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Information Systems and Health Care VIII-Using Paper-Based Scenarios to Examine Perceptions of Interactive Health Communication Systems

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USING PAPER-BASED SCENARIOS TO EXAMINE PERCEPTIONS OF INTERACTIVE HEALTH COMMUNICATION SYSTEMS

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ABSTRACT

While information and communication technologies can increase the health care provided to underserved populations, research concerning these technologies often involves only those patients who possess access to technology or who are otherwise willing and able to use it. This issue is important for both researchers and practitioners because non-users' beliefs may not only be different from users' beliefs, they may become more important to understand as access to technology increases. To address this problem:

1. We develop a model of the antecedents to perceived usefulness of an interactive health communication (IHC) system. While our research model combines health-related beliefs with technology perceptions, the antecedents can all be measured before an individual has contact with a particular IHC system. Thus, in the current (and in future) work, they can be used to assess the beliefs of individuals who may not currently be willing or able to use technology.

2. We test this model using paper-based scenarios that depict hypothetical interactions with an IHC system. These paper-based scenarios are more flexible and easier to use than a working system, thus we are able to obtain data from many sources, resulting in a perceptually diverse sample.

Results of our hypothesis testing show that patients with higher knowledge and discipline are less likely than those with less knowledge and/or discipline to find an IHC system useful. In addition we learned several lessons from our research process including how to increase participation rates and what reactions to expect from participants.

Key Words: Disease management, self-management, chronic diseases, IHC systems, usefulness, self-management knowledge, self-management discipline, health beliefs, scenarios, prototypes.

I. INTRODUCTION

An American Medical Informatics Association council met in 2004 to develop a framework for enhancing the health care of underserved populations[1] by using information and communication technologies [Chang et al. 2004]. However, often these information technologies are less accessible to these populations. Research often creates biased community samples that include patients who trust health care providers and those who are willing and able to use technology [Kwon et al. 2004; Chang et al. 2004]. Understanding the attitudes and beliefs of those who are not currently willing or able to use this technology is important. Their needs and beliefs may differ from those who are more willing or able [Moore 1991]. Furthermore, as information technologies such as the Internet become more accessible, some of these individuals may change from being non-users of information technology to users.

We examine this issue in the context of an interactive health communication (IHC) system made for patients[2] with diabetes. IHC systems are patient-centered health care technologies that can be used by patients with chronic diseases such as diabetes and asthma, both to access and transmit medical information, and to receive support and advice. Diabetes was selected as the chronic disease to examine in this study because of its prevalence (over 18 million people in the United States suffer from diabetes: [CDC 2004]), its tremendous costs (the annual direct and indirect health care costs for diabetes are nearly $132 billion: [CDC 2004]), and because treatment of the disease places heavy demands on patients for self-management.

We first develop a model of the antecedents to perceived usefulness of IHC systems that combines health-related beliefs with technology-related beliefs. Perceived usefulness is the degree to which a patient believes that using the technology will enhance his/her self-management and is an important predictor of eventual technology use [e.g., Davis and Venkatesh 2004; Boberg et al. 1995]. While prior research examined patients' perceived usefulness of these systems [Boberg et al. 1995], we provide further insights about the antecedents to these beliefs.

The health-related antecedents we examine include self-management knowledge, discipline, benefits, and barriers. In addition we examine individuals' attitudes toward computers in general. Because individuals form these beliefs and attitudes prior to interacting with a specific IHC system, researchers can assess the antecedents from individuals who currently may not be willing or able to use the technology. In turn, predictions can be made from these antecedents regarding usefulness of the system as perceived by patients with different adoption timelines.

We also address the issue of obtaining more diverse samples by testing the proposed model with data collected using paper-based scenarios. These early prototypes consist of narratives and screen shots that walk the patient through a hypothetical interaction with the IHC system. Such paper-based scenarios are often used during early stages of system development to obtain user feedback that can predict eventual acceptance of working systems [Van Buskirk and Moroney 2003; Van Schaik 1999]. For our purposes these paper-based scenarios allow more flexibility because they are easier to transport than a working system, and they are easier for participants to interact with and understand than a working system. Thus, by using paper-based scenarios we are able to obtain data from a wider sample of patients including patients who are willing and able to use the technology as well as those who are currently not as willing or as able to use the technology.[3]

By developing a model of the antecedents to perceived usefulness and testing the model using paper-based scenarios we provide health care information system researchers and practitioners

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[1] Underserved populations are those who encounter barriers to primary medical care services

[2] For purposes of this study, we use the term "patient" to refer to individuals with a specific medical need that would cause them to use an IHC system.

[3] Our data was collected during 2000. The scenarios we used reflect information, support, and advice, which was relevant at the time and is still relevant today.

viable ways to assess and understand the beliefs of early and later adopters. The results should eventually lead to improved access and care for underserved populations.

The remainder of this paper is organized as follows. In Section II we develop a research model and hypotheses regarding IHC system usefulness. We then present the methodology we used to test the hypotheses, including a description of our use of paper-based scenarios (Section III). Section IV presents the results. A discussion of the findings, limitations, and directions for future research (Section V) completes the paper.

II. BACKGROUND AND HYPOTHESIS DEVELOPMENT

IHC systems are built for academic research and for commercial use.[4] These systems generally provide on-line health provider and/or peer support, informational materials, tracking mechanisms, and goal setting and monitoring tools. IHC systems support patients with chronic diseases such as diabetes [McKay et al. 2001; Feil et al. 2000; McKay et al. 1998], AIDS/HIV and cancer [Gustafson et al. 1999; Pingree et al. 1996; Boberg et al. 1995; Gustafson et al. 1994], and asthma [Myasthma.com 2005; iMetrikus 2003].

Research on IHC systems generally shows that patients perceive these systems positively. For example, research data reports that patients using IHC systems are generally satisfied [Long et al. 2005; McKay et al. 2001], and find the systems useful and easy to use [Boberg et al. 1995], helpful [Piette and Mah 1997] and relevant [McKay et al. 2001]. However, some studies report that certain participants used the systems minimally or did not use them at all [Kwon et al. 2004; McKay et al. 2001; Boberg et al. 1995; Meyerhoff et al. 1994]. Researchers attempted to explain some of these discrepancies by examining how perceptions and use of IHC systems vary by subject demographics such as gender [Pingree et al. 1996; Boberg et al. 1995] and age [Feil et al. 2000; Piette and Mah 1997], and by medical conditions such as years since diagnosis [Feil et al. 2000; Glasgow et al. 1996].

Because IHC system use can improve medical outcomes [McKay et al. 2001; Gustafson et al. 1999; Glasgow et al. 1996], our research tries to:

1. Enhance our understanding of the antecedents to patients' perceptions and use of these systems.
2. Identify antecedents that can predict usefulness, because this belief can influence behavioral intention and use of information systems [e.g. Hu et al. 1999; Venkatesh and Davis 2000; Wilson and Lankton 2004; Boberg 1995].
3. Assess antecedents without patients needing to interact with the system.

The antecedents we examine are (Figure 1):

- self-management discipline
- self-management knowledge
- self-management benefits
- self-management barriers
- general computer attitudes

The hypotheses regarding these antecedents are discussed in the following subsections.

[4] For comprehensive reviews see [Balas et al. 1997; Lehman and Deutsch 1995; Lewis 1999].

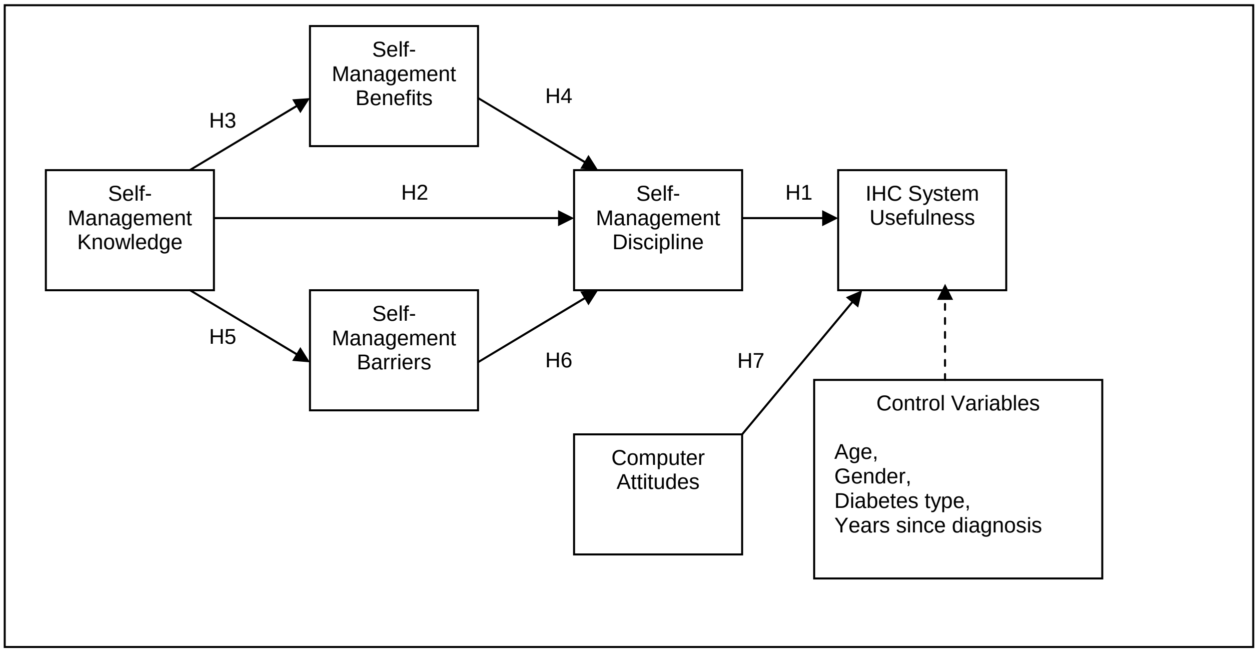

Figure 1. Research Model

SELF-MANAGEMENT DISCIPLINE

The responsibilities of patients with chronic diseases include taking medications, making lifestyle changes, and undertaking preventive actions. The performance of these behaviors is called self-management [Newman et al. 2004]. Self-management can account for the majority of care in many chronic diseases. For example, more than 95% of the care for diabetes consists of self-management behaviors [Funnell and Anderson 2000]. More advanced self-management care models involve patients setting goals for their own self- management behaviors [Funnell and Anderson 2000]. Patients then use internal motivation to accomplish needed changes in behavior to meet these goals [Bodenheimer et al. 2002].

Given this background, we examine one form of internal motivation: discipline. We predict that patients' discipline or their ability to make themselves perform self-management behaviors will influence their perceptions of an IHC system. Meyerhoff et al. [1994] find that patients who are better at performing their self-management activities more fully use an IHC system's capabilities.

> *Hypothesis 1: Individuals with more discipline in performing self-management behaviors will find an IHC system more useful than individuals with less discipline.*

SELF-MANAGEMENT KNOWLEDGE

In chronic diseases, the two main types of knowledge are:

1. disease knowledge that consists of having a sufficient understanding of the disease, and

2. self-management knowledge that consist of understanding how to manage the disease in terms of problem-solving and coping skills [Newman et al. 2004; Holman 2004].

In this study, we examine self-management knowledge, which is known to improve patients' abilities significantly in performing, or becoming more disciplined at self-management behaviors in chronic diseases such as diabetes, arthritis, and asthma [Newman et al. 2004; Norris et al. 2001].

Hypothesis 2: Individuals with more self-management knowledge will have more discipline performing self-management behaviors than individuals with less self-management knowledge.

HEALTH BELIEFS

The health belief model [Becker 1974; Janz and Becker 1984; Rosenstock 1974] is used widely in health care to investigate the probability that individuals will take recommended health actions such as disease prevention and self-management. The health belief model predicts that actions depend not only on the perceived threat of the disease (i.e. the probability of getting the disease and its seriousness), but also on the perceived benefits and barriers of taking the action. In terms of chronic diseases, perceived benefits are beliefs that a behavior will result in successful treatment of the disease whereas perceived barriers are the impediments to or negative aspects of taking the action.

Health beliefs are thought to be a potential link between knowledge and ability to make lifestyle changes. Greater knowledge can result in perceptions of more benefits or fewer barriers, which can result in more discipline [Becker and Janz 1985; Quackenbush et al. 1996]. Empirical research finds that more benefits and fewer barriers lead to better performance of health behaviors relating to chronic disease [Harris et al. 1982; Mirotznik et al. 1998; Montgomery et al. 1989; Wdowik et al. 2001].

Hypothesis 3: Individuals with more self-management knowledge will perceive greater self-management benefits.

Hypothesis 4: Individuals with greater perceived self-management benefits will have greater self-management discipline.

Hypothesis 5: Individuals with more self-management knowledge will perceive less self-management barriers.

Hypothesis 6 Individuals with greater perceived self-management barriers will have less self-management discipline.

GENERAL COMPUTER ATTITUDES

Computer attitudes are a person's positive or negative feelings (evaluative affect) about computers in general [Davis et al. 1989]. This construct is derived from Rubin [1981 and 1984], who theorizes that affinity or feelings can influence media choice. Empirical researchers found general computer attitudes are significantly correlated with perceptions and use of specific computer systems in many contexts including health care [Ammenwerth et al. 2003; Brown and Coney 1994; Cork et al. 1998; Fann et al. 1988-89]. Thus we believe that computer attitudes play an important role in predicting IHC system usefulness.

Hypothesis 7: Individuals with more positive attitudes towards computers perceive an IHC system more useful than individuals with less positive attitudes.

CONTROL VARIABLES

Prior research (Section II) finds that certain medical and demographic factors can contribute to the perceptions and use of an IHC system. Therefore, we add several control variables to our research model including age, gender, diabetes type, and years since diagnosis.

III. METHODOLOGY

PAPER-BASED SCENARIOS

Use of paper-based scenarios[5] in this study allowed us to test our research model with a wider sample than could be accomplished using a working IHC system. Paper-based scenarios are early prototypes that are used in systems analysis and design to obtain functionality specifications and perceptions from potential users [Carroll 1992; Carroll and Rosson 1992; Van Buskirk and Moroney 2003]. Specifically, scenarios are task-based expressions of human-machine interactions and can include textual descriptions, screen layouts (either drawn on paper or created using a computer application), and graphical stories [Van Schaik 1999; Van Buskirk and Moroney 2003]. Carroll [1992] proposes that scenarios should include both situations and consequences of use. In terms of an IHC system, a scenario might depict the information a patient should track, when they would enter the information, and what advice or support the system would then provide.

Advantages to using paper-based scenarios are:

- they are easy for users to relate to because of their simplicity,
- they include a shorter preparation time that allows quick evaluation of competing designs,
- they allow for easy changes based on user feedback, and
- they can have modular components that can easily be rearranged [Van Buskirk and Moroney 2003; Van Schaik 1999].

While some [e.g., Norman 2005] suggest that involving too many users in the design process can lead to ineffective systems, research results show that scenarios can help guide basic functionality and can help explain beliefs, attitudes, and intentions towards use [e.g., Van Buskirk and Moroney 2003; Van Schaik 1999].

We use paper-based scenarios to gain a better understanding of individual perceptions of an IHC system.

PARTICIPANTS

Participants were people with either Type 1 (juvenile onset) or Type 2 (adult onset) diabetes who take insulin, diabetes oral medication, or both. Because we used paper-based scenarios, we were able to recruit participants from a variety of sources including support groups, senior/adult centers, community events, health-related Internet bulletin boards, and a physician's office. All sources (with the exception of the Internet) were located in Arizona. Diabetes support groups are open to the public and run by people who are either professionally or personally interested in diabetes. The groups typically meet once a month and feature speakers on diabetes-related topics. The senior/adult centers are for older adults and are typically run by the city in which they are located. Most of the centers serve lunch and provide programs and activities such as bingo, cards, and movies. We also recruited participants at three community events. The first was a diabetes health fair featuring numerous diabetes supply vendors who provided health screenings and demonstrations about diabetes self-care. The other two community events were diabetes walk-a-thons featuring vendors and an after-the-walk barbeque. Participants were also recruited at a physician's office and from postings made on diabetes- related Internet bulletin boards.

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[5] A scenario is a postulated sequence of possible events. The standard criteria for a scenario is that it is (1) possible (it could happen), plausible (is considered reasonable by the person to whom it is told) and (3) internally consistent (contains no internal contradictions). Multiple scenarios can be used with the same situation to reflect alternative futures. For a detailed discussion of scenarios, see Helmer [1983].

In total, 436 surveys were distributed and 352 surveys were collected for a response rate of 81%. The difference between distributed and collected surveys arose mainly from survey packets that were given to participants to complete at a later time. Of the surveys collected, 279 were usable and are included in the analysis. Surveys were considered unusable if the patient was not using insulin or a diabetes oral medication, or if the patient did not complete all the survey items. Thirty-six percent of the surveys were obtained from diabetes support groups, 25% from senior/adult centers, 24% from community events, and the remaining 15% from the physician's office and Internet bulletin boards. Of the 279 respondents whose questionnaires were used, 44% were male. Fourteen percent suffered Type 1 diabetes. Age ranged from under 45 (12%) to 75 or over (26%), and years since diagnosis ranged from under one year (11%) to 20 years or more (21%). In all cases, individual participation in the study was voluntary.

VARIABLES AND PROCEDURE

We used three instruments for this research including two questionnaires and a packet containing the paper-based scenarios.[6]

First Questionnaire. We first administered a questionnaire measuring participants' perceived self-management benefits, barriers, knowledge, and discipline, and the control variables. The perceived benefits and barriers measures were taken from Given et al. [1983] and modified slightly to clarify meaning and to produce an adequate number of items for each construct. The result was 15 items for measuring the perceived self-management benefits of following a diet, taking medication, and exercising, and 18 items for measuring the perceived self-management barriers of these same three activities. The questionnaire is shown in Appendix I). Because these constructs are considered formative (a high value on one item does not necessarily mean a high value on another item), we averaged the item values for the analysis.

The first questionnaire also assessed the subjects' perceptions of their self-management knowledge and discipline, and their computer attitudes. While self-management knowledge and discipline are sometimes measured objectively, due to time and resource constraints we measured them subjectively. We measured knowledge using the item "How much do you know about what you can do to control your diabetes", we measured discipline using the item "How disciplined are you with respect to following your diabetes care plan", and we measured computer attitudes using the item "How much do you like computers?" The researchers created these three items, and participants responded to them using 5-point Likert scales. Questions for each of the control variables were also included on this questionnaire.

Paper Based Scenarios. After participants completed the first questionnaire, we gave them a packet containing the paper-based scenarios consisting of computer screens with narratives (an example is provided in Appendix II). Users were told to imagine they were seeing these screens on a computer. We were interested in providing participants with a generic system interface that contained some of the features found on typical IHC systems such as information tracking and advice on what to do next (i.e., disease management support). Narratives accompanied each screen explaining when and why a user would see that particular screen (e.g., after login or after data input). Thus the screens contained definitions, descriptions, general guidelines for a specific self-management behavior and, where appropriate, one or more actions to take regarding the behavior. The participants were told that the action suggested would vary depending on what they input into the system and would be personalized for their situation. The information content of the computer screen shots was taken mainly from the web site of the American Diabetes Association [www.diabetes.org/ada], although to avoid any possible bias this was not disclosed to participants.

[6] We pre-tested all three of the instruments before administering them. Ten doctoral students reviewed the two questionnaires, while three physicians reviewed the scenario packet. As a result of these reviews, several minor changes were made to the instruments.

Second Questionnaire. We asked participants to review the packet. When they finished this task we gave them the second questionnaire, which was designed to capture information about their perceived usefulness of the IHC system for performance of self-management behaviors (Appendix I). We developed 11 new items for this scale, because much of the previous research about perceived usefulness refers to the usefulness of technologies for work-related activities. The items we created are consistent with the conceptual definition of perceived usefulness that refers to the degree to which a system enhances performance of a task [Davis et al. 1989]. These items exhibited high reliability (.98), and convergent validity (they loaded on one factor at .89 or greater).

Completing both questionnaires and reviewing the scenario packet generally took about 15-20 minutes. However, we gave participants as long as needed to perform these tasks. To accommodate participants when English was not their native language, the three instruments were translated to Spanish, incorporating regional differences in language for the local metropolitan area. Fifteen out of the 279 participants[7] (5%) completed the Spanish version of the surveys. Due to logistics and/or time constraints, seventy-one of the participants (25%) were given all or part of the instruments to complete at a later time. To rule out the procedure as a reason for our results, we included this item as a control variable in the initial data analysis.

IV. RESULTS

Table 1 presents means, standard deviations, ranges, and correlations for the research variables. The responses for most of the research variables ranged from the lowest to highest point on the scale. Thus, it appears that we were able to capture a wide range of perceptions. Despite this

Table 1. Variable Means, Standard Deviations, Ranges, and Correlations

	Mean		Correlations				
Variables	**(Std Dev)**	**Range**	(1)	(2)	(3)	(4)	(5)
(1) Usefulness	4.79 (2.00)	1.00 – 7.00	1.00				
(2) Self-Management Benefits	4.29 (.55)	1.43 – 5.00	.13*	1.00			
(3) Self-Management Barriers	2.36 (.71)	1.00 – 5.00	.05	.23**	1.00		
(4) Self-Management Knowledge	3.65 (1.23)	1.00 – 5.00	-.11	.24**	-.26**	1.00	
(5) Self-Management Discipline	3.43 (1.11)	1.00 – 5.00	-.13*	.26**	-.42**	.45**	1.00
(6) Computer Attitudes	2.84 (1.51)	1.00 – 5.00	.22*	.02	-.05	.26**	.18**

* Correlation is significant at the .05 level.
** Correlation is significant at the .01 level.

variation, the mean perceived usefulness for all participants was 4.79 out of 7.00, which we interpret to imply that, in general, participants agreed that the computer system as represented by the paper-based scenarios was useful. The means for self-management benefits and self-management barriers were 4.29 and 2.36 (out of 5.00) respectively, indicating that participants strongly agreed that there are benefits and somewhat disagreed that there are barriers to self-management. The means for self-management knowledge and self-management discipline were 3.65 and 3.43 (out of 5.00) respectively, indicating that the participants felt they had somewhat above average self-management knowledge and discipline. Finally, participants' average attitude toward computers was neutral as the mean score was 2.84 (out of 5.00).

We used structural equation modeling (using PLS Graph) to analyze the data and to test the hypotheses formally (Figure 1). This technique allowed us to test both the measurement model

[7] We use the term participants here to refer to people whose questionnaires were used.

(links among items and constructs)[8] and the structural model (paths among theoretical constructs). The control variables were also included in the analysis to see if they changed the significance of the hypothesized variables and if they resulted in any effect on perceived usefulness over and above the hypothesized relationships. Adding the control variables did not change the significance of the hypothesized variables, and none of the control variables were significant. Thus, our analysis excludes these variables. Finally, to test for mediation we examined direct effects of the independent variables on perceived usefulness that were not hypothesized. We found that the relationships between benefits and usefulness, and knowledge and usefulness were significant and thus we include these in the discussion of our results.

Standardized beta coefficients, t-statistics, and explained variances for the research model are shown in Figure 2. While the relationship between self-management discipline and usefulness is significant (*B* = -.15, p < .05), contrary to hypothesis 1 it is negative. In support of hypothesis 2, self-management knowledge is significantly positively related with self-management discipline (*B* = .35, p < .001). Knowledge is significantly positive related with benefits (*B* = .24, p < .001), and benefits is significantly positively related with discipline (*B* = .11, p < .05). Thus, hypotheses 3 and 4 are supported.

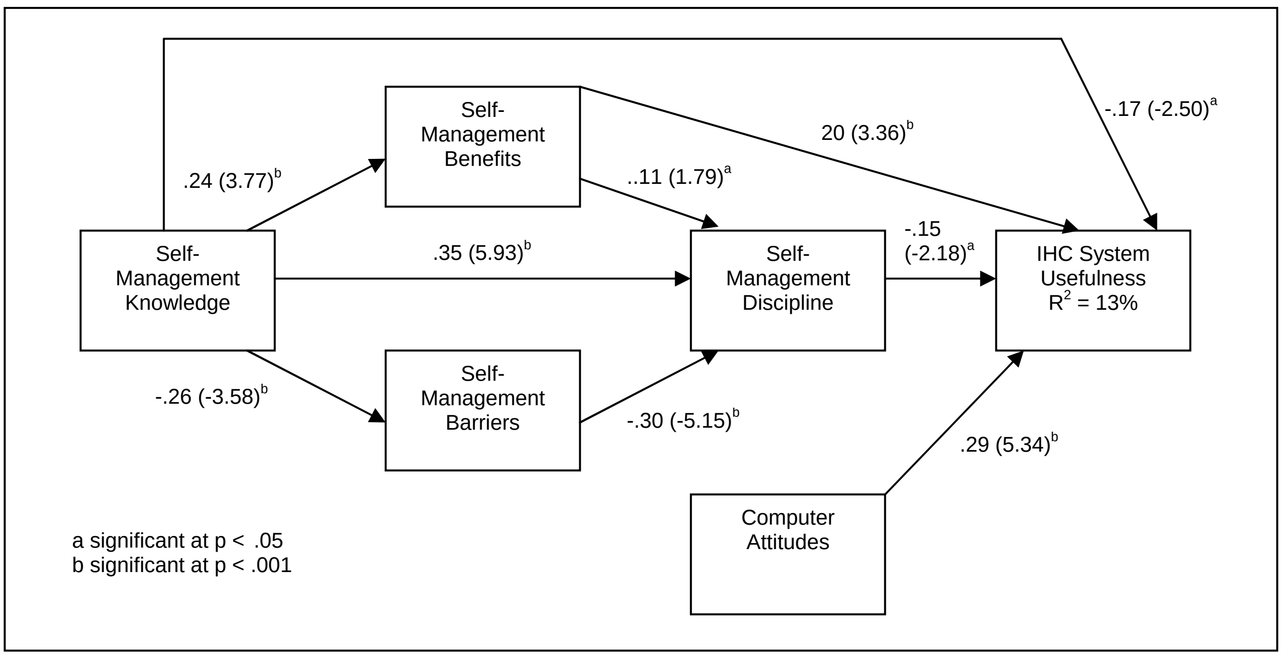

Figure 2. Research Model with Standardized Betas, t-statistics, and Explained Variance

Furthermore, knowledge is significantly negatively related with barriers (*B* = -.26, p < .001), and barriers is significantly negatively related with discipline (*B* = -.30, p < .001), supporting both hypothesis 5 and hypothesis 6. Finally, the relationship between computer attitudes and usefulness is significant and positive (*B* = .29, p < .001), thus supporting hypothesis 7.

While not hypothesized, the direct relationship between self-management benefits and usefulness is significant and positive (*B* = .20, p < .001) showing that participants with higher benefit scores found the system more useful than participants with lower benefits. In addition, the

[8] Our measurement model consisted of the links for the 11 perceived usefulness items. As mentioned in section IV, the items loaded at .89 or greater, which is well above the .70 minimum acceptable level [Fornell and Larcker 1981].

direct relationship between self-management knowledge and usefulness is significant and negative (*B* = -.17, $p < .05$) showing that participants with higher knowledge scores found the system less useful than participants with lower knowledge.

V. FINDINGS, LIMITATIONS, AND FUTURE RESEARCH

In this study we developed a model of antecedents to IHC system usefulness, and tested this model using data from a large number of patients with diabetes. Four of the five antecedents we examined exhibited significant direct effects on perceived usefulness. Each of these antecedents can be assessed without the patient interacting with a specific IHC system Thus these factors can be used to assess perceptions from patients who are currently unwilling or unable to use an IHC system.

We infer from the range of responses that our use of paper-based scenarios depicting typical interactions with the system enabled us to collect data from more patients than would have been possible with a working system. For example, patients with low computer attitudes or low self-management benefits may not have been willing to participate in a study using computers to help manage their disease, however they were willing to examine paper-based materials. These patients might be willing or able to use a computer system to self-manage their disease in the future, and thus understanding their perceptions is important.

In this section we first discuss the results of our hypotheses tests followed by a discussion of the lessons learned from our research process. We conclude with limitations and directions for future research.

RESEARCH MODEL

After examining the paper-based scenarios, participants on average indicated that they would find such a system useful. Because prior studies showed that an individual's perceived usefulness of a system creates a positive influence on both behavioral intention to use and actual use of a system, this finding implies that participants would tend to use such a system. In addition, our study supports previous findings from health care research that self-management knowledge significantly influences self-management benefits, barriers, and discipline.

In our study, computer attitudes had the largest influence on perceived usefulness. This finding is consistent with previous research that attitudes towards computers in general transfer to beliefs about a particular system. Because of our methodology, we were able to obtain data from patients with a wide range of computer attitudes. Thirty eight percent of participants responded below the midpoint of the scale meaning they did not like computers very much, and 35% responded above the midpoint, implying they did like computers. These results imply that our participants may be more representative of people with diabetes than those in typical studies.

Perhaps the most surprising finding in our study was that self-management discipline is significantly negatively related to perceived usefulness of IHC systems. Thus, participants who perceived they were not as self-disciplined as they would like in performing self-management found the system more useful than those who perceived they were. This finding contradicts prior research that found subjects who performed more self-management activities were more likely to use an IHC system. This finding may indicate that participants felt the system would be helpful in improving their discipline, just as consumers buy exercise equipment thinking it will improve their exercise discipline. In addition, this finding may indicate we did not ask participants about any specific type of self-management behavior and, thus, when responding to the question, they focused on one or more behaviors that were most relevant to them at the time. This behavior may not have been addressed by our IHC system prototype, causing the negative relationship found between discipline and usefulness.

The negative relationship between discipline and usefulness may also be explained by examining the negative relationship between knowledge and perceived usefulness. A supplemental analysis shows the mean perceived usefulness of participants with high knowledge and high discipline was 4.33 (n = 91), as compared to 5.01 (n = 188) for participants with low scores in perceived knowledge and/or discipline. These means vary significantly ($F_{278} = 7.28$, $p < 0.01$). Thus, people with high self-management knowledge and high self-management discipline actually find the system less useful than people who are deficient in one or both of the areas. These results are consistent with the results from research concerning decision aids, which show that people with more confidence (e.g., knowledge and ability) tend to use decision aids less [Arkes et al. 1986; Boatsman et al. 1997; Whitecotton 1996]. The results are also consistent with suggestions that patients may not use a system if there is nothing to gain from it in terms of knowledge and/or discipline [Meyerhoff et al. 1994].

Our study also finds the direct influence of perceived self-management benefits on perceived usefulness is positive, showing that people with higher perceived self-management benefits perceive the system to be more useful than people with lower perceived self-management benefits. Because benefits are the second most influential factor in determining usefulness, education or training programs regarding IHC systems should emphasize the benefits of self-management activities. For individuals with lower perceived self-management benefits, Quackenbush et al. [1996] showed that for chronic diseases these beliefs can be positively changed, promoting motivation for behavior change. Our study suggests that changing these beliefs will also increase an individual's perceptions of IHC system usefulness.

LESSONS LEARNED

Because our paper-based scenarios were easy to transport, we were able to attend different community events and meetings to obtain volunteers. As we administered the instruments at these places, we learned some lessons that may be both relevant and valuable for future research in this area. We present some of the more important "lessons learned" in the following sections.

Participation

During our research we learned several lessons about participation.[9] To motivate patients to participate we created a personal incentive by telling patients their participation would benefit themselves as well as others by increasing knowledge about IHC systems with the ultimate goal of improving health care and quality of life. We found most patients were well motivated to participate with this incentive. However, we also discovered other factors that may have increased participation rates. For example, participation was greater when the study was announced or advertised in advance than when it was not. We also found participation to be lowest when we recruited at the physician's office. This may be because patients at the physicians office did not perceive their responses would remain anonymous, or because they were asked to complete the study at the end of their appointment when they were anxious to leave, or because this was a private setting rather than a public one as in the support groups and meetings. In summary, factors such as overcoming time pressures and anonymity issues may have helped increase participation beyond that obtained through personal incentives.

Paper-Based Scenarios

Several advantages to using paper-based scenarios emerged that we did not expect include:

1. Because the paper-based scenarios were fairly easy and quick for the patients to examine, plenty of time became available to talk with the patients after the questionnaire. This conversation produced some unexpected yet rich qualitative data. If we knew about this opportunity in advance, we would have created a structured interview format to specifically address each of the hypotheses, and possibly tried to record the discussions.

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[9] We refer to participation here as those patients volunteering to fill out the surveys and review the materials.

2. Because we were focusing on eliciting beliefs about the usefulness of the prototype, we were not expecting as many comments involving the design of the prototype itself, even though this information was an important reason for using prototypes. For example, one participant asked why the interface did not monitor stress levels as this can increase blood sugar levels. Ideas about design features such as this one could form the basis for future research.

3. Virtually all participants we met face-to-face went on to complete the survey. However, we do not believe that our being present while participants completed the surveys biased the results.

4. Some of the participants were so excited about the proposed technology depicted in the scenarios that they volunteered on the spot to help with other aspects of the project. While the use of scenarios may not have been the sole reason for these responses, research results in system development show that users who participate more in the development process and who communicate in depth with the developer are more likely to be satisfied with the system [McKeen et al. 1994].

Medical Advice

Because the aim of this study was to collect data on perceptions about the IHC system and not to dispense medical advice, we made sure to incorporate several disclaimers. First, we put a disclaimer on the scenario packet that read: "The materials in this packet are examples only. They are not meant to be used by you for your health care. Please consult your health care provider for questions and concerns about your health care." In addition, when introducing ourselves we made sure to disclose that we were not medical professionals. Despite these actions, some individuals still tried to solicit our advice on medical matters. In these cases we politely suggested that they discuss the matter with their health care provider.

LIMITATIONS AND FUTURE RESEARCH

In this subsection we acknowledge several limitations inherent in the sample, the paper-based scenarios, and the research model. We discuss these limitations along with ways to address them in future research.

Our study only examines perceptions as they relate to an IHC system for one chronic disease, and thus our results may not be generalizable over other chronic diseases. However because the basis for our IHC system is providing support for self-management and because many chronic diseases involve extensive self-management, we believe our results are robust over these diseases. To verify this future research should test our research model with participants who suffer from other chronic diseases such as asthma or heart disease.

In addition, the particular paper-based scenarios we used may have influenced our results. For example, our scenarios had a considerable amount of informational material, and thus it is possible that participants with higher levels of knowledge and discipline found them less useful for this reason. However, the scenarios also included a significant amount of tracking mechanisms and support and thus it is not clear what part(s) of the system these individuals found more or less useful. Future research could explore this issue further by using different IHC system prototypes for users with differing levels of knowledge and discipline, or by examining individual perceptions of knowledge and discipline over time as they interact with a system. In addition, developers should ensure that IHC systems are dynamic in nature, responding to varying levels of self-management knowledge and discipline. However, because we did not measure actual self-management knowledge and discipline, there is a chance that participants in this study with high perceived knowledge and discipline are actually not as effective in carrying out their self-management activities, which could have negative implications in disease management. For patients with diabetes, inaccurate or wrong decisions could present life-threatening consequences. Future research could investigate objective and subjective measures of knowledge and discipline.

Our results indicate possible IHC system features beyond those we explored may increase patients' perceived usefulness. For example, the finding that more than a third of participants do not like computers, along with researchers' findings that many factors including computer experience, knowledge, skills, ownership, and anxiety are significantly associated with computer attitudes [Ammenwerth et al. 2003; Brown et al. 1994; Cork et al. 1998], imply that it may be possible to incorporate mechanisms that increase these factors within an IHC system, thus increasing participants' favorable computer attitudes. Participant comments in our study suggest that ownership and anxiety may be the most influential factors for increasing attitudes. For example, one participant complained that he has limited access to a computer, and another participant claimed he had heard that computers could give wrong answers. These factors should be explored in future research.

There are also limitations regarding our research model. For example, there may be other antecedents of perceived usefulness including social influence, computer playfulness, and innovativeness. Future research should consider these factors in developing an expanded research model to explain IHC system use and perceptions.

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REFERENCES

EDITOR'S NOTE: The following reference list contains the address of World Wide Web pages. Readers who have the ability to access the Web directly from their computer or are reading the paper on the Web, can gain direct access to these references. Readers are warned, however, that

1. these links existed as of the date of publication but are not guaranteed to be working thereafter.

2. the contents of Web pages may change over time. Where version information is provided in the References, different versions may not contain the information or the conclusions referenced.

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American Diabetes Association (1999). *Diabetes Information*, 1996 - 1998. http://www.diabetes. org/ada/. Accessed Dec 19, 1999.

Ammenwerth, E., Mansmann, U., Iller, C., and Eichstadter, R. (2003) "Factors Affecting and Affected by User Acceptance of Computer-Based Nursing Documentation: Results of a Two-year Study," *JAMIA* (10), pp. 69-84.

Arkes, H., Dawes, R., and Christensen, C.(1986) "Factors Influencing the Use of a Decision Rule in a Probabilistic Task," *Organizational Performance and Human Performance* (37), pp. 93-110.

Balas, E. A., Jeffrey, F., Kuperman, G. J. , Boren, S. A. , Brown, G. D. , Pinciroli. F., et al. (1997) "Electronic Communication with Patients: Evaluation of Distance Medicine Technology," *JAMA* (278), pp. 152-159.

Becker, M. (1974) "The Health Belief Model and Personal Health Behavior," *Health Education Monographs* (2), pp. 324-508.

Becker, M., and Janz, N. (1985) "The Health Belief Model Applied to Understanding Diabetes Regimen Compliance," *The Diabetes Educator* (11), pp. 41-47.

Boatsman, J., Moeckel, C., and Pei, B. (1997) "The Effects of Decision Consequences on Auditors' Reliance on Decision Aids in Audit Planning," *Organizational Behavior and Human Decision Processes* (71), pp. 211-247.

Boberg, E. W., Gustafson, D. H., Hawkins, R. P., et al. (1995) "Development, Acceptance, and Use Patterns of a Computer-based Education and Social Support System for People Living with AIDS/HIV Infection," *Computers in Human Behavior* (11), pp. 289-311.

Bodenheimer, T., Lorig, K., Holman, H., and Grumbach, K. (2002) "Patient Self-Management of Chronic Disease in Primary Care," *JAMA* (288), pp. 2469-2475.

Brown, S. H., and Coney, R. D. (1994) "Changes in Physicians' Computer Anxiety and Attitudes Related to Clinical Information System Use," *JAMIA* (1), pp. 381-394.

Carroll, J. M. (1992) *Making Use a Design Representation,*Internal Report RC 19287 (79613), IBM Research Division, Yorktown Heights, NY: T. J. Watson Research Center,.

Carroll, J. M., and Rosson, M. B. (1992) "Getting Around the Task-Artifact Cycle: How to Make Claims and Design by Scenario," *ACM Transactions on Information System*s (10)2, pp. 181-212.

CDC: Centers for Disease Control and Prevention (2004). *The Burden of Chronic Diseases and Their Risk Factors: National and State Perspectives*. http://www.cdc.gov/nccdphp/burdenbook2004. Accessed Mar 20, 2005.

Chang, B. L., Bakken, S., Brown, S. S., et al. (2004)"Bridging the Digital Divide: Reaching Vulnerable Populations," *JAMIA* (11), pp. 448-457.

Cork, R. D., Detmer, W. M., and Friedman, C. P. (1998) "Development and Initial Validation of an Instrument to Measure Physicians' Use of, Knowledge about, and Attitudes toward Computers," *JAMIA* (5), pp. 164-176.

Davis, F., Bagozzi, R., and Warshaw, P. (1998) "User Acceptance of Computer Technology: A Comparison of Two Theoretical Models," *Management Science* (35), pp. 982-1003.

Davis, F. D., and Venkatesh, V. (2004) "Toward Prototype User Acceptance Testing of New Information Systems: Implications for Software Project Management," *IEEE Transactions on Engineering Management* (51), pp. 31-46.

Fann, G., Lynch, D., Murranka, P.(1988-89(=) "Integrating Technology: Attitudes as a Determinant of the Use of Microcomputers," *Journal of Educational Technology Systems* (17), pp. 307-317.

Feil, E. G., Glasgow, R. E., Boles, S., and McKay, H. G. (2000) "Who Participates in Internet-Based Self-Management Programs? A Study among Novice Computer Users in a Primary Care Setting," *The Diabetes Educator* (26), pp. 806-11.

Fornell, C., and Larcker, D. F. (1981) "Evaluating Structural Equations with Unobservable Variables and Measurement Error," J*ournal of Marketing Research* (18) pp. 39-50.

Funnell, M. M, and Anderson, R. M. (2000) "The Problem with Compliance in Diabetes," *JAMA* (284), p. 1709.

Given, C., Given, B., Gallin, R., and Condon, J. (1983) "Development of Scales to Measure Beliefs of Diabetic Patients," *Research in Nursing and Health* (6), , pp. 127-141.

Glasgow, R. E., Toobert, D. J., and Hampson, S. E. (1996) "Effects of a Brief Office-Based Intervention to Facilitate Diabetes Dietary Self-Management," *Diabetes Care* (19), pp. 835-842.

Gustafson, D. H. , Hawkins, R. P., Boberg, et al. (1994) "The Use and Impact of a Computer-based Support System for People Living with AIDS and HIV Infection," *JAMIA, Symposium Supplement, SCAMC Proceedings*, 1994, pp. 604-608.

Gustafson, D. H., Hawkins, R., Boberg, E., (1999) et al. "Impact of a Patient-Centered, Computer-based Health Information/Support System," *American Journal of Preventive Medicine* (16), pp. 1-9.

Harris, R., Skyler, J. S., Linn, M. W., et al. (1982) "Relationship between the Health Belief Model and Compliance as a Basis for Intervention in Diabetes Mellitus," *Pediatric Adolescent Endocrinology* (10) pp. 123-32.

Helmer, O. (1983) *Looking Forward: A Guide to Futures Research* London: Sage Publications.

Holman, H. (2004) "Chronic Disease: The Need for a New Clinical Education," *JAMA* (292), pp. 1057-1059.

Hu, P. J., Chau, P. Y. K., Sheng, et al. (1999) "Examining the Technology Acceptance Model Using Physician Acceptance of Telemedicine Technology," *Journal of Management Information Systems* (16), pp. 91-112.

iMetrikus (2003) http://www.imetrikus.com. Accessed Oct 10, 2003.

Janz, N., and Becker, M. (1984) "The Health Belief Model: A Decade Later," *Health Education Quarterly* (11), pp. 1-47.

Kwon, H., Sho, J., Kim, H., Song, B., et al. (2004) "Establishment of Blood Glucose Monitoring System using the Internet," *Diabetes Care* (27), pp. 478-83.

Lehmann, E. D., and Deutsch, T. (1995) "Applications of Computers in Diabetes Care: A Review II, Computers for Decision Support and Education," *Medical Informatics* (20), pp. 303-329.

Lewis, D. (1999) "Computer-Based Approaches to Patient Education," *JAMIA* (6), pp. 272-282.

Long, A. F., Gambling, T., Young, R. J., et al., (2005) "Acceptability and Satisfaction with a Telecarer Approach to the Management of Type 2 Diabetes," *Diabetes Care* (28), pp. 283-289.

Meyerhoff, C., Bischof, F., and Pfeiffer, E. F. (1994) "Long term Experiences with a Computerized Diabetes Management and Glucose Monitoring System in Insulin-Dependent Diabetic Patients," *Diabetes Research and Clinical Practice* (24), pp. 1-7.

McKay, H. G., Feil, E. G., Glasgow, R. E., and Brown, J. E. (1998) "Feasibility and Use of an Internet Support Service for Diabetes Self-management," *The Diabetes Educator* (24), pp. 174-179.

McKay, H. G., King, D., Eakin, E. G., et al. (2001) "The Diabetes Network Internet-based Physical Activity Intervention," *Diabetes Care* (24), 2001, pp. 1328-1334.

McKeen J. D., Guimaraes, , T., and Wetherbe, C.(1994) "The Relationship between User Participation and User Satisfaction," *MIS Quarterly* (18)4, pp. 427-451.

Mirotznik, J., Ginzler, E., Zagon, G., and Baptiste, A. (1998) "Using the Health Belief Model to Explain Clinic Appointment-Keeping for the Management of a Chronic Disease," *Journal of Community Health* (23), pp. 195-210.

Montgomery, S. B., Joseph, J. G., Becker, M. H., et al. (1989) "The Health Belief Model in Understanding Compliance with Preventive Recommendations for AIDS: How Useful?" *AIDS Education and Prevention* (1), 1989, pp. 303-323.

Moore, G. A. (1991) *Crossing the Chasm*, New York: Harper Business.

Myasthma.com.(2005) http://www.myasthma.com. Accessed Mar 20, 2005.

Newman, S., Steed, L., and Mulligan, K. (2004) "Self-Management Interventions for Chronic Illness," *The Lancet* (364), pp. 1523-1537.

Norman, D. A. (2005) "Human-Centered Design Considered Harmful," *Interactions* (12)4, July, pp. 14-19.

Norris, S. L., Engelgau, M. M., and Naravan, K. M., (2001) "Effectiveness of Self-Management Training in Type 2 Diabetes: A Systematic Review of Randomized Controlled Trials," *Diabetes Care* (24), pp. 561-587.

Piette, J. D., and Mah, C. A. (1997) "The Feasibility of Automated Voice Messaging as an Adjunct to Diabetes Outpatient Care," *Diabetes Care* (20), pp. 15-21.

Pingree, S., Hawkins, R. P., Gustafson, D. H., et al. (1996) "Will the Disadvantaged Ride the Information Highway? Hopeful Answers from a Computer-based Health Crisis System," *Journal of Broadcasting & Electronic Media* (40) pp. 331-353.

Quackenbush, P. A., Brown, S. A., and Duchin, S. P.(1996) "The Influence of Demographic and Treatment Variables on the Health Beliefs of Adults with Diabetes," *The Diabetes Educator* (22), pp. 231-236.

Rosenstock, I. (1997) "Historical Origins of the Health Belief Model," in Becker, M. (ed). *The Health Belief Model and Personal Health Behavior,* New Jersey: Charles B. Slack Inc, pp. 1-8.

Rubin, A. M. "An Examination of Television Viewing Motivations," (1981) *Communication Research* (8)2, April, pp. 141-165.

Rubin, A. M. (1984) "Ritualization and Instrumental Television Viewing," *Journal of Communication* (34)3, Summer, pp. 67-78.

Van Buskirk, R., and Moroney, B. W. (2003) "Extending Prototyping," *IBM Systems Journal* (42)4, pp., 613-623.

Van Schaik, P. (1999) "Involving Users in the Specification of Functionality Using Scenarios and Model-Based Evaluation," *Behaviour & Information Technology* (18)6, pp. 455-466.

Venkatesh, V., and Davis, F. D. (2000) "A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies," *Management Science* (46), pp. 186-204.

Wilson, E. V., and Lankton, N. K. (2004) "Modeling Patients' Acceptance of Provider-Delivered e-Health," *JAMIA* (11), pp. 241-248.

Wdowik, M. J., Kendall, P. A., Harris, M. A., and Auld, G. (2001) "Expanded Health Belief Model Predicts Diabetes Self-Management in College Students," *Journal of Nutrition Education* (33), pp. 17-23.

Whitecotton, S. (1986) "The Effects of Experience and Confidence in Decision Aid Reliance: A Causal Model," *Behavioral Research in Accounting* (8), pp. 194-216.

APPENDIX I. ITEMS MEASURED IN THE QUESTIONNAIRES

QUESTIONNAIRE ONE

Self-Management Benefits – *(Measured on a5-point Likert scale from 1 = Strongly Disagree to 5 = Strongly Agree)*

1. Following my diabetes diet helps minimize complications related to my diabetes.
2. I am committed to following my diabetes diet.
3. Following my diabetes diet improves my physical health.
4. Following my diabetes diet helps control my diabetes.
5. In general, there are benefits to following my diabetes diet.
6. I am committed to taking my diabetes medication as prescribed.
7. Taking my diabetes medication as prescribed helps minimize complications related to my diabetes.
8. Taking my diabetes medication as prescribed helps control my diabetes.
9. Taking my diabetes medication improves my physical health.
10. In general, there are benefits to taking my diabetes medication as prescribed.
11. Exercising regularly improves my physical health.
12. I am committed to exercising regularly.
13. Exercising regularly helps control my diabetes.
14. Exercising regularly will help minimize complications related to my diabetes.
15. In general, there are benefits to exercising regularly.

Self-Management Barriers – *(Measured on a5-point Likert scale from 1 = Strongly Disagree to 5 = Strongly Agree)*

1. Following my diabetes diet interferes with my normal daily activities.
2. I have to change too many habits to follow my diabetes diet.

3. I have difficulty following my diabetes diet.
4. I do not have time to follow my diabetes diet.
5. My personal life interferes with following my diabetes diet.
6. There are barriers to following my diabetes diet that I cannot overcome.
7. The instructions the doctor has given me for taking my medication are confusing.
8. I do not have the time to take my diabetes medication as prescribed.
9. It requires a lot of effort to take my diabetes medication as prescribed.
10. I have to change too many habits to take my diabetes medication as prescribed.
11. Taking my diabetes medication as prescribed interferes with my normal daily activities.
12. There are barriers to taking my diabetes medication that I cannot overcome.
13. I do not have time to exercise regularly.
14. I exercise only if someone exercises with me.
15. I have to change too many habits to exercise regularly.
16. Exercising regularly interferes with my normal daily activities.
17. It takes a lot of effort to exercise regularly.
18. There are barriers to exercising regularly that I cannot overcome.

QUESTUONNAIRE TWO

Perceived Usefulness – *(Measured on a 7-point Likert scale from 1 = Strongly Disagree to 7 = Strongly Agree)*

1. Using this computer system would make it more likely that I would perform my self-care activities (by reminding me to make and keep my appointments, etc.).
2. Using this computer system would make it easier for me to stay on schedule with my self-care activities (such as testing my blood sugar when I am supposed to).
3. Using this computer system would help me perform my self-care activities more correctly (such as knowing what to do before exercising).
4. Using this computer system would make it easier for me to perform my self-care activities (by keeping me from running out of needed supplies, etc.).
5. Using this computer system would help me perform my self-care activities at the appropriate times (such as exercising regularly).
6. Using this computer system would make it easier for me to perform my self-care activities the way I am supposed to perform them (such as eating the right amounts and kinds of food).
7. Using this computer system would help me remember to perform my self-care activities (like testing my blood sugar).
8. Using this computer system would increase the timeliness with which I perform my self-care activities (such as when to treat low blood sugar).
9. Using this computer system would improve the way I perform my self-care activities (such as how to adjust my medication and how to avoid low blood sugar).
10. Using this computer system would allow me to accomplish more of my health objectives (such as losing weight, reducing my HbA1c, and improving my circulation).
11. Overall, I believe this computer system would be useful to me.

APPENDIX II. NARRATIVES AND SCREENS

John's treatment plan involves testing his blood sugar level in the morning before breakfast. John has done this and is entering the result of the test into the computer via the screen shown below. Because John's blood sugar level is high, a screen called "High Blood Sugar" appears (see next page). This screen indicates that one of the reasons that John's blood sugar level might be high is that he did not exercise as planned last night. The screen also gives John the appropriate action to take for treating high blood sugar.

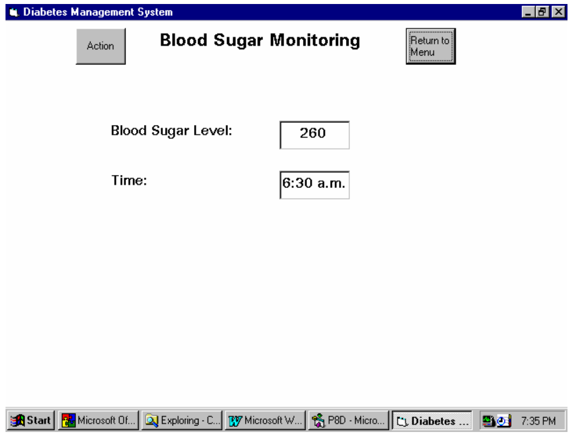

Figure A-1. Blood Sugar Monitoring Screen

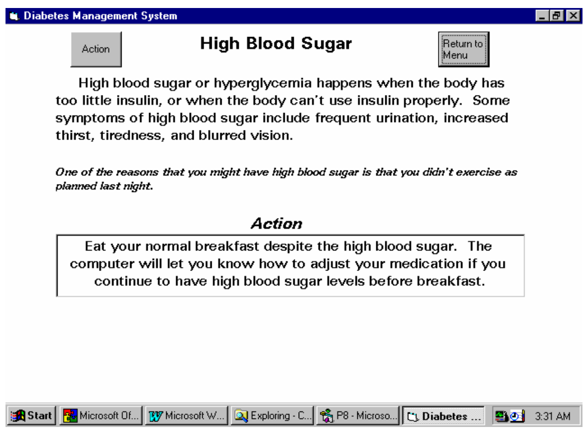

Figure A-2 Blood Sugar Information Screen

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