Spanish