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Joanne Adeyemi

*School of Information Systems and Technology, Claremont Graduate University, Claremont, United States.,  
tyadeyemi@gmail.com*

Rondalynne McClintock

*School of Information Systems and Technology, Claremont Graduate University, Claremont, United States.,  
rmwork@gmail.com*

Victoria Kisekka

*School of Management, State University of New York, Buffalo, Buffalo, NY, United States., vkisekka@buffalo.edu*

Yoonmi Lee

*School of Information Systems and Technology, Claremont Graduate University, Claremont, United States.,  
Yoonmi.lee@cgu.edu*

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# Americas Conference on Information Systems AMCIS2012 Seattle

## Sustaining Gains: SMS-GIS Enabled Model for Diabetes Self-Care

**Joanne Adeyemi**

Claremont Graduate University  
School of Information Systems and Technology  
tyadeyemi@gmail.com

**Victoria Kisekka**

State University of New York, Buffalo  
vkisekka@buffalo.edu

**Rondalynne McClintock**

Claremont Graduate University  
School of Information Systems and Technology  
rmwork@gmail.com

**Yoonmi Lee**

Claremont Graduate University  
School of Information Systems and Technology  
yoonmi.lee@cgu.edu

### ABSTRACT

Adherence to care and treatment of chronic conditions is a well-researched area. In the context of diabetes, many experts have identified self-care adherence as one of the major factors influencing patients' health outcomes. Cases of non-adherence to self-care among diabetic patients have been well documented. The adverse effects of non-adherence are costly to both the patient and the healthcare industry. This proposed research attempts to mitigate the problem of non-adherence to care by incorporating mobile technology as a tool of support to promote care adherence. Specifically, the use of cellular phone Short Message Service (SMS) and Geographic Information System (GIS) technology to increase adherence to self-care amongst diabetes patients is investigated.

### Keywords

Care Adherence, Self-Management, Information Technology, Mobile Support Tools, Mobile GIS Technology

### INTRODUCTION

Care-adherence is identified as a major factor influencing health outcomes among diabetic patients (Lin, B et. al, 2004). Care adherence is pertinent among diabetic patients as it is a self-care managed health condition. The adverse effect of non-adherence is costly to both the patient and the healthcare industry. Identified in 2007 as the 7<sup>th</sup> cause of death in the United States (CDC, 2010), the number of people that will contract diabetes will continue to increase in the United States. According to the Centers for Disease Control and Prevention (CDC), it is projected that 1 in 3 adults in the United States of America will be diabetic by 2050 (CDC, 2010). In addition, health complications from diabetes are equally devastating. Diabetic patients are prone to numerous diseases such as retinal failure, amputation of extremities, blindness, heart diseases and stroke (U.S. Department of Health and Human Services, 2005). Many of these complications result from non-adherence to care. The monetary cost of non-adherence is also significant, the CDC estimated that about \$174 billion was spent directly and/or indirectly on diabetes care in 2007 (CDC, 2010). Faced with these devastating facts, it is imperative to mitigate these negative trends.

Many research outcomes have identified reasons for non-adherence to care. These reasons vary from low health literacy to unhealthy life style. Reasons also include a lack of health insurance and a lack of self-efficacy (Griva, Myers, & Newman, 2000; Piette, Heisler, & Wagner, 2004). The inability to self-manage diabetes is poignant to patients, causing health

complications such as kidney failure, amputation, stroke and blindness (Campbell & Martin, 2009). While researchers continue to perform studies to better understand the reasons for non-adherence, common trends are starting to emerge. Factors such as poor patient-provider communication (Piette, J, et. al 2003), low health literacy (Schilinger, D, et. al, 2002), existing health co-conditions such as depression (Ciechanowski, Katon, & Russo, 2000), lack of access to care, diverse health care workforce, family structure (Sevilla, E, et.al, 1995), cost (Karter et al., 2003), and inadequate healthcare insurance (Piette, J et.al, 2004) are identified as reasons for diabetes non-adherence to care. While research outcomes are encouraging, sustaining the success continues to be elusive; noted in their research, (Fischer, Moore, Ginosar, Davidson, Rice-Peterson, Durfee, Mackerson, Estacio & Steele, 2012) anticipate “message fatigue” as the challenge to their research outcome. While non-adherence and sustaining positive research continue to pose a challenge, this paper attempts to mitigate non-adherence to care by incorporating another facet of technology as a tool of support.

Technology in this paper is the utilization of mobile technology. Specifically, we argue that the use of cellular phone Short Message Service (SMS) and Geographic Information System (GIS) technology to persuade/remind diabetes patients to adhere to care has the potential to increase care adherence. Use of mobile GIS technology would enable healthcare providers to provide relevant and specific reminders and care-related information to patients based on their location. Another benefit of using mobile GIS technology is the ability to assist patients in locating the nearest diabetes healthcare facility patients can go to for support/questions regarding self-care. In addition, the utilization of GIS technology has the potential to address the issue of access, diet and exercise (Box, K, 2009).

According to the CDC, 26 million Americans are diabetic (CDC, 2010), with a significant percentage of non-adherents. Because of the high prevalence of diabetes non-adherence (Cramer, 2004), the goal of this research is to evaluate the potential of using SMS and GIS combined as tools for care adherence among diabetic patients (Misono, A, et. al, 2010); an increase in patient adherence would not only improve quality of life, but also reduce diabetic mortality rates and financial costs. It is incumbent upon healthcare providers, patients and community support systems to work together to establish means of improving diabetic care adherence. With advances in Information Technology and its ubiquity in many forms, patients and providers may have an effective communication tool; the familiarity of technology device(s) and the ability to access educational materials in a friendly environment may enable patients to self-manage better (Krishna, Boren, & Balas 2009).

In this research in progress, we propose the use of cell phone Short Message Service (SMS) and mobile GIS technology to improve adherence to care among diabetic patients. As of the writing of this paper, no other research has looked at the effect of SMS and GIS technology combined on care adherence. Furthermore, this paper proposes to add to the body of knowledge by utilizing SMS and GIS combined to maximize the perceived ease of use of mobile technology. The rest of the paper is organized as follows: The next section is the literature review, followed by a detailed description of the theory base for this research. Subsequently, we describe the methodology that will be employed including data collection and data analysis. Lastly is the concluding paragraph, followed by the references.

## **SIGNIFICANT PRIOR RESEARCH (LITERATURE REVIEW)**

Numerous studies have investigated the role of information systems within health care provider organizations. For example, cell phones and text messages can assist in increasing care adherence among diabetes patients, helping to address the issue of non-adherence, which continues to pose a challenge to both patients and health care providers. To mitigate this problem, many have advocated for various methods to address the challenge of non-adherence in order to promote positive health behavior (Bellazzi et al., 2004; Fjeldsoe, Marshall, & Miller, 2009; Hussein, Hasan, & Jaradat, 2011). The method being explored in this research is the use of information technology (cell phone, text messages and GIS) to promote adherence through support and communication. Support and communication can promote self-efficacy, which is inherently important in enhancing care adherence among diabetes patients. More than half of the United States citizens have cell phones, with over 35% being text users (Krishna, & Boren, 2008). While there is a high disparity in care non-adherence among the under privileged, there is no evidence that socioeconomic status creates any form of disparity in cell phone subscription (Krishna, & Boren, 2008). In their research, it was concluded that cell phones and text messages have the potential to increase positive health outcomes and increase self-efficacy among diabetes patients. A similar study on behavioral change found that interventions delivered via SMS showed positive short-term behavioral outcomes, however, more research is still needed to access intervention programs that affect both behavioral outcomes and user acceptance (Fjeldsoe, et al., 2009).

A research article by Gomez (Gomez E.J et al, 2002) explored the use of telemedicine systems (DIABTel) as a backup tool to monitor diabetes patients for 6 months. It was described as a “virtual diabetes disease management center” with the potential to save costs; it is easy-to-use, on-line and provides cost-effective access to telemedicine. The system was utilized for communication (via text messages) to patients; it was also used for glucose readings, day-to-day exercise regime, insulin

adjustment and diet. The system's architecture was "based on 2 main components: the medical workstation (MW), a PC-based application used by healthcare providers and the patient units (PU), implemented on a palmtop computer and used by patients during their daily living" (Gomez, E.J et al, 2002). Both systems (MW & PU) interacted around the clock. The systems afforded physicians the opportunity to monitor patients through the patients' self-monitoring data. This system enabled the physicians to care for their patients in a non-conventional method, and also improved patient-provider communication. The communication generated by the system was an array of visual communication aids such as a patient logbook, graphical data visualization and statistics, email, consultation of prescribed insulin therapy and meal information. The combination of all these tools increased (participants) patients' self-efficacy, which resulted in enhanced care-adherence.

Research evidence continues to show a positive trend towards health behavioral change through the use of information technology among patients with chronic diseases (Bauer, de Niet, Timman, & Kordy, 2010; Cole-Lewis & Kershaw, 2010; Cramer, 2004; Fjeldsoe, et al., 2009; Kollmann, Riedl, Kastner, Schreier, & Ludvik, 2007; K.J. Petrie, Perry, Broadbent, & Weinman, 2011; Keith J. Petrie, Perry, Broadbent, & Weinman, 2012). (Fjeldsoe et al, 2009) affirms the potential of SMS via cell phones to improve healthcare. Fjeldsoe (Fjeldsoe et al, 2009) reviewed a number of studies to assess the impact of mobile SMS on health behavior change and concluded that SMS had a positive short-term impact on health behavior outcomes. In particular, researchers found that "tailored messages" were effective in improving adherence among diabetes patients. It is, therefore, reasonable to assume that with increased access to cell phones, their usage has the capacity to effect positive health outcomes among diabetes patients.

Using adolescents as subjects of their research, Franklin (Franklin, et al, 2008) claimed that text messages were successfully utilized to engage diabetes patients. Text messages, a popular term for SMS, are a major communication tool among adolescents, and promises to be a support tool to utilize in managing chronic illnesses such as diabetes. While patients sent limited messages, receiving texts messages was generally perceived as positive, resulting in enhanced self-management of the disease.

Cole et. al. (Cole-Lewis & Kershaw, 2010) reviewed several articles that investigated text messages as a tool for behavior change in disease prevention and management. Their conclusion was consistent with findings in other studies. While this research did not directly investigate diabetes, many of the articles reviewed for this research were diabetes driven. In addition, the study affirms the potential positive impact of text messages in prevention and management of diseases. The research also addressed cost, ease of use, and accessibility. All of these findings reinforce the positive rationale for utilizing text messaging (SMS) as a tool for health behavior change. Another area (Cole-Lewis & Kershaw, 2010) addressed was the role of behavioral theory; according to the article, utilizing theoretical rationale to design and measure text messages has the potential to bring positive health outcomes.

Of recent interest to researchers in healthcare is mobile GIS technology, which extends the capabilities of cell phones and has the potential to improve self-care adherence. Several research studies have acknowledged the potential of location-specific services such as mobile GIS technology in improving delivery of care (Boulos, 2003, 2004a, 2004b; Geanuracos et al., 2007; Schuurman, Hameed, Fiedler, Bell, & Simons, 2008). The need for incorporating GIS technology into the delivery of adherence reminders is evident as more languages become widely used. In the United States, for example, 10.4% of diabetic patients were Hispanics in 2009 (National Diabetes Education Program, 2009) and according to the 2010 Census Bureau report, 37% of Hispanics were not fluent in English (United States Census Bureau, 2010). Healthcare providers and support groups can potentially use GIS technology to send language specific SMS messages relevant to the location of diabetic patients.

Boulos (Boulos, 2004a) describes a geo-aware device for monitoring older patients at an assisted living community. One of the objectives of the geo-aware device was to improve patient safety by detecting and reporting falls, and communicating such information to emergency personnel (Boulos, 2004a). Box (Box, 2009) identifies the utility of GIS in identifying geographical areas with high dispositions to diabetes, hence developing effective programs and allocating resources efficiently; this model can be adopted for this research. Understanding the geographical areas in which the research subjects live will drive the types of information that will be texted. These messages will serve to persuade, encourage and remind research subjects of the value of adherence to care. Similar GIS applications need to be deployed specifically for cell phones to facilitate timely delivery of relevant information, thereby improving self-care adherence among diabetic patients. In this research we propose a customization of mobile GIS applications for self-care management used by diabetic patients. We will particularly evaluate how the alignment of diabetes care information with location specific information – such as diabetes management programs, access to behavioral psychologists to advise patients about problems related to diabetes, insulin pump management programs, etc – affects adherence to self-care.

Even though there are an abundance of studies regarding the impact of cell phones and text messages on care adherence among diabetes patients, none of the studies have resulted in long term gain or provided methods of sustaining the increase in

care adherence (Gomez E.J et al, 2002). At the writing of this paper, no research examines the impact of cell phone text messages and GIS technology combined for self-management of diabetes. The goal of this research therefore would be to build on what has been achieved by suggesting methods for fostering positive health behavior (self management/ care adherence).

## **THEORY BASE FOR RESEARCH**

The theoretical focus of this research is drawn from the social cognitive theory and Information-Motivation-Behavior skills theory (IMB). The research also draws upon the Health Belief Model (HBM).

The social cognitive theory is an off-spring of social learning theory; social cognitive theory espouses “a multifaceted causal structure in which self-efficacy beliefs operate together with goals, outcome expectations, perceived environmental impediments, and facilitators in the regulation of human motivation, behavior, and well-being” (Bandura, 2000). The theory identifies a number of significant factors that are important to health behavior and health outcome; these factors include knowledge of the disease, perceived self-efficacy, perceived facilitators and structural impediment. In this theory the most important element to behavior change is self-efficacy. The notion of self-ability, positive or negative health behavior coupled with health status plays an important role in health outcome. Other drivers of behavior are facilitators and barriers such as access to health care, socio-economic status, health literacy and patient-provider communication (Bandura, 2004). This theory contends that the reduction or elimination of barriers may result in health behavior change. Perceived self-confidence promotes conviction, which in turn reduces the threats posed by barriers to desired behavior (Armitage & Conner, 2000).

Originally developed for the use and prevention of HIV, Information-Motivation-Behavior skills theory (IMB) has since been adapted to promote care adherence (Fisher & Fisher, 1992). The theory’s three components are information, motivation, and behavior; these components are key to behavior change. The information component relates to the cognitive capability (knowledge) about a medical condition, this knowledge would influence behavior change, however the change would not be achieved in isolation. The second component is motivation; it captures the affective domain, which deals with adherence. In addition, it focuses on social acceptance of behavior, personal beliefs and subjective beliefs of how others with the same disease behave. The third component is behavioral skills, which are associated with the psychomotor skills. It is important in assuring that the patient has the needed skills and ability to perform as well as a sense of self-efficacy (Fisher J et al, 2006).

The Health Belief Model (HBM) is closely associated with Social Cognitive Theory (Rosentock, et al, 1988). It is believed that perception plays an important role in an individual health behavior, hence vulnerability to an illness and the potential effectiveness of treatment with respect to deciding whether to seek medical attention can also be attributed to perception (Elder, J et al 1999). The proponents of HBM claim that individual health related action is dependent on 3 major factors (Rosentock, et al, 1988): Concern about a relevant health issue, perception of the health issue as health threat (quality of life), and belief that treatment would mitigate the health threat and that it is affordable.

## **CONCLUSION**

Using information technology to deliver healthcare services and to support patients has been shown to be successful. Several studies have shown that short-term positive behavioral outcomes are associated with the use of SMS. In this paper, we proposed the use of SMS and GIS technology to achieve increased sustainable adherence to self-care and treatment of diabetes. Effectiveness of intervention programs for improving adherence to self-care is dependent on patients’ acceptance of the intervention program/instrument. The study of instruments in this research, cell phones, have been shown to be feasible and highly acceptable for usage in diabetes management (Kollmann, et al., 2007).

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