Internet Use Among Primary Care Patients with Type 2 Diabetes

The Generation and Education Gap

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BACKGROUND: The Internet represents a promising tool to improve diabetes care.

OBJECTIVE: To assess differences in demographics, self-care behaviors, and diabetes-related risk factor control by frequency of Internet use.

DESIGN AND PARTICIPANTS: We surveyed 909 patients with type 2 diabetes attending primary care clinics.

MEASUREMENTS: Frequency of Internet use, socioeconomic status, and responses to the Problem Areas in Diabetes (PAID), Summary of Diabetes Self-care Activities (SDSCA), and Health Utilities Index (HUI) scales. Survey responses were linked to last measured hemoglobin A1c, cholesterol, and blood pressure results. Comorbidities and current medications were obtained from the medical record.

RESULTS: Internet "never-users" (n=588, 66%) were significantly older (70.0 ± 11.2 vs 59.0 ± 11.3 years; P<.001) and less educated (26% vs 71% with > high school; P<.001) than Internet users (n=308, 34%). There were few significant differences in PAID or SDSCA scores or in diabetes metabolic control despite longer diabetes duration (10.3 ± 8.2 vs 8.3 ± 6.7 years; P<.001) and greater prevalence of coronary disease (40% vs 24%; P<.001) in nonusers. Less than 10% of current nonusers would use the Internet for secure health-related communication.

CONCLUSIONS: Older and less educated diabetes patients are less likely to use the Internet. Despite greater comorbidity, nonusers engaged in primary care had equal or better risk factor control compared to users.

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Strategies using the Internet have been advocated to improve the care of patients with diabetes.[1–3] A wide range of diabetes-related websites currently offers such features as diabetes education, online patient support groups, and personalized counseling by "health coaches" to motivate behavioral change.[4–6] Recent technologic advances have also provided some patients with access to their physicians, their clinics, and even their electronic medical records via the Internet.[7–9] Although there are few rigorous, controlled studies in this nascent field, there have been several reports of improved diabetes-related outcomes.[10,11]

In the United Sates, diabetes disproportionately affects the poor and the elderly.[12,13] Despite evidence that Internet access has been steadily increasing for all groups nationwide, the promise of Internet-based diabetes care must be balanced against the problem of limited access.[14,15] Patients who are unable to—or have chosen not to—access the Internet may have important behavioral and clinical differences compared to patients who have already adopted this technology. These differences may have important implications for the generalizability of Internet-based interventions.

We surveyed over 900 patients with type 2 diabetes to assess acceptance and usage of the Internet and to test the hypothesis that Internet users were healthier and more motivated to manage their diabetes.

Research Design and Methods

This research was conducted at a community health center in Revere, Massachusetts and a hospital-based internal medicine practice in Boston, Massachusetts. Revere (population 47,283) is located in a Health Professionals Shortage Area for primary care 5 miles north of Boston. More than 26% of Revere residents live below 200% of the federal poverty level. According to 2000 Census data, 83% of the residents were white, 9% Latino, 5% Asian, and 3% African-American. The Internal Medicine Associates (IMA) primary care faculty practice serves a wide socioeconomic spectrum of patients living in the local Boston area. Seventy-three percent of IMA patients are white, 15% African-American, 4% Latino, and 3% Asian.

We developed diabetes patient registries for each clinic site.[16] These registries contained the names of all patients who were diagnosed with diabetes and received care from one of the clinic physicians, with at least 1 visit in the prior 18-month period. There were 898 patients in the Revere Health Center (RHC) registry and 1,137 in the IMA registry during the study period. From March 2002 to December 2003, we screened the diabetes registries to identify patients with upcoming appointments at either RHC or IMA. Primary care providers (PCPs) reviewed lists of their own patients to exclude the small number of individuals deemed ineligible due to severe comorbid medical or psychiatric illness. The remaining patients were mailed a letter signed by both their PCP and the study principal investigator (JBM) informing them of the questionnaire-based research study and providing them the opportunity to opt out from further contact. Patients who did not opt out were subsequently approached by a research assistant at their next clinic visit and asked to consent to participate in the survey. Consenting patients filled out the survey either while waiting in clinic or after returning home. Thus, our sampling technique favored patients who had a designated PCP, had previous clinic visits, and were less likely to no-show for a scheduled appointment. Conversely, patients with less consistent contact with the clinic or less inclination to consent to a research survey are likely to be underrepresented.

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Of the 1,263 eligible patients successfully contacted, 198 patients (16%) declined consent and 55 (4%) did not participate due to concurrent illness (34) or patient disagreeing with diabetes diagnosis (21). An additional 57 patients (5%) who consented to the study did not return the survey after taking it home. In all, 953 surveys (373 from RHC and 580 from IMA) were completed (76%). Compared to nonrespondents ($n=310$), survey respondents ($n=953$) were more likely to be white (83% vs 72%; $P<.001$) and English speaking (98% vs 87%; $P<.001$). There were no other significant demographic or clinical differences between respondents and nonrespondents. After exclusion of patients with type 1 diabetes, there were 909 completed surveys.

The survey included questions about current Internet use ("Do you use the Internet?" Responses were limited to: "No, never"; "yes, less than once a week"; or, "yes, more than once a week") and about willingness to use the Internet for different health-related activities if confidentiality of personal health information was protected (see Appendix, available online). There were no formal systems of Internet-based patient-physician communication or patient electronic access to medical records in place during the survey period. In addition, patients were asked about education, employment, marital status, race/ethnicity, and medication adherence. Research assistants scanned for missing responses and encouraged patients to fill out all questions.

As part of the questionnaire, we also administered 4 validated survey instruments: the Problem Areas in Diabetes (PAID) scale,[17] the Summary of Diabetes Self-care Activities (SDSCA) measure,[18] and the Health Utilities Index (HUI).[19] Survey data were linked to a diabetes clinical research database that included the most recent laboratory and blood pressure results preceding the interview date, medication regimens, and medical problem lists queried from the electronic medical record (EMR).[20] Both study clinics relied exclusively on EMRs for clinical care. This study was approved by the Massachusetts General Hospital Institutional Review Board.

Statistical Methods

In this cross-sectional analysis, Internet nonusers were compared to Internet users (combining both "occasional" and "frequent" users) using t tests, Wilcoxon rank sum, or χ^2 tests as appropriate. Patients with missing responses to the Internet-related questions were excluded from analysis ($n=13$). Independently significant demographic and socioeconomic variables were entered into logistic regression models to determine adjusted odds ratios of Internet use. Because PAID scores are substantially different in insulin users versus nonusers, we stratified our PAID analyses *a priori* by insulin use status.

To determine the association between Internet use and overall diabetes control, we constructed separate linear regression models for each of 3 diabetes-related risk factors (HbA1c, LDL cholesterol [LDL], and blood pressure) and assessed differences in most recently measured levels according to Internet use status after adjusting for other factors impacting risk factor control such as age, body mass index, and duration of diabetes. In addition, we identified patients in the cohort with poor metabolic control, defined separately as HbA1c > 9.0, blood pressure > 140/90 mm Hg, or LDL > 130 mm/dl based on commonly used thresholds, and compared the proportion of Internet users versus nonusers above these goals. Missing data were not imputed. All analyses were performed using SAS (version 8.0, SAS Institute, Cary, NC).

RESULTS

Cohort Characteristics

Slightly less than two thirds of patients reported never using the Internet ($n=588$, 66%). Table 1 shows baseline characteristics and compares them between Internet users and nonusers. Among the demographic variables, younger age, better insurance status, and higher educational attainment remained independently predictive of Internet use in a multivariate logistic regression model, but gender did not.

Responses to Survey Instruments

PAID summary scores were significantly higher among patients prescribed insulin (24.6 ± 23.2, $n=212$) compared to patients not prescribed insulin (16.7 ± 18.9, $n=602$; $P<.001$), indicating higher diabetes-related emotional stress in the insulin-treated group. PAID scores were also higher in younger patients, with a 0.55 decline in score for each increasing year of age ($P<.001$). We found no significant differences in PAID scores comparing Internet users and nonusers prescribed insulin (25.7 ± 21.8 vs 24.1 ± 23.8; $P=.7$). In the group not treated with insulin, PAID scores were significantly higher among Internet users (20.3 ± 18.5, $n=230$ vs 14.5 ± 18.9 for nonusers, $n=372$; $P<.001$). However, this difference was entirely negated when controlling for the difference in ages between the two groups ($P=.95$). Overall physician satisfaction was high in our cohort, with nonusers more likely to be satisfied with their physician than users (91% vs 82%; $P<.001$).

There were few differences between groups in SDSCA survey responses. Of the 11 questions pertaining to number of days in the past week that patients followed various diet, exercise, and self-care plans, we found that Internet users were more likely to have eaten high-fat foods (2.6 ± 1.9 days vs 2.3 ± 1.9 days; $P=.004$) and less likely to have inspected their shoes (1.7 ± 2.7 days vs 2.8 ± 3.2 days; $P<.001$). These small differences were attenuated or eliminated after controlling for diabetes duration and insulin usage.

Diabetes Management

Table 2 compares users and nonusers with regard to prevalence, management, and control of diabetes and related comorbid conditions. Differences in age and comorbidity were reflected in significantly lower HUI scores among Internet nonusers (0.57 ± 0.33 vs 0.68 ± 0.28; $P<.001$). However, HbA1c, cholesterol, and blood pressure control were comparable and in some cases better in the nonuser group. Overall, there were no significant differences in the proportion of Internet users versus nonusers among patients with poor metabolic control (data not shown).

Potential Use of the Internet

Even if their confidentiality could be strictly guarded, fewer than 10% of nonusers reported that they would be likely to use the Internet for medically related activities such as viewing

Table 1. Patient Demographic and Clinical Characteristics

	Internet Users (*N*=308)	Internet Nonusers (*N*=588)	*P* Value
Mean age, y (SD)	59.0 (11.3)	70.0 (11.2)	<.001
Diabetes duration, y (SD)	8.3 (6.7)	10.3 (8.2)	<.001
Women, *n* (%)	118 (38)	317 (54)	<.001
Race, *n* (%)			
White	257 (84)	484 (83)	.09
African-American	31 (10)	50 (9)	
Hispanic	4 (1)	24 (4)	
Other/not recorded	14 (5)	27 (5)	
English fluency, *n* (%)	304 (99)	570 (97)	.1
Marital status, *n* (%)			
Married/partnered	198 (64)	282 (49)	<.001
Widowed	17 (6)	127 (22)	
Single/divorced	91 (30)	172 (30)	
Level of education, *n* (%)			
11th grade or less	12 (4)	184 (31)	<.001
12th or GED	78 (25)	244 (42)	
Any college	217 (71)	156 (27)	
Employment status, *n* (%)			
Employed	170 (55)	141 (24)	<.001
Unemployed	35 (11)	74 (13)	
Retired	101 (33)	369 (63)	
Primary insurer, *n* (%)			
Medicare	103 (33)	428 (73)	<.001
Managed care	59 (19)	31 (5)	
Private	118 (38)	65 (11)	
Self-pay/Medicaid	28 (9)	64 (11)	
Total number of medicines (SD)	3.5 (4.5)	4.8 (5.1)	< .001
Hemoglobin A1c, % (SD)	7.5 (1.5)	7.4 (1.4)	.2
Blood pressure, mm Hg (SD)	129 (15)/77 (9)	134 (17)/75 (10)	<.01
Cholesterol, mg/dl (SD)	179.7 (38.5)	169.4 (35.7)	<.001
LDL, mg/dl (SD)	98.5 (30.8)	92.4 (20.0)	.004
BMI, kg/m^2 (SD)	32.9 (7.3)	31.4 (6.6)	.008

Numbers are means and standard deviations, or number and column percent; Due to rounding, percentages may not add to 100; P *values compare Internet users versus nonusers by t test or* χ^2 *test.*
SD, standard deviation; GED, General Equivalency Exam (costs are $US); LDL, low-density lipoprotein cholesterol; BMI, body mass index.

their own medical records, communicating with their physicians, or receiving health-related information. In contrast, over 60% of frequent users would use the Internet for these activities ($P<.001$ for all comparisons). Likelihood of using the Internet to communicate with other diabetes patients was lower for both groups (5% of nonusers and 22% of frequent users would do so; $P<.001$).

Conclusions

In a detailed survey of over 900 primary care patients with type 2 diabetes, we identified twice as many Internet nonusers as users. Compared to Internet users, nonusers were over a decade older, substantially less educated, and less likely to be privately insured. These findings identify a limited capacity for

Table 2. Adjusted Odds Ratios for Prevalence, Management, and Control of Diabetes and Related Comorbid Conditions

	Crude Prevalence, *n* (%)		Adjusted Odds Ratios (95% CI)
	Internet Users (*N*=308)	Internet Nonusers (*N*=588)	
Coronary artery disease	73 (24)	237 (40)	1.3 (0.9 to 1.9)
Peripheral vascular disease	25 (8)	103 (18)	1.7 (0.99 to 3.0)
Heart failure	19 (6)	96 (16)	1.6 (0.9 to 3.0)
COPD	42 (14)	114 (19)	1.3 (0.8 to 2.0)
Oral hypoglycemic therapy	137 (45)	284 (48)	1.2 (0.9 to 1.7)
Any insulin therapy	66 (21)	173 (29)	1.3 (0.9 to 2.0)
Hemoglobin A1c<7.0	125 (41)	260 (45)	1.0 (0.7 to 1.4)
Hypertension	263 (85)	537 (91)	0.8 (0.4 to 1.3)
Antihypertensive therapy	134 (44)	348 (59)	1.0 (0.7 to 1.5)
Blood pressure<130/80 mm Hg	88 (33)	144 (27)	1.3 (0.9 to 2.0)
Hyperlipidemia	226 (73)	448 (76)	1.0 (0.7 to 1.5)
Lipid-lowering therapy	71 (23)	31.8 (32)	1.1 (0.7 to 1.6)
LDL<100 mg/dl (SD)	157 (54)	356 (64)	0.7 (0.5 to 0.99)*

Numbers are means and standard deviations, or number and column percent; Adjusted odds ratios are for Internet nonusers compared to users, adjusted for age, insurance status, and level of education.
*P<.05.
SD, standard deviation; COPD, chronic obstructive pulmonary disease; LDL, low-density lipoprotein cholestrol.

Internet-based interventions to reach vulnerable patient populations, particularly the older and poorer patients disproportionately affected by type 2 diabetes.

What are the clinical consequences of this technological divide between Internet users and nonusers? Despite marked differences in demographic and clinical characteristics, we found few differences in patient attitudes toward diabetes and in reported adherence to recommended self-care activities. Furthermore, lack of Internet use did not identify a group of patients with poor control of diabetes-related risk factors. Patients in our cohort were well engaged with primary care and had high satisfaction with their PCPs. Our finding of good metabolic control among Internet nonusers suggests that interventions based on improved Internet access may have limited impact among patients already engaged in high-quality primary care.

One limitation of our study is the lack of data on patients who are less connected to primary care, the very group who may be most likely to benefit from interventions to improve diabetes management. For Internet-based interventions to have a dramatic impact on diabetes care, they will have to successfully engage poorly controlled patients who are not receiving regular care. Although it is possible that patients less inclined to attend clinic might be reached via the Internet, it is likely that sociodemographic barriers to engaging in primary care may also be barriers for Internet use by this patient group.

Among the frequent Internet users (>once/week) in our survey, nearly two thirds expressed interest in more advanced Internet-based methods of communication with their providers and clinics. In contrast, few of the Internet nonusers reported that they would adopt this technology to communicate with their clinic, PCP, or fellow diabetes patients even if provided with secure access. This contrast suggests that patient attitudes are an important barrier to medically related Internet use. Future studies are needed to identify reversible barriers to Internet adoption.

Successful design and implementation of web-based diabetes care interventions must overcome patient reservations to Internet use, particularly among the elderly and less educated. Moreover, such interventions may have limited impact if restricted to patients with regular access to high-quality primary care. Efforts must be made to identify and engage patients with poor diabetes control and significant barriers to current systems of care.

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Supplementary Material

The following supplementary material is available for this article online:

Appendix. Patient Health and Activities Questionnaire

REFERENCES

1. **Bodenheimer T, Grumbach K.** Electronic technology: a spark to revitalize primary care? JAMA. 2003;290:259–64.
2. **Smith SP.** Internet visits: a new approach to chronic disease management. J Med Pract Manage. 2002;17:330–2.
3. **Ball MJ, Lillis J.** E-health: transforming the physician/patient relationship. Int J Med Inform. 2001;61:1–10.
4. **Kassirer JP.** Patients, physicians, and the Internet. Health Aff (Millwood). 2000;19:115–23.
5. **McKay HG, Feil EG, Glasgow RE, Brown JE.** Feasibility and use of an Internet support service for diabetes self-management. Diabetes Educ. 1998;24:174–9.
6. **Zrebiec JF, Jacobson AM.** What attracts patients with diabetes to an internet support group? A 21-month longitudinal website study. Diabet Med. 2001;18:154–8.
7. **Cimino JJ, Patel VL, Kushniruk AW.** The patient clinical information system (PatCIS): technical solutions for and experience with giving patients access to their electronic medical records. Int J Med Inform. 2002;68:113–27.
8. **De Clercq PA, Hasman A, Wolffenbuttel BH.** A consumer health record for supporting the patient-centered management of chronic diseases. Med Inform Internet Med. 2003;28:117–27.
9. **Masys D, Baker D, Butros A, Cowles KE.** Giving patients access to their medical records via the internet: the PCASSO experience. J Am Med Inform Assoc. 2002;9:181–91.
10. **Glasgow RE, Boles SM, McKay HG, Feil EG, Barrera MJ.** The D-Net diabetes self-management program: long-term implementation, outcomes, and generalization results. Prev Med. 2003;36:410–9.
11. **Montani S, Bellazzi R, Guaglini S, d'Annunzio G.** Meta-analysis of the effect of the use of computer-based systems on the metabolic control of patients with diabetes mellitus. Diabetes Technol Ther. 2001;3:347–56.
12. **Harris MI, Flegal KM, Cowie CC, et al.** Prevalence of diabetes, impaired fasting glucose, and impaired glucose tolerance in U.S. adults. The Third National Health and Nutrition Examination Survey, 1988–1994. Diabetes Care. 1998;21:518—24.
13. **Robbins JM, Vaccarino V, Zhang H, Kasl SV.** Socioeconomic status and type 2 diabetes in African American and non-Hispanic white women and men: evidence from the Third National Health and Nutrition Examination Survey. Am J Public Health. 2001;91:76–83.
14. **Whaley KC.** America's digital divide: 2000–2003 trends. J Med Syst. 2004;28:183–95.
15. **Cashen MS, Dykes P, Gerber B.** eHealth technology and Internet resources: barriers for vulnerable populations. J Cardiovasc Nurs. 2004;19:209–14.
16. **Grant RW, Meigs JB.** The use of computers in population-based diabetes management. J Clin Outcomes Manage. 2002;9:390–6.
17. **Welch GW, Jacobson AM, Polonsky WH.** The Problem Areas in Diabetes Scale. An evaluation of its clinical utility. Diabetes Care. 1997;20:760–6.
18. **Toobert DJ, Hampson SE, Glasgow RE.** The summary of diabetes self-care activities measure: results from 7 studies and a revised scale. Diabetes Care. 2000;23:943–50.
19. **Torrance GW, Feeny DH, Furlong WJ, Barr RD, Zhang Y, Wang Q.** Multiattribute utility function for a comprehensive health status classification system. Health Utilities Index Mark 2. Med Care. 1996;34:702–22.
20. **Grant RW, Cagliero E, Sullivan CM, et al.** A controlled trial of population management: diabetes mellitus—putting evidence into practice (DM-PEP). Diabetes Care. 2004;27:2299–305.