The impact of ICT in health promotion : a randomized experiment with diabetic patients

Balsa, Ana I.
Universidad de Montevideo

Gandelman, Néstor
Universidad ORT Uruguay

Febrero de 2011

*

Abstract

We conducted a randomized experiment to study the effects of an Internet-based intervention on type II diabetes patients in Montevideo, Uruguay. The intervention consisted of a specially designed website and an electronic social network where participants were able to navigate freely, download materials, and interact with other diabetics and with specialists. We found no significant impact on knowledge, behavior, or health outcome of participants. We also found that only a minority of patients logged on to the website and most were only reached by email and mobile text (SMS). Participation in the website is correlated with patients' characteristics, such as gender, marital status, and education.

Keywords: randomized experiments, ICT, diabetes

Documento de Investigación, Nro. 63, febrero 2011. Universidad ORT Uruguay.
Facultad de Administración y Ciencias Sociales. ISSN 1688-6275

---

*We wish to acknowledge the key role played by the Evimed team (Alvaro Margolis, Elisa Martinez, Thais Forster, Graciela Vitarella, Susana Maggiolo, Laura Llambí, Natalia Miranda, and Antonio Lopez) in the design and implementation of the intervention evaluated in this paper. We thank Diego Lamé and Eugenia Rivas for their valuable research assistance in this project and Giorgina Piani for her help in the survey design. Funding for this project was provided by the IDB Research Department. The content of this paper is the sole responsibility of its authors and does not represent in any way the opinions of the IDB or the universities with which the authors are affiliated.

1. Introduction

The World Health Organization defines e-health as the combined use of electronic information and communication technology (ICT) in the health sector. According to a systematic review of evaluations of e-health implementations by Blaya et al. (2010), the greatest potential for e-health may lie in systems that improve communication between health care institutions, support medication ordering and management, and help monitor and improve patient compliance with care regimens. Evaluations of personal digital assistants and mobile devices may also indicate the level of effectiveness in improving data collection time and quality. Despite this potential, there is a severe need for more rigorous evaluation of the effectiveness and cost-effectiveness of these systems in less-developed countries (Blaya et al., 2010; Kahn et al., 2010).

In this study, we use a randomized controlled trial to evaluate the impact of an Internet and SMS-based information intervention on the health promotion and disease management of diabetic patients treated in health care centers in Montevideo, Uruguay. Patients with type 2 diabetes require constant follow-up from the head physician and significant support to achieve self-control. Also, diabetes is one of the most expensive diseases for the health care system. A recent study in the United States (Dall et al., 2010) shows that the average annual cost per case is $2,864 for undiagnosed diabetes, $9,975 for diagnosed diabetes ($9,677 for type 2 and $14,856 for type 1), and $443 for pre-diabetes (medical costs only). This amounts to approximately $700 annually for every American, regardless of diabetes status. The prevalence of diabetes in Uruguay is 8.2 percent (90 percent of these have type 2 diabetes).[1]

An Internet-based intervention can empower diabetic patients by providing them with information and supportive tools that can help them improve their health-related decision making and ultimately increase their quality of life and wellbeing. Better disease management by the patient can also result in lower health care costs. These expected effects on health care utilization, together with the relative low cost and massive scope of Internet-based programs, suggests that e-health interventions have the potential for substantial cost effectiveness. Nevertheless, we did not find significant impact of the internet and SMS intervention in knowledge, behavior or health outcomes. We found that effective participation in the web platform is in itself a challenge and we also found that participation is correlated with patients' characteristics like gender, marital status and education.

2. Background and Significance

The widespread use of the Internet and mobile phones is currently challenging the way patients are educated, supported, and followed up. A number of U.S. surveys show that between 40 and 50 percent of American adults use the Internet to look for advice or information about health or health care (Diaz et al., 2002; Baker et al., 2003; Dickerson et al., 2004; Fox, 2007). Through the Internet, patients can access wide-ranging, up-to-date information about their disease, available medical treatments, costs, and preventive health practices on a 24/7 basis. Interactivity and anonymity provide patients with new

---

[1] http://diabetologia.org.uy/templates/gega_diabetologia/documentos/prevalencia.htm
http://www.presidencia.gub.uy/_web/noticias/2008/04/2008040310.htm

communication options, the potential for accessing information tailored to their needs, and new sources of support (Anderson and Klemm, 2008; Cline and Haynes, 2001). The information and support available through the Internet make it a promising cost-effective vehicle for empowering patients by improving their control over their health conditions and promoting better decision-making.

There are still a number of pitfalls associated with the use of the Internet as a health education, management, and supportive tool. The quality of the information on the Internet is not uniform and is often inaccurate, which increases the vulnerability of the patient (Eysenbach et al., 2002). Patients face security and privacy issues (Hong et al., 2008). And access is usually unequal. In the United States, whites, more educated patients, and individuals of higher socioeconomic status are more likely than others to access the Internet for health information reasons (Dickerson et al., 2004; Diaz et al., 2002). Age can also be a source of disparity when it comes to successfully accessing relevant health information (Ybarra and Suman, 2008).

While there is some skepticism about the value of the Internet for patients' health-related decisions (Baker et al., 2003), the literature shows very few reported cases of harm associated with the use of poor quality health information on the Internet (Crocco et al., 2002). On the other hand, a growing number of studies are showing positive effects of Internet-based interactive and informative tools on health, health-related decision-making, and wellbeing, although most of them occur in developed countries. In a survey of patients with chronic conditions and disabilities (Fox, 2007), three out of four patients who used the Internet (e-patients) reported that their online searches had positively affected treatment decisions, their ability to cope with their condition, and their dieting and fitness regimes.

Kalichman et al (2003) found an association between using the Internet for health-related information and health benefits among people living with HIV/AIDS. Fogel et al. (2002) found that Internet use for breast health issues was associated with greater social support and less loneliness than Internet use for other purposes or non-use among breast cancer patients. Broom (2005) investigated how access to information and online support affected prostate cancer patients' experiences of disease and their relationships with their physicians. They found that online access had a profound effect on men's experience of prostate cancer, helping them gain control over their disease and limiting inhibitions in face-to-face encounters with the physician. Gustafson et al. (1999) used a randomized controlled trial to analyze the effects of a computerized system that provided HIV-positive patients with information, decision support, and networking tools. They found that the system improved their quality of life and promoted a more efficient use of health care by these patients.

Several e-health interventions have been associated with the management of diabetes. Harno et at. (2006) conducted an evaluation of an e-health application with a diabetes management system and a home care link. They found significantly lower levels of HbA1c, blood pressure, cholesterol and fasting plasma glucose in the study group relative to the control individuals, and a lower number of visits by the study patients to doctors and nurses. Meigs et al. (2003) tested the effects of the Disease Management Application (DMA), a web-based decision support tool for diabetics developed to improve evidence-based management of type 2 diabetes. Patients in the intervention group increased the number of HbA1c tests, cholesterol tests, and foot examinations within a year. They also experienced stronger decreases in levels of HbA1c and cholesterol than patients in the control group. McKay et al. (2001) evaluated the short-term benefits of an Internet-based supplement to usual care that focused on providing support for sedentary patients with type 2 diabetes to increase their physical activity levels. The study showed no difference in physical activity between patients that were randomized to the Diabetes Network (D-Net) Active Lives Physical Activity Intervention and patients assigned to an Internet Information-only condition.

One recurring problem with Internet-based interventions has been patient participation over time. Fell et al. (2000) found that younger diabetic patients showed increased interest in interactive Internet interventions, but older patients increased participation only when barriers to access were addressed. Glasgow et al. (2003) evaluated participation and effects of the “Diabetes Network (D-Net)” Internet-based self-management project, a randomized trial evaluating the incremental effects of adding tailored self-management training or peer support components to a basic Internet-based, information-focused comparison intervention. The study encountered a strong decrease in participation over time. Additions of tailored self-management and peer support components generally did not significantly improve results.

The use of the Internet by patients is also challenging the basis of the patient-physician relationship. There are studies suggesting that some physicians may react negatively to the demands of patients that use the Internet as a source of information and education (Broom, 2005). Research shows that the majority of the patients that use the Internet for health information do not discuss this information with their doctors (Diaz et al., 2002). And those who take information sought on the web to the physician want the physician's opinion, rather than a specific intervention (Murray et al., 2003). In Murray's study, the effect of taking information to the physician on the physician-patient relationship was likely to be positive as long as the physician had adequate communication skills and did not appear challenged by the patient bringing in information.

While research on e-health interventions is growing exponentially in developed countries, less is known about the impacts of similar programs in less developed nations. A number of experiences using mobile phone technology are showing great promise in some Latin American countries. In Chile, a nurse-based telephone-care service linked with key clinical events and outpatient visits resulted in improved glycemic levels, blood pressure, and perception of health, and healthier eating. Another public health disease management program in Nicaragua based on SMS contributed to increased compliance of patients taking TB drugs (Anta, El Wahab, and Giuffrida, 2010). Blaya et al. (2010) and Kahn et al. (2010) highlight the need for more rigorous evaluations of the effectiveness and cost-effectiveness of e-health interventions in less developed countries.

While e-health interventions are still relatively scarce in Uruguay, the country has shown a positive trend in the adoption of ICTs in recent years. In a 2008 ranking of 20 Latin American countries comparing the penetration rates of Internet, broadband Internet, personal computers (PCs), wireless subscribers, and fixed telephone lines, Uruguay was rated Latin America’s top technology country (Latin Business Chronicle, 2008). According to data from the International Telecommunications Union, Uruguay's mobile penetration exceeded 100 percent in 2008, Internet penetration was 40 percent and broadband penetration 9 percent in the same year. A study conducted in 2006 found significant socioeconomic and age-related inequities in access to ICTs. The gap in PC use between the poorest and richest income quintiles was only 2 among adolescents, but increased to 20 when assessing the population age 50 and over (Pittaluga y Sienra, 2007). This generational gap is of particular concern when considering that many e-health interventions aim at reaching middle-aged or older individuals.

3. Methodology

3.1 Design Overview

A randomized design was employed to evaluate the effects at six months following randomization of diabetic patients in primary care practices to an Internet-based education and networking intervention versus the distribution of a brief educational brochure. The aim of the study was to analyze the effectiveness and cost-effectiveness of the ICT intervention in terms of achieving higher overall patient wellbeing (self-reported and quality-of-life-adjusted years), treatment compliance, use of health care, patient's sense of control of the disease, information about the disease and its treatment, a better patient-physician relationship, and technology related skills. The study design was submitted for review by an ethics committee at the University ORT Uruguay.

3. 2 Recruitment and Participants

Our target population was defined as adult patients suffering from type 2 diabetes that had Internet access at home (i.e. had a PC and Internet connection at home) or reported navigating the Internet at least once a week, and were currently being treated in one of three HMOs in Montevideo. Pregnant women, patients taking insulin, patients under dialysis treatment, or patients with other complications (such as severe eye disease, cancer, or celiac disease) were excluded from the study. Patients that had participated as leaders in diabetes education groups were also excluded from the study.

To recruit the participants, we contacted patients in the waiting rooms of internists treating diabetic patients or endocrinologists at three HMOs in Montevideo: a large HMO with 236,085 enrollees, and two smaller HMOs, one with 46,612 enrollees and the other with 43,427 enrollees.[2] Interviewers were assigned to the waiting rooms at different times of the day between April and July 2009. After ensuring that they qualified for the study, patients were asked to sign an informed consent form that described the study and the implications of their participation.

At baseline, most patients were interviewed while waiting for their appointment or right after the appointment. The survey consisted of two questionnaires. The first questionnaire was administered by the interviewer and inquired about socio-demographics, perceived health status, morbidity, severity of diabetes, diabetes-related care, disease management and compliance with treatment, health care utilization in general, and knowledge about diabetes. A second self-administered questionnaire inquired about depression, the patient-physician relationship, the patient’s sense of empowerment regarding the disease, use of alcohol and other substances, physical activity, and diet. All participants were given a brochure developed by experts in diabetes, which explained the fundamental aspects of type 2 diabetes treatment.

Subjects completing the baseline interview were randomly assigned to the control group and the intervention group. We ended up with a sample of 388 individuals that qualified for the study. Patients were randomized to the e-health intervention or a no-intervention setting. Our final sample consisted of 195 individuals in the intervention group and 193 in the control group.

---

[2] Data from the October 2008 Health Census

A follow-up interview was conducted six months after the initiation of the distance phase of the intervention, between January 26 and May 6, 2010. This second survey consisted of a subset of questions that had already been asked in the first questionnaire and that reflected attitudes or behaviors that could potentially be affected by the intervention, and a small set of new questions referring to some of the topics covered in the e-health intervention. The surveys were completely administered by the interviewer, and the time and place of the interview was coordinated beforehand between the interviewer and the participant. We were able to complete 280 interviews in this way. Participants refusing to participate in the face-to-face interview (due to lack of time, lack of interest, or unwillingness to let a stranger come into their homes or fear of a scam), were offered the option of answering the survey over the phone. Sixty additional surveys were completed using this modality. Final sample attrition was 48 observations (12 percent of the original sample): 3 patients died between the baseline and the follow-up survey, 4 could not be located, and 41 refused to participate at follow-up.

The inclusion and exclusion restrictions that defined the study made recruitment difficult. Even though the survey took place in the diabetes departments of the above-mentioned HMOs, many individuals did not qualify for the project. By eliminating type 1 diabetics, we cut out the younger segment of the diabetic population. The remaining population had a greater chance of suffering any of the medical conditions that would exclude them from the project (except pregnancy). Furthermore, only 17 percent of

Uruguayans over 50 use the Internet at least sporadically, according to a recent survey.[3] A great majority of those contacted in the waiting rooms were over 50 years old.

3.3 The Intervention

Before the *online* phase, patients in the intervention group were invited to participate in a short workshop that instructed them on how to search information on the Internet, and on the use of social network platforms (wikis, chat, forums). An expert in search and documentation coordinated each of these workshops, which lasted around two hours. The workshops included an organized set of practical activities using a PC (one participant per PC) and took into account the knowledge of participants regarding their "computer skills". The workshops took place at the facilities of the Universidad ORT=-09Uruguay between July 20 and July 30, 2009.

Out of the 195 participants in the intervention group, only 57 agreed to attend the workshop. The main reasons for the decision not to attend were: current illnesses, difficulty to travel due to lack of mobility, lack of available time to participate, lack of interest in the subject, and particularly the risks of the Influenza A virus at the time (the workshops took place in winter).

Eight workshops were originally scheduled, with an average of 20 participants each expected to attend. The first 10 minutes of the workshop were used for introductions and a brief presentation of the topics to be discussed in the session; in the next 30 minutes, the documentation specialist in charge of the workshops gave a tutorial of how to perform good and efficient searches on the Internet. After that, the participants were given 20-30 minutes

---

[3] *"El perfil del internauta Uruguayo" 2008* – Grupo Radar

to search the Internet with personalized assistance from the workshop coordinators. The remaining 50-60 minutes were devoted to introducing the diabetes platform created by EviMed[4] specifically for this project, with special attention to the forum, chat and wiki, which the participants were less familiar with.

After the workshop, the instructions for logging on to the website were mailed and e-mailed to every participant whether they participated in the workshop or not. A week later, everyone received a phone call to check if they had received the information and to offer assistance with logging on. The intervention was active through January 2010.

The intervention consisted of the dissemination through the Internet of information and materials related to type 2 diabetes. The information and materials for the patients were published on a website (DIABETES 2.0) specially designed for this study and updated weekly. The intervention group had unlimited access to the site and could download all of the available materials at no charge. Materials included articles or brief presentations, videos and images, schedules, news, and links to other related websites. In addition, patients in this group received periodic reminders about new topics through email and SMS.

The messages and educational materials were developed and chosen by specialists and edited by EviMed's interdisciplinary team (documentation specialist, internist, and communicators) using sources such as Medline Plus, eviDoctor, and others.

Besides providing access to information, one of the main advantages of the Internet in empowering individuals is its anonymity. The Internet allows individuals to ask

---

[4] EviMed is a private firm that develops information and educational products and services for physicians throughout Latin America. http://www.evimed.net/

questions they may be ashamed to ask in face-to-face encounters. For instance, sexual dysfunction may be associated with the evolution of diabetes. The anonymity of the Internet also allows patients to share their personal experiences and learn from each other. The intervention group had access to a social network through the site, aimed at facilitating the exchange of personal experiences, questions, and knowledge between patients that share the same condition. The network was facilitated through an electronic platform, where patients could meet in forums, chats, and wikis to discuss ideas or ask about the materials or other aspects of their life as chronic patients. An example of a forum topic is "What physical workout do we usually do?" and a wiki topic is "Healthy recipes with spinach." An "animator" (non-medical) organized and stimulated network participation. Periodically, a physician specializing in diabetes participated in the network by commenting on the patients' comments, clarifying points, and answering some questions.

3.4 Program Evaluation

The evaluation of the effects of ICT programs is challenged by selection problems. Individuals that decide to participate in the program are in general subtly different from those that do not participate. These differences (e.g., motivation, laziness) may have an impact on the evolution of the disease, the satisfaction of the patient with treatment, and other dimensions of disease management. The randomized controlled trial framework minimizes this endogeneity problem but does not completely eliminate it. In this scenario, there is still one concern that needs to be addressed: non-participation. Although each individual invited to participate in the intervention could have benefitted from the workshop and the online phase of the study, some of them chose not to participate. This non-participation may be associated with individual or contextual characteristics that may also affect the variables under study.

In order to avoid this situation, it is important to implement the treatment with an “intention to treat” variable, defined as all those that were invited to participate in the intervention whether they took part in it or not. Once the exogeneity of the treatment is established, the identification of the causal effects of ICT technologies follows from simple econometric techniques. Given a certain indicator that we would like to measure, *Y*, the effect of the intervention is given by a difference-in-difference procedure.

We implement the difference-in-difference framework (Card, 1992; Gruber, 1994) by pooling observations in both surveys and estimating a regression of the form:

$$Y_i = \beta_0 + \beta_1 ITT_i + \beta_2 Wave_{2i} + \beta_3 ITT_i * Wave_{2i} + \varepsilon_i$$

where ITT_i and $Wave_{2i}$ are dummies. Y_i is the variable under study, ITT_i represents the "intention to treat" group and takes the value 1 if the *i*th patient was invited to participate in the internet based intervention and 0 otherwise. $Wave_{2i}$ takes the value of 1 when the answer refers to the second survey. The coefficient multiplying ITT_i (β_1) reflects baseline differences between the intention to treat and control groups. The coefficient of $Wave_{2i}$ (β_2) reflects time trends in outcomes that are common to the intervention and control groups. The effect of the intervention is captured by the interaction term. When the dependent variable is discrete this same approach can be used in a probit or ordered probit regression.

4. Results

4.1 Participation in the Diabetes 2.0 Intervention

According to the information automatically collected by the website Diabetes 2.0, 77 participants (39 percent of the *ITT*) logged on at least once during the experiment. Among this subgroup, 34 participants (44 percent) logged on one day, 12 (16 percent) did so two days and the remaining 40 percent did so three days or more. On average, those who logged on did so 4.5 times. Forty-seven participants (24 percent of the *ITT*) engaged in a variety of activities, such as forums, chats, wikis, or online surveys.

There is some discrepancy between the participation records stemming from the web logs and levels of participation as reported by the participants in the second survey. Of the original 195 *ITT* participants, 162 took the second survey and answered the question: “How often did you enter the Diabetes 2.0 website?” Twenty-four participants (15 percent of respondents to the second survey) who had logged on at least once according to automatic registers did not remember having visited the site when asked about their participation in the follow-up survey. And 22 participants (14 percent) who did not log on according to our records reported having visited Diabetes 2.0. Some of the participants who attended the workshop were provided with a username and password during the workshop and had a chance to navigate the Diabetes 2.0 website that same day. Other participants that also attended the workshops were sent an email with the username and password later on. To avoid biases, we did not take into consideration that first login during the workshop as evidence of participation in the program. This may partially explain the difference between our records and self-reports of participation. Another reason for the discrepancies between web registers and self reports may be the lack of experience in the use of the Internet among some of the participants, which may have led to confusion regarding whether they actually entered the website or not.

In the second survey, we asked all participants who reported never logging on the reasons for not doing so. Participants were offered several alternatives and could select as many choices as they wanted. Eight percent declared that they did not log on because they were not interested in the topic, 12 percent reported that they preferred using other channels of information on diabetes, 54 percent reported that they were not frequent Internet users, and 14 percent claimed to already have all the diabetes-related information they needed.

Although more than half of the participants never visited Diabetes 2.0, most members in the "intention to treat" group were reached by the experiment via e-mail messages and/or SMS messages. Around 65 percent of participants reported having received text messages related to the project, and 57 percent reported having received e-mails from the project staff. Overall, 75 percent of the participants reported having received text messages or emails from the staff (again, some participants may have gotten e-mails or text messages but did not remember or simply considered it as spam). Combining this information with the web registers, only 30 participants never logged on to Diabetes 2.0 or do not recall receiving emails or text messages. However, the data indicate that 132 participants were reached by the project's information and communication technologies in one way or another.

In order to investigate the possible determinants of participation in the web based intervention, we estimated a probit model, with a dichotomous indicator of participation in the Diabetes 2.0 website (according to electronic records) as the dependent variable. The explanatory variables were gender, age, marital status, any children in the household, education, employment status, self reported health status, time elapsed since the patient was first diagnosed with diabetes, self-reported knowledge about diabetes, Internet access at home, previous use of an e-mail account, previous use of the Internet for health related information, and participant's HMO.

The first column in Table 1 shows the marginal effects of the participation regression for a selected set of explanatory variables. Women were 18 percentage points more likely to enter the Diabetes 2.0 website than men. Having Internet at home was not significantly related to participation in the website. One of the exclusion restrictions for recruitment into this study was that participants should have Internet access at home or access to the Internet at least once a week. The non-significance of the Internet dummy reflects that there are no differences between those that have Internet at home and those that browse the Internet from somewhere else. Having a previous e-mail account was not a significant determinant of the participation decision. Having previously searched for health-related topics on the Internet, on the other hand, increased the likelihood of participation by 24 percentage points. This suggests that the source of access to the Internet and the frequency of use are not sufficient conditions for participation in these types of programs. Those who did participate in the program were inherently more interested in using the Internet as a source of health-related information.

Although age was not a significant determinant of the participation decision, living with a partner was positively associated with navigating the diabetes website. In addition to encouraging the diabetic patient to take better care of him or herself, a partner might provide helpful insights to the infrequent Internet user. On the other hand, participation was negatively associated with the presence of children at home. Time constraints associated with taking care of children or the fact that kids monopolize the use of computers at home could explain this result. Finally, education was also significantly related to participation. Being a high school or a college graduate increased the likelihood of entering the Diabetes 2.0 website by 17 and 29 percentage points respectively relative to individuals with less than a high school education.

In a second regression (second column of Table 1), we added an indicator for workshop participation to the set of controls. Participation in the workshop was positively associated with use of the Diabetes 2.0 website. While this effect could capture some unobservable characteristics of the patient, such as motivation, none of the previously significant variables lost statistical significance or changed magnitude significantly when accounting for this factor. This suggests that participation in a workshop could enhance participation in these types of programs.

Table 1. Determinants of Participation in the Website Diabetes 2.0
Marginal Effects of Probit Regression

	Includes workshop participation	Doesn't include workshop participation
Male	-0.18	-0.18
	(0.079)**	(0.080)**
Reports good health	0.03	0.04
	(0.078)	(0.079)
Diabetes diagnosed five years ago or less	0.10	0.09
	(0.085)	(0.086)
Reports high knowledge about diabetes	-0.07	-0.05
	(0.149)	(0.151)
Has Internet access at home	0.06	0.05
	(0.098)	(0.100)
Has an email account	0.08	0.05
	(0.094)	(0.098)
Searched health related information on the Internet in the last 6 months	0.24	0.27
	(0.092)**	(0.089)***
Age 55-65	0.03	-0.02
	(0.108)	(0.108)
Age 65-70	0.10	0.09
	(0.129)	(0.135)
Age 70+	0.15	0.15
	(0.131)	(0.133)
Lives with a couple	0.23	0.20
	(0.081)***	(0.084)**
Lives with sons/daughters	-0.17	-0.13
	(0.077)**	(0.078)*
Interviewed in CASMU	-0.29	-0.27
	(0.177)	(0.182)
Completed high school or equivalent	0.17	0.18
	(0.096)*	(0.098)*
Completed college or equivalent	0.29	0.31
	(0.126)**	(0.127)**
Employed	-0.06	-0.04
	(0.093)	(0.095)
Participated in the workshop		0.21
		(0.082)***
Observations	195	195

Standard errors in parentheses. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent

4.2 Evaluation of the Impact of Diabetes 2.0

The aim of the Diabetes 2.0 intervention was to improve diabetic patients' control over their health and promote better decision-making by providing patients with relevant up-to-date information as well as social support. First, we expected the intervention to improve patients' knowledge and beliefs about their disease and its management. Empowered by this information, patients might change their health-related behaviors and make more effective health care decisions. Health outcomes could improve as a result. Following this knowledge-behavior-outcomes paradigm, we proceed to evaluate the results in each of these three steps.

4.2.1 Impact on Knowledge

In the baseline and follow up survey, patients were asked several questions about what they knew or thought they knew about diabetes. Table 2 reports patients' perceptions of their knowledge in many relevant dimensions, including medical questions (need for medication), most common complications (eyes and feet problems and long run effects of diabetes), and consumption habits (alcohol, smoking) among others. In all cases but one, the majority of patients considered their knowledge level to be good. The effect of being sick (e.g., having the flu) on their diabetes was the only dimension where the majority of patients considered that they lacked adequate knowledge. On the other hand, more than a quarter of respondents considered they had insufficient knowledge about the impact of cholesterol, alcohol, and smoking on diabetes and what happens when their blood sugar level is too low.

Table 2. How much do you know about…?
Baseline Survey

	Nothing	A little	Enough	A lot	All	Cases
1...the effect of being sick (e.g. flu) on diabetes?	36%	16%	42%	6%	100%	340
2...maintaining an appropriate weight?	6%	7%	55%	32%	100%	340
3…what happens when the level of glucose in blood is too low?	12%	14%	53%	21%	100%	339
4…why medication is needed in treating diabetes?	8%	12%	53%	28%	100%	339
5…the long-term impact of diabetes in health?	7%	9%	53%	31%	100%	338
6…the impact of cholesterol on diabetes?	20%	14%	45%	20%	100%	339
7…eye care and control?	14%	9%	50%	27%	100%	340
8…foot care and control?	6%	9%	53%	32%	100%	339
9…the impact of alcohol on diabetes?	16%	10%	50%	24%	100%	340
10…the impact of smoking on diabetes?	16%	9%	49%	26%	100%	340
11…the impact of stress on diabetes?	13%	10%	50%	27%	100%	340
12…the impact of fatigue on diabetes?	16%	11%	49%	24%	100%	339
13…diet plans to control diabetes?	5%	5%	54%	36%	100%	340

In Table 3 we report the results of implementing the difference-in-difference framework in an ordered probit regression. The dependent variables, capturing knowledge about diabetes, take the following values: 1 for nothing, 2 for a little, 3 for enough and 4 for a lot. The interaction between the intention to treat and second wave dummies is not significant for any of the 13 knowledge questions. This means that the distribution of the beliefs about diabetes was not affected in any way by the intervention.[5]

---

[5] There was a significant effect of time on knowledge: both treatment and control patients gain knowledge about the disease over time.

Table 3. The Impact of the Intervention on Knowledge
Dif-in-dif Estimation Using an Ordered Probit Model

	Question1	Question2	Question3	Question4	Question5	Question6	Question 7
ITT	0.078	0.063	0.082	0.014	0.080	0.083	0.071
	(0.119)	(0.127)	(0.121)	(0.121)	(0.124)	(0.119)	(0.122)
Wave2	-0.207	0.521	0.303	0.426	0.396	0.035	0.277
	(0.118)*	(0.125)***	(0.119)**	(0.121)***	(0.122)***	(0.117)	(0.120)**
ITTxWave2	0.011	-0.030	-0.044	0.153	0.234	0.068	0.016
	(0.170)	(0.178)	(0.171)	(0.172)	(0.176)	(0.168)	(0.173)
Observations	680	680	678	678	676	678	680
	Question 8	Question 9	Question 10	Question 11	Question 12	Question 13	
ITT	0.059	0.059	0.020	-0.051	-0.023	-0.033	
	(0.124)	(0.119)	(0.119)	(0.120)	(0.120)	(0.130)	
Wave2	0.545	0.204	0.261	0.331	0.161	0.651	
	(0.124)***	(0.118)*	(0.118)**	(0.119)***	(0.118)	(0.129)***	
ITTxWave2	0.016	0.150	0.198	0.102	0.287	-0.037	
	(0.176)	(0.170)	(0.169)	(0.171)	(0.170)*	(0.182)	
Observations	678	680	680	680	678	680	

Standard errors in parentheses. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent
Dependent variable takes the following values: 1 for nothing, 2 for a little, 3 for enough and 4 for a lot.

4.2.2 Impact on Empowerment and Behavior

Table 4 reports the baseline values for several variables measuring physician-patient relationship and health-related behavior patterns. One of the ways in which the intervention can improve health care decisions is by empowering the patient in the physician-patient relationship. We assessed patient trust and doctor-patient communication by implementing a scale developed for the Primary Care Assessment Survey (PCAS). The PCAS is a validated, patient-completed questionnaire designed to operationalize formal definitions of primary care. Extensive psychometric testing and evaluation have been conducted on the PCAS scales. All scales exceed established standards for excellent instrumentation and perform consistently well across population subgroups (Murray, 2000). The trust and communication scales range from 0 to 100 points, with higher scores indicating better outcomes. According to the baseline survey, the level of patient trust and the quality of clinical communication were very good. To facilitate interpretation of the magnitudes for someone not familiar with the PCAS, we also report a direct question on trust. Patients were asked to rank on a scale from 0 to 10 how much they trusted their medical doctors. The average answer was almost 9.

We also collected information on food consumption in the past week, including things that diabetics should avoid (French fries, ready-to-eat meals) and foods that should be encouraged (fruits, vegetables). On average, the consumption pattern seemed reasonable at baseline: patients reported consuming fruits and vegetables almost daily, while the average frequency of intake of less healthy food was once a week or less.

Table 4. Trust, Communication and Consumption Patterns
Baseline Survey

		Mean	Standard deviation	Cases
Trust (1-10)		8,8	1,5	318
Trust (PCAS)		88,7	11,7	329
Communication with M.D. (PCAS)		85,7	14,1	325
During the last week, on how many days did you consume...	Fruits	6,4	1,5	340
	Vegetables	5,6	2,0	340
	Ready-to-eat meals	0,6	1,1	340
	French fries	0,7	1,1	340
	Cookies and other pastry	1,4	2,0	340
	Regular soda and juices with sugar	0,4	1,2	339
	Fish	1,1	1,1	340
	Cold cuts and sausages	1,4	1,8	340

The econometric results of Table 5 show that the intervention had no effect on any of the variables considered.

Table 5. The impact of the intervention on patient-physician relationship and health-related behaviors
Dif-in-dif estimation. OLS

	Trust (1-10)	*Trust (PCAS)*	*Communication (PCAS)*
ITT	-0.080	-0.838	-0.347
	(0.150)	(1.222)	(1.471)
Wave2	-0.251	1.612	-0.789
	(0.146)*	(1.198)	(1.442)
ITTxWave2	-0.166	-2.226	-1.723
	(0.212)	(1.728)	(2.081)
Constant	9.180	88.519	87.508
	(0.103)***	(0.847)***	(1.019)***
Observations	636	658	650

	Consumption in the past week of:							
	Fruits	*Vegetables*	*Ready-to-it meals*	*French fries*	*Cookies and similar*	*Regular soda*	*Fish*	*Cold cuts and sausages*
ITT	-0.230	0.124	-0.040	0.001	0.076	-0.094	0.036	0.021
	(0.173)	(0.216)	(0.129)	(0.112)	(0.225)	(0.135)	(0.116)	(0.207)
Wave2	0.040	0.040	-0.153	-0.080	0.028	-0.011	-0.080	-0.148
	(0.170)	(0.212)	(0.127)	(0.110)	(0.221)	(0.133)	(0.114)	(0.203)
ITTxWave2	0.180	-0.211	0.202	0.110	-0.187	0.011	-0.042	0.075
	(0.245)	(0.305)	(0.182)	(0.159)	(0.319)	(0.191)	(0.164)	(0.293)
Constant	6.358	5.608	0.705	0.676	1.449	0.411	1.165	1.534
	(0.120)***	(0.150)***	(0.089)***	(0.078)***	(0.157)***	(0.094)***	(0.080)***	(0.144)***
Observations	680	680	680	680	680	678	680	680

Standard errors in parentheses. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent

4.2.3 Impact on Outcomes

Finally, in this subsection we address the effect of the intervention on health outcomes. Table 6 reports the baseline values for self-perceived health status, several medical tests, and complications of diabetes.

The majority of respondents reported that they were in good health. Only a minority considered themselves to be in very good or excellent health, and a sizeable share of respondents ranked their health at the bottom two levels of the distribution (fair or bad).

Blood pressure is the pressure exerted by circulating blood upon the walls of blood vessels. During each heartbeat, blood pressure varies between a maximum (systolic) and a minimum (diastolic) pressure. According to Appel et al. (2006), the risk of cardiovascular disease increases progressively above 115/75 mmHg (millimeters of mercury), but for diabetic patients, higher levels are considered acceptable (below 130/80 mmHg). The average patient in this study is just below this limit. This suggests that a sizeable fraction of the patients in our sample have problems associated with hypertension.

The blood glucose level is the amount of glucose (sugar) present in the blood. This level fluctuates throughout the day. In the morning, before the first meal of the day (termed "the fasting level"), glucose levels are the lowest and rise after meals for an hour or two. A healthy individual’s blood sugar level is in a range of about 82 to 110 mg/dL (milligrams/deciliter). After eating, the blood glucose level may rise up to 140mg/dL for non-diabetics. The American Diabetes Association recommends a post-meal glucose level of less than 180 mg/dl and a pre-meal plasma glucose of 90–130 mg/dL. The mean glucose level for the patients in this study is considered acceptable for people with diabetes.

From the baseline survey it is also clear that the population under study has a significant probability of suffering from diabetes-related incidents. Over the past six months, about 10 percent had to stay at least one night in a hospital, and about one-third made a visit to the emergency room. Eight percent, 14 percent, and 6 percent of the sample had foot, eye, and kidney problems, respectively.

Table 6. Outcomes: Descriptive Statistics
Baseline Survey

		Bad	Fair	Good	Very good	Excellent	Cases
	Self-perceived health	4%	36%	53%	7%	1%	340
					Mean	s.d.	Cases
Last measure	Systolic blood pressure				129	15	312
	Diastolic blood pressure				76	10	309
	Fasting blood glucose level				121	35	173
	After eating (2 hours) blood glucose level				136	40	66
In the last 6 months	% that had to stay a night in hospital				10%	30%	340
	% that had to go to the emergency room				29%	45%	340
	% with foot injuries				8%	27%	340
	% with eye problems				14%	35%	339
	% with kidney problems				6%	24%	337

Given the lack of significant results in the knowledge, assessment of quality of health care, and health behavior sections, the absence of significant econometric results among the outcome variables is not surprising. Table 7 reports these results. The regressions in the upper panel are OLS and in the lower panel are probits.

Table 7. The Impact of the Intervention on Health Outcomes
Dif-in-dif Estimation

			Last measure of:			
	Health evaluation		*Systolic blood pressure*	*Diastolic blood pressure*	*Fasting blood glucose level*	*After eating (2 hours) blood glucose level*
ITT	-0.004		-1.999	-0.701	0.504	17.511
	(0.121)		(1.704)	(1.160)	(5.753)	(9.280)*
Wave2	0.070		0.203	0.236	-5.898	5.389
	(0.119)		(1.693)	(1.150)	(5.703)	(8.849)
ITTxWave2	0.101		-0.917	-0.301	0.062	-5.422
	(0.171)		(2.409)	(1.640)	(8.136)	(13.124)
Constant			130.051	76.293	126.602	124.889
			(1.197)***	(0.813)***	(4.033)***	(6.257)***
Observations	680		624	618	346	132
			0.01	0.00	0.01	0.04
			In the last 6 months:			
	Night stay in hospital	*Emergency room*	*Foot injuries*	*Eye problems*	*Kidney problems*	
ITT	0.010	0.095	0.154	-0.261	-0.335	
	(0.181)	(0.143)	(0.235)	(0.208)	(0.290)	
Wave2	0.030	0.066	0.345	0.289	0.346	
	(0.177)	(0.141)	(0.220)	(0.176)	(0.220)	
ITTxWave2	-0.212	-0.227	-0.198	0.175	0.025	
	(0.262)	(0.203)	(0.309)	(0.269)	(0.365)	
Constant	-1.237	-0.571	-1.753	-1.335	-1.751	
	(0.126)***	(0.100)***	(0.172)***	(0.132)***	(0.172)***	
Observations	680	680	680	678	674	

Standard errors in parentheses. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent

5. Conclusions

We implemented a randomized controlled trial to study the effects of an Internet-based intervention on type 2 diabetic patients. After an initial face-to-face workshop, the intervention group entered the “distance phase” of the project, which lasted six months. Participants were granted access to a website with information on diabetes and its management and to a social network platform. Participants were able to navigate the

Internet site free of charge, download materials, and access links. The social network worked through an electronic platform that promoted social exchange on the basis of different activities (forums, chats, wikis) set up by the specialists. Specialists participated sporadically in the forums with the aim of informing and correcting any misperceptions that participants had about their disease and its treatment and management. Access to the website and social network was granted for six months. A follow-up survey was conducted immediately after the intervention ended.

The evaluation of the intervention showed no significant impact of information technologies on knowledge, perception of health care quality, health-related behaviors, or health outcomes on the participating diabetic patients. Our results present a less optimistic picture of the potential benefits of web platforms for the empowerment of patients with chronic diseases than some of the previous literature (Harno et al., 2006; Meigs et al., 2003; and McKay et al., 2001). There are several possible explanations for this discrepancy. First, the success of these types of programs may be different in developed and less developed countries where both Internet development and the health care system are at different stages of progress. Even among patients that had initially reported having Internet access at home or using the Internet at least once a week, a majority mentioned that they did not access the Diabetes 2.0 website because they were not frequent Internet users. Second, participants in our study were not necessarily interested ex ante in an IT-based intervention. Recruitment and the baseline survey were conducted in the waiting room of the HMO, and the randomization was conducted over the full set of respondents to this baseline survey. The majority of the patients selected for the intervention never logged on to the website and were only reached by email or SMS. In other studies, the randomization is conducted on a sample of individuals that have volunteered to participate in the research. Thus, a priori interest in these types of interventions may be a prerequisite for their success.

This conjecture is reinforced by our finding that prior use of the Internet as a source of health information significantly increased participation in the website. We found, in addition, that participation in the website is correlated with variables like gender, marital status, and education. Women, patients living with a partner, and those who completed high school appeared to have a greater appreciation of the value of the IT tool.

One last reason for the lack of significant effects of the intervention could be related to timing. It may take some time for patients not used to checking the Internet as a source of information to adopt this new tool as an everyday aid to their disease management. Moreover, the effects of empowerment derived from the new information tool might appear with some lag. The positive perception of the intervention among those that ended up participating in the website partially supports this argument. Those that reported visiting the Diabetes 2.0 website gave it an average grade of 8.5 out of 10, and most of those who reported receiving e-mails from the program staff said they had read the emails. Thus, we cannot discount the fact that the intervention may have produced some effects beyond the six-month follow-up period, or that it could have been more effective had it been active for a longer period.

To sum up, we did not find information technology tools to increase diabetic patients' knowledge, empowerment, or health outcomes at six months’ follow-up. Lack of familiarity with the Internet, associated with the patient's age and educational profile, was one of the main barriers to participation. Future interventions of this type should exploit patients' prior interest in participation as well as prior Internet literacy.

References

American Diabetes Association. 2006. Diabetes Care. "Standards of Medical Care-
Table 6 and Table 7, Correlation between A1C level and Mean Plasma Glucose Levels on Multiple Testing over 2-3 Months." 29 Supplement 1: 51-580.

Anderson, A. S. and P. Klemm. 2008. "The Internet: Friend or Foe when providing Patient Education?" *Clinical Journal of Oncology Nursing* 12(1): 55-63.

Anta, R., S. El-Wahab, and A. Giuffrida, A. 2009. *Mobile Health: The Potential of Mobile Telephony to Bring Health Care to the Majority*. Inter-American Development Bank. Innovation Note.

Appel L., et al. 2006. "Dietary Approaches to Prevent and Treat Hypertension: a Scientific Statement from the American Heart Association." *Hypertension* 47(2): 296–308.

Baker, L., et al. 2003. "Use of the Internet and e-mail for Health Care Information: Results from a National Survey. *JAMA* 289: 2400-2406.

Blaya, J., H. Fraser, and B. Holt, B. 2010. "E-Health Technologies Show Promise in Developing Countries." *Health Affairs*, 29(2): 244-251.

Blonde L. and C. G Parkin. 2006. "Internet Resources to Improve Health Care for Patients with Diabetes." *Endocrine Practice*. 12 Suppl 1:131-137.

Bonina C. and M. Rivero Illa. 2008. "Telefonía móvil y pobreza digital en América Latina. ¿Puede la expansión de los teléfonos celulares reducir la pobreza en América Latina?" DIRSI. (Serie Concurso de Jóvenes Investigadores, 3).

Broom, A. 2005. "Virtually Healthy: the Impact of Internet Use on Disease Experience and the Doctor-Patient Relationship." *Qualitative Health Research* 15(3): 325-345.

Bull S.S., et al. 2005. "Harnessing the Potential of the Internet to Promote Chronic Illness Self-management: Diabetes as an Example of how well we are Doing." *Chronic Illness* 1(2):143-155.

Card, D. 1992. "Do Minimum Wages Reduce Employment? A Case Study of California, 1987–89." *Industrial and Labor Relations Review* 46: 38-54.

Crocco, A. G., et al. 2002. "Analysis of Cases of Harm Associated With Use of Health Information on the Internet." *JAMA* 287: 2869-2871.

Cline, R. J. W. and K. M. Haynes. 2001. "Consumer Health Education Seeking on the Internet: the State of the Art." *Health Education Research* 16(6): 671-692.

Dall, T., et al. 2010. “The Economic Burden of Diabetes.” *Health Affairs* 29(2): 297-303.

Diaz J. A., et al. 2002. “Patients´ Use of the Internet for Medical Information.” *Journal of General Internal Medicine* 17(3): 180-185.

Dickerson S., et al. 2004. “Patient Internet Use for Health Information at Three Urban Primary Care Clinics.” *Journal of American Medical Informatics Association* 11(6): 499-504.

Drummond, M. F. et al. 2005. *Methods for the Economic Evaluation of Health Care Programmes*. London, United Kingdom: Oxford University Press.

Eysenbah G., et al. 2002. “Empirical Studies Assessing the Quality of Health Information for Consumers on the World Wide Web: a Systematic Review.” *JAMA* 287: 2691-2700.

Faridi Z, et al. 2008. “Evaluating the Impact of Mobile Telephone Technology on Type 2 Diabetic Patients' Self-management: the NICHE Pilot Study. 14(3):465-459.

Fogel, J., et al. 2002. “Internet Use and Social Support in Women with Breast Cancer.” *Health Psychology* 21(4): 398-404.

Fox, Susannah. 2007. *E-patients with a Disability or Chronic Disease*. Washington, DC: Pew Internet and American Life Project.

Glasgow, R.E., et al. 2003. “The D-Net Diabetes Self-Management Program: Long-term Implementation, Outcome, and Generalization Results.” *Preventive Medicine* 36(4): 410-419.

Gruber, J. 1994. “The Incidence of Mandated Maternity Benefits.” *American Economic Review* 84(3): 622-641.

Gustafson, D.H., et al. 1999. “Impact of a Patient-centered, Computer-based Health Information/Support System.” *American Journal of Preventive Medicine* 16(1): 1-9.

Harno, K., R. Kauppinen/Makelin, and J. Syryalainen. 2006. “Managing Diabetes Care using an Integrated Regional e-Health Approach. *Journal of Telemedicine and Telecare* 12 Supplement 1:13-5.

Hong, Y., T. B. Patrick, and R. Gillis. 2008. “Protection of Patient's Privacy and Data Security in E-Health.” BMEI 1: 643-647.

Kahn, J., Yang, J., & Kahn, J.. 2010. “'Mobile' Health Needs and Opportunities in Developing Countries.” *Health Affairs* 29(2), 252-258.

Kalichman, S.C., Benotsch E.G., , Weinhardt, L., Austin, J., Luke, W., Cherry, C. 2003. “Health-Related Internet Use, Coping, Social Support, and Health Indicators in People Living With HIV/AIDS: Preliminary Results From a Community Survey.” *Health Psychology* 22(1): 111-116.

Latin Business Chronicle. 2008. http://www.latinbusinesschronicle.com/app/article.aspx?id=3507

McKay, H.G., D. King,, and E. G. Eakin. 2001. “The Diabetes Network Internet-Based Physical Activity Intervention. A Randomized Pilot Study.” *Diabetes Care* 24(8): 1328-1334.

Meigs, J. B. et al. 2003. “A Controlled Trial of Web Based Diabetes Disease Management. The MGH Diabetes Primary Care Improvement Project.”*Diabetes Care* 26(3): 750-757

Murray, E., et al. 2003. “The Impact of Health Information on the Internet on the Physician Patient Relationship.” *Archives of Internal Medicine* 163(14): 1727-1734.

Murray A. and D. G. Safran. 2000. The Primary Care Assessment Survey: A Tool for Measuring, Monitoring and Improving Primary Care. In: *Handbook of Psychological Assessment in Primary Care Settings.* Mark E. Maruish, editor. Lawrence Erlbaum Associates: 623-651.

Pittaluga, L. and M. Sienra. 2007. “Utilización de las Teconologías de la Información y las Comunicaciones en el Uruguay. Encuesta Nacional de Hogares Ampliada.” Módulo TIC 2do trimestre de 2006. Montivideo, Uruguay: Instituto Nacional de Estadística..

Rivero Illa, M. 2007. *Enhancing the Livelihoods of the Rural Poor. The Role of Information and Communication Technologies.* ICP-Universidad de la República.

Ybarra, M. and M. Suman. 2008. “Reasons, Assessments and Actions Taken: Sex and Age Differences in Uses of Internet Health Information.” *Health Education Research* 23(3): 512-521.

Wangberg, S. C. 2008. “An Internet-based Diabetes Self-care Intervention Tailored to Self-efficacy.” *Health Education Research* 23(1):170-9.