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Recommended Citation

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Abstract

The goal of this study is aimed at using technology to make information more accessible and encourage positive self-care behavior changes to manage one's diabetes. By combining the theories of diffusion, self-efficacy, goal setting, and technology in healthcare we expect the results of this study will help deepen our understanding about how technology might enhance our ability to positively influence patient behavior.

Keywords

Diabetes self-care management, Self-efficacy, Adoption, Goal setting, Technology

1. Introduction

It is estimated that 23.6 million people in the US have diabetes and another 54 million are in pre-diabetic stage. "In adults, type 2 diabetes accounts for about 90 to 95 percent of all diagnosed cases of diabetes" (NDIC, 2007). A total of 1.6 million new cases of diabetes were diagnosed in people ages 20 years or older in 2007. The estimated diabetes costs in the US in 2007 alone are $174 billion. After adjusting for population age and sex differences, average medical expenditures among people with diagnosed diabetes were 2.3 times higher than what expenditures would be in the absence of diabetes. Indirect costs include expenses such as disability, work loss, and premature mortality, an estimated $58 billion.

While diabetes has such a strong impact in the US in both direct and indirect measures, steps can be taken to help mitigate the impact. People with diabetes can lower the occurrence of serious complications by controlling blood glucose, regulating medication appropriately, eating healthy and exercising regularly. American Diabetic Association in cooperation with care providers, service providers, and other agencies has been promoting education and self-management of diabetic care and monitoring. In spite of this push, diabetic patients are not self-managing as desired (Leeman, 2006; Toobert, 2000). The consequences of inadequate management of diabetes can be severe; such as increased cost of health care, loss of productivity and death.

2. The Research Question

The overarching research question of this study analyzes the use of technology to make information more accessible and encourage positive self-care behaviour changes to manage one's diabetes. Self-care in this study consists of healthy eating, regular exercise, monitoring blood glucose and regulating proper medication intake. Additionally, we aim at offering improved quality of care by increasing the influence of the doctor/patient relationship while making more efficient the resources required to provide quality care. Research has demonstrated that diabetes self-management interventions can effectively improve patients' glycemic control (Leeman, 2006).

3. Background and Theoretical Framework

It has been shown that self-care improves the condition of diabetes patient outcomes (Glasgow, et al., 2001; Leeman, 2006); especially, to prevent problems with diabetes such as damage to the blood vessels of the eye, the kidneys and the nervous system (Bijl, Poelgeest-Eeltink, & Shortridge-Baggett, 1999).

In order for self-care management to be effective, patients need to be aware of what regimen should be executed. They also must adopt the regimen, and sustain the regimen activities on a regular basis. Information enables individuals to evaluate the specific benefits of adopting an innovation (Deffuant, Huet, & Amblard, 2005), which will in turn, support diabetic patients to adopt self-care management. Executed regimen for diabetes self-care on a regular basis includes glucose monitoring, diet, exercise, and medication administration (Bijl, et al., 1999; Toobert, 2000; Weinger, Butler, Welch, & La Greca, 2005). An example question aimed at measuring self-care behavior would be, "On how many of the last seven days did you test your blood sugar?"

Access to information and erudition of knowledge has significant influence on the adoption and diffusion of innovations (Chakrabarti, Feineman, & Fuentevilla, 1983). Specifically, the different sources of information and channels of communication affect the level of diffusion. As the portfolio of information and knowledge are codified in individuals, their self-efficacy levels improve and results in behavioral changes.

The theory of self-efficacy is a social cognitive theory that originated with Bandura (1977). Selfefficacy measures a person's perception of their ability to accomplish a task or achieve a goal. In our conceptual model, we will measure two specific forms of self-efficacy; (1) diabetes self efficacy, and (2) computer self-efficacy. Diabetes self-efficacy (DSE) is the measure of a patient's self-perceived ability to manage their diabetes through diabetes self-

care behaviours (Bijl, et al., 1999). Computer self-efficacy (CSE) refers to an individual's perception of their capabilities to use computers and the Internet to accomplish a task (Compeau & Higgins, 1995; Marakas, Yi, & Johnson, 1998). One example question on the CSE scale would be, "I am very confident in my abilities to use computers."

Diabetes self-efficacy (DSE) is operationalized for patients to manage diabetes. Since self-care management of diabetes is complicated, self-efficacy is important in dealing with diabetes care. Many studies have also shown that self-efficacy positively affected health behavior and improved outcome of diabetes (Bijl, et al., 1999). DSES (diabetes self-efficacy scale) is the tool used in this study to measure patients' self-perceived ability to manage their diabetes through diabetes self-care behaviors. DSES is composed of items, which include four self-care management dimensions: diet, exercise, medication, and blood sugar testing. One example question from the DSES questionnaire is, "How confident do you feel that you can eat your meals every 4 to 5 hours every day, including breakfast every day?"

According to goal setting theory, task performance is positively related to a specific high goal (Locke & Latham, 2007). This study investigates whether technology-supported knowledge about diabetes is mediated through goals so that the technology improves the patients' condition.

DeWalt et. al (2009) found that goal setting intervention along with self-care management guide patients to set and achieve healthy behavior goals. In another study, Estabrook et. al (2005) showed that when participants are given information on health behavior status and an option to set behavior goals for managing Type 2 diabetes, they select personally appropriate goals resulting in significant changes over a six month period.

Influence of technology on patient care and self-management has been of interest in many recent studies. One such study by Solomon (2008) reviewed a number of recent studies that examined use of IT by individuals for self-education and self-monitoring. The review also included a small number of studies exploring applications to enable collaboration of providers and individuals in self-management planning and activities. Changes in patient adherence and levels of knowledge were the most popular outcome variables measured, with reports of significant improvements in both areas. IT can affect patient care in multiple ways. Online sources of information have been widely used and research studies have examined the quality and influence of these sources on medical care. Integrity, credibility, and ease of use have shown to be of value. In the absence of any guided use of these online sources, patients remain confused and often rely on social networks to either use or accept the information. Recent efforts by software firms, healthcare service providers, and research institutions to create unified, validated online resources indicate a new direction in patient care. Success may depend on technology literacy, network externalities, and issues of digital divide.
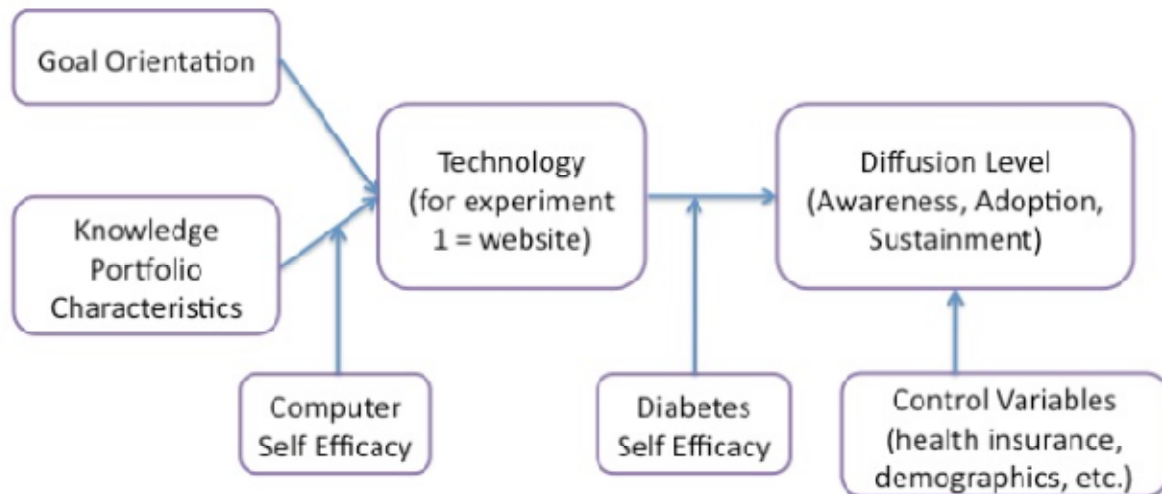In summary, we propose the theoretical framework in figure 1.

Figure 1: Propose theoretical model

In addition, the following are the proposed supporting four hypotheses:

H1. Information technology will mediate the influence of knowledge use on Patient behavioural change processes.
H2. Computer self-efficacy will moderate the relationship between knowledge use and information technology.
H3. Diabetes self-efficacy will moderate the relationship between information technology and patient behavior change processes.
H4. Patients' personal goals will moderate the mediated relationship between knowledge use and patient behavior change processes.

4. Methodology

Researchers at a Midwest university and the diabetes research center at a major hospital in the Midwest teamed up to study what type of technological interventions can be implemented into the traditional care of diabetes patients that would increase diabetes self-care behavior.

The proposed research is one part of a multi-year and multiple-part project. Based on our initial interactions with the research partners and patient observations we propose the following conceptual framework to identify the factors that influence improved diabetes self care. We propose that diabetes self-efficacy and computer self-efficacy mediate the relationship between the information characteristics and diabetes self-care behavior. Diabetes self-care behavior is assessed by focusing on the awareness, adoption and sustainment of the diabetes information which leads to the four elements of diabetes self-care behavior; glucose monitoring, medication administration, diet and exercise (Subramanian & Nilakanta, 1996).

This research looks through the lens of diffusion and application, in order to work towards the goal. We suggest that diabetes self-care behaviors resemble the dimensions of diffusion, namely, awareness, adoption, and sustainment (Subramanian & Nilakanta, 1996). Awareness examines the increase in recognition of diabetes information and self-care behaviors. The second dimension of diffusion, adoption, measures the extent to which patients begin to incorporate positive self-care behavior changes. Finally, sustainment, measures a sustained

level of change in patient behavior. We combined items from Subramanian and Nilakanta with that of Toobert to develop our dependant measures. In addition, we also will collect patient outcomes such as measured blood sugar level, hemoglobin counts and other pertinent health data.

4.1 Experiment One Proposed Experimental Design

Experiment one will focus on the role of technology in diabetes self-care behavior. Participants in this study will be drawn from a sample, which has been selected based on a set of inclusion and exclusion criteria, and will be divided into two groups. Some of the inclusion criteria will include adult patients (18 to 78 years old) with Type II diabetes, who have bee a patient at the research clinic for at least six months, who has Internet access at home and has been on a stable prescription for at least three months. Exclusion criteria will include children, anyone with Type I diabetes, and anyone who has had a hospitalization in the past three months. Both groups will first attend a regularly scheduled doctor's visit. One group will receive a brochure of information relevant to the dependent variables of diabetes self-care behavior. The other group will receive a link to a website with the same information of diabetes self-care behavior. The difference between the two forms of information will be the characteristics of the interaction with the information. For example, the web interaction provides navigation via hyperlinks so that users may follow a path through the information as they choose, whereas, the brochure will provide information in a traditionally structured ontology. During the initial visit with the doctor, patients will receive questionnaires measuring diabetes self-efficacy, computer self-efficacy, and diabetes self-care behavior. Items related to these measures were adapted from prior studies and instruments (Marakas, Johnson, & Clay, 2007). For example the ten-point confidence rating is used to measure computer self-efficacy. Additionally, the data that was collected during the doctor's visit such as the patient's glucose level, medication regime, weight and self-reported exercise regime will be recorded. Currently the clinic meets with patients every three to six months as the standard level of care. For this experiment, the patients in both groups will meet with the doctor again after three to four months time. Web analytics will be implemented to measure the website activity by participants in the technology group. During the second visit with the doctor, the same information (glucose level, medication, weight, exercise) will be collected. At this time measurements of patients computer self-efficacy, diabetes self-efficacy, and diabetes self-care behavior are repeated. These measures are again taken after the six and nine month visits.

5. Data Analysis Methodology

We plan to use a structural equitation modeling to analyze the collected data. Specifically we plan to test the hypothesis that over time patients who establish personally appropriate goals and use on line (technology support) knowledge resources are more likely to maintain consistent behavior change.

6. Expected Contributions

We expect the results of this study will help deepen our understanding about how technology might enhance our ability to influence patient behavior. While our current research focuses on patients at one clinic and a controlled set of knowledge portfolio, expanded studies need to be conducted to generalize our results across a larger population.

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