

Internet-Based Diabetes Self-Management and Support: Initial Outcomes From the Diabetes Network Project

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ABSTRACT. *Objective:* The Diabetes Network (D-Net), a randomized trial of an Internet-based, diabetes self-management and peer support intervention, was evaluated after 3 months. *Design:* The study assessed separate and combined effects of diabetes self-management and peer support. Outcomes included physiologic, behavioral, mental health, and website usage. Results are presented on the first 160 type 2 diabetes patients recruited from 16 primary care offices. Of those eligible, 61% participated in the study. *Results:* There was significant overall improvement, especially on dietary behavior, but no significant between-condition differences. *Conclusions:* Providing basic diabetes information as well as a “personal coach,” self-management intervention entirely over the Internet proved feasible. Even novice computers users will participate in an Internet-based program to assist themselves in managing their diabetes. Validated Internet interventions could prove to be valuable resources that overcome many costs and limitations of conventional diabetes management.

Improvements in Internet technologies paired with the dramatic drop in the cost of getting online and gains in access among the technology “have-nots” of the Digital Divide has created the potential for practitioners to assist patients with

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chronic illness and health promotion support in an unprecedented manner (National Telecommunications and Information Administration [NTIA], 2000). There are currently at least 117 million U.S. households with access to the Internet, with some estimates as high as 174 million (NTIA, 2000; Nielson NetRatings, 2001). Paralleling this online growth is an increasing number of eHealth web sites dedicated to helping health care consumers find information they need to make decisions about their health across a variety of chronic illnesses (Spielberg, 1998; Stevens, 1999). Healthcare information seekers, or "HealthMed retrievers" (M. S. Brown, 1998), currently estimated at 60 million people, are active users of eHealth web sites and are expected to grow at roughly twice the rate of the overall online population (Cyber Dialogue, 2001; Kaufman, 1999). According to the Cybercitizen Health 2000 study, 89 million of these healthcare information seekers will go online in search of health information, support, and services by 2005 (Cyber Dialogue, 2001).

These online health care consumers are taking more responsibility for their health care decisions and relying less on individual practitioners as the sole source for the management of their health (Ferguson, 1997, 1998). For example, eHealth consumers report that online health information helps them to decide how to treat their illnesses, prepares them to ask questions of their doctors, and helps them determine whether a visit to a doctor is required (Pew Internet & American Life Report, 2000). They are also active users of health-related web sites, seeking support and sharing personal experiences as patients and caregivers (Mittman & Cain, 1999). Moreover, diabetes ranked as the fourth most frequently retrieved disease category among HealthMed retrievers. Across all disease categories the reported behavioral actions taken after eHealth disease site visits included "asked Dr. about treatment" (54%), "made treatment decisions" (45%), and "altered exercise/eating habits" (46%), indicating active engagement with health care professionals for treatment decision support and lifestyle behavior change (Cyber Dialogue, 2001).

The growing shift in the demographics of Internet users to more closely reflect the general American population and increased consumer demand are among the driving forces prompting many healthcare systems to embrace initiatives that use technology such as the Internet to enhance the care and management of their patients (Mittman & Cain, 1999). In the last several years there has been a dramatic increase in the number of high quality diabetes-specific web sites. However, despite the growing number of these sites and the potential advantages of using the Internet for diabetes education and support, there is to our knowledge currently no empirical evidence that any of these web sites improve either the health or quality of life among those with diabetes who use them.

DIABETES SELF-MANAGEMENT IN PRIMARY CARE

Diabetes self-management regimens are one of the most complex of all chronic diseases and require a high level of patient involvement (Anderson &

Funnell, 1990; Wysocki, Hough, Ward, & Green, 1992). Although diabetes education programs [e.g., those recommended by the American Diabetes Association (ADA), 1999] are beneficial, they reach only a minority of persons in need of such self-management education and support (Coonrod, Betschart, & Harris, 1994; Glasgow, Toobert, & Hampson, 1991; Harris, Eastman, & Siebert, 1994; Sprague, Shultz, Branen, Lambeth, & Hillers, 1999). Moreover, there is a large gap between the ideal approach to diabetes management as outlined in guidelines and ADA position statements and what happens in practice, particularly in primary care settings (Glasgow, Strycker, Toobert, & Eakin, 2000; Marrero, 1994). Recommendations are not uniformly applied in the treatment of type 1 patients, and there is even less adherence to recommendations in the treatment of type 2 patients (Harris et al., 1994).

The Diabetes Control and Complications Trial (DCCT; DCCT Research Group, 1993) conclusively demonstrated that intensive treatment dramatically reduces diabetes complications. In the DCCT, intensive therapy included multiple daily insulin injections and blood glucose testing, monthly physician office visits, frequent meetings with an interdisciplinary team over a several year period, and ongoing telephone contact with a nurse. However, there may be lower cost alternatives that incorporate many of the features of the DCCT model and are more feasible to apply to type 2 patients. It is also questionable whether most physicians have the time or the skills to provide self-management interventions to patients, particularly in the area of lifestyle changes (Glasgow & Toobert, 1988; Green, Cargo, & Ottoson, 1993; Pang, 1994).

Previous research indicates that to bring about patient lifestyle change requires ongoing support (Glasgow, Orleans, Wagner, Curry, & Solberg, 2001; Perri et al., 1988; Wing, 1989). Although physicians believe that lifestyle counseling is important, national surveys of medical practice reflect strikingly low overall rates of lifestyle counseling by primary care physicians (Coonrod et al., 1994; Radecki & Mendenhall, 1986; Stange, Flocke, Kelly, & Zyzanski, 2000). Moreover, most primary care physicians do not perceive themselves as effective in changing patient behavior (Orleans, George, Houpt, & Brodie, 1985). Discussions of lifestyle components of diabetes care are often conducted by health care providers other than the physicians (e.g., nurses, diabetes health educators, dietitians). These discussions require specialized knowledge and skills, and physicians usually do not have sufficient time for them during the medical consultation (Green et al., 1993; Pang, 1994).

However, a major challenge is how to deliver the necessary skills training and support to diabetes patients, initially and over the long term, that will allow them to control their blood glucose and other risk factors in ways that are feasible and cost effective. One of the reasons for the success of the DCCT was undoubtedly the extraordinary amount of support, health care professional contacts, and attention provided to participants of the study (Fisher et al., 1994). However, this amount of direct contact, and even telephone contact, is unlikely to be feasible in most practice settings.

The Diabetes Network (D-Net) intervention was designed to complement

medical treatment of diabetes by providing (a) personalized lifestyle interventions and (b) social support via an Internet-based program accessible from patients' homes. This approach allows a small number of staff to serve patients from a variety of providers and clinics and could become a generalizable model for use in managed Veterans Administration (VA) and other large health care systems.

CONCEPTUAL MODEL AND LIMITATIONS OF DIABETES EDUCATION AND SUPPORT

We conceptualize diabetes education as serving three important functions: increasing knowledge, providing skills training, and enhancing social support. Most reviewers have concluded that although knowledge transmission is necessary, it alone is not sufficient to produce or sustain meaningful behavior change (S. A. Brown, 1990; Clement, 1995; Glasgow & Osteen, 1992). Effective self-management training also helps participants to set personal goals and provides them with feedback and diabetes problem-solving and coping skills needed to deal with the ever-changing challenges to self-care (Glasgow & Eakin, 2000; Johnson, 1992; Toobert & Glasgow, 1991; Von Korff et al., 1996; Wing, 1989). Another important but often overlooked function of diabetes education is to provide social and emotional support. It has been hypothesized that the high level of success and retention in the DCCT was due to the intensive and ongoing level of patient contacts and social support (Fisher et al., 1994).

There are three important limitations to the majority of available diabetes self-management approaches that are usually delivered in small group or classroom settings. The first is intensity and related cost. As discussed by Kaplan and Davis (1986), the time costs of both multidisciplinary staff members and patients are considerable. A second limitation is the disappointing reach or participation rates (Glasgow, Vogt, & Boles, 1999) due to numerous barriers for patients to attending education classes, including inconvenience, transportation, time commitments, and so forth. Although comprehensive diabetes education programs are beneficial, they have an important limitation: They reach only a minority of the patients in need of such self-management education and support (Coonrod et al., 1994; Glasgow, Toobert, & Hampson, 1996; Harris et al., 1994).

The third major limitation to diabetes education is that it appears, especially in lifestyle areas such as nutrition, that ongoing contact and support are necessary for long-term maintenance (Glasgow & Toobert, 1988; Perri, Sears, & Clark, 1993). The feasibility of providing frequent health care professional contact over long time periods in most real-world settings is limited given decreasing health care resources and lifetime maximum reimbursement amounts enforced by payers.

The D-Net project was initiated because we felt each of these limitations to most current approaches to diabetes education and behavioral self-management

interventions could be addressed by an appropriately designed diabetes-specific Internet web site (McKay, Feil, Glasgow, & Brown, 1998).

METHOD

The purpose of this article is to report the initial results from a study evaluating the effect of an Internet-based diabetes support program on diet, mental health, and physiologic outcomes. The study used a randomized design to determine the incremental effectiveness of two main components: (a) peer support and (b) personalized self-management and feedback dietary intervention facilitated by a professional mediator. The design assigned participants to the presence or absence of each of these conditions, resulting in a total of four conditions; two having and two not having each of the above components.

All participants were provided with a D-Net system computer dedicated to diabetes self-management and Internet access. To make participants more comfortable in learning to use the project computers, we used simplified computers, provided complete computer installation and extensive training (i.e., 2–6 hours), and employed a user-friendly Internet web site. The home-based “as your schedule permits” intervention was free of charge, convenient, and designed to mitigate common participation barriers such as cost, transportation, child care, and work schedules. Participants were assessed via a paper-and-pencil and computer survey as well as through blood drawn at baseline and 3 months.

Participants and Recruitment

Participants were 75 men and 85 women who were diagnosed with type 2 (noninsulin dependent) diabetes mellitus. Recruitment procedures began with a letter to patients from 1 of 16 participating primary care physicians (including 3 specializing in diabetes). The practices had a mean of 40.6 type 2 patients ($SD = 49.1$). Participants had a mean age of 59 years and had been diagnosed with diabetes an average of 11 years. These and other participant characteristics are summarized in Table 1.

To be eligible, participants had to be diagnosed with type 2 diabetes. The criteria established by Welborn (Welborn, Garcia-Webb, Bonser, McCann, & Constable, 1983) were used to differentiate type 1 from type 2 diabetes based on age of diagnosis, body mass index, and when they started taking insulin (40 years or older). Participants had to be 40–75 years old, have a telephone, read and write English, live in the local area, and be planning to remain in the area during the year of the study. Furthermore, because of our concern about “digital divide” issues, we restricted the sample to individuals who reported that they did not have Internet access at home or work, and we restricted participation to the local community in order to give rapid in-home technical support for our novice computer users. We also wished to ensure that our Internet-delivered intervention

Table 1. Descriptive Statistics on Participant Characteristics in Each Condition and the Entire Sample

Variable	Information-only condition (<i>n</i> = 40)	Peer support condition (<i>n</i> = 40)	Personal self-management coach condition (<i>n</i> = 40)	Combined condition (<i>n</i> = 40)	Total sample (<i>n</i> = 160)
% women	52.5	47.5	57.5	55.0	53.1
% education ^a	25.0	22.5	27.5	27.5	25.6
% income ^b	22.5	30.0	15.0	25.0	23.1
Age					
<i>M</i>	60.8	57.6	57.6	62.1	59.3
<i>SD</i>	9.1	9.2	9.0	9.5	9.4
Years diagnosed					
<i>M</i>	11.85	11.72	10.00	11.60	11.29
<i>SD</i>	6.80	8.71	6.39	9.23	7.84

Note. There were no statistically significant between-conditions differences at Time 1 for any of these variables.

^aThis was a 7-point scale where 1 = 6th grade or less, 2 = 7th-9th grade, 3 = 10th-11th grade, 4 = high school graduate, 5 = some college, 6 = college graduate, 7 = graduate or professional school. Reported as percentage of those with college degree or more.

^bThis was a 6-point scale where 1 = less than \$10,000. The other scale points represented \$20,000 increments (where 6 = greater than \$90,000). Reported as percentage of those with income range of \$30K to \$50K.

would be effective and appeal to non-computer users and avoid the criticism that such technologically based interventions would only be appropriate for the computer savvy. Participants were recruited through 16 primary care physicians who sent letters describing the study to their patients with type 2 diabetes. The letters contained a stamped postcard that patients could use to decline further contact with the research staff. Of the 265 patients who were eligible, 160 (61%) agreed to participate. Only 12 of the 265 (4%) people eligible declined participation in the study due to objections to using a computer. For participation results in greater detail, see Feil, Glasgow, Boles, and McKay (2000).

Program Study Conditions

All participants received home computers provided by the project for a period of 10 months. Each participant received training in using the D-Net computer system which allowed him or her access to the D-Net web site. On connection to the system, a username (first name and last initial) and password were required to track individual program usage and to maintain confidentiality.

Information-only condition (IOC). Participants in the IOC had access to an extensive number of articles on medical, nutritional, and lifestyle aspects of diabetes. All articles gave information only and did not systematically instruct participants in changing dietary practices or other behaviors. We chose to use this information condition as our basic comparison–active control condition rather than a usual care condition for two reasons. First, because the project tested for Internet-mediated support and feedback, the effect of a simple information provision (i.e., introduction of a home computer) should be separated from the overall and respective effects of our Internet support and personalized self-management. Second, the study involved invasive assessments (i.e., blood draws). To secure high levels of participation in follow-up assessments and control for the “Hawthorne” effect (Homans, 1968), we felt it important that all participants be offered something of potential benefit.

Personalized self-management coach condition (PSMCC). Participants in the PSMCC also had Internet-mediated access to a professional who had expertise in providing dietary advice to diabetes patients. Participants worked with their coach and interactive resources on the web site to reach their dietary goals, which were based on feedback from an online assessment taken at baseline. These dietary goals were then set collaboratively with the participants’ online coach, who could be contacted twice per week throughout the 3-month intervention period. The coach suggested strategies for overcoming barriers and provided tips, information, and encouragement to assist the participants in meeting their goals. PSMCC participants also had access to an online blood glucose tracking and graphing system where they could enter their blood glucose levels for different periods of each day (e.g., breakfast, dinner, before and after exercise). All data entered could be graphically displayed in real time for feedback to participants as a way to support their dietary change efforts.

Peer support condition (PSC). Individuals in the PSC received the same information as those in the IOC. In addition, they participated in activities that provided opportunities to exchange diabetes-related information, coping strategies, and emotional support. The main activity area, the D-Net Support Area Conferences, was a peer-directed (but professionally monitored) forum for participants to interact with one another in a safe, supportive setting where participants were encouraged to express their concerns, successes, and frustrations with their day-to-day coping with diabetes. Group members posted messages that other members could read and answer. In addition, participants could also engage in real-time live chat discussions.

Combined condition (CC). Participants in the CC had access to all resources that were available to the IOC, the PSMCC, and the PSC.

Measures

Measures were divided into 5 categories: (a) demographic characteristics, (b) web site usage, (c) physiological behavior, (d) dietary and eating behavior, and (e) mental health status. All measures were collected at both baseline and 3 months from computer installation (with the exception of demographics).

Demographic and background characteristics. Information was collected on age, gender, education, income, number of years since the initial diabetes diagnosis, and degree of physical disability. Participants reported their educational attainment on a 7-point scale that ranged from *less than seventh grade* (1) to *graduate or professional school* (7), and their family income on a 6-point scale that ranged from *less than \$10,000* (1) to *greater than \$90,000* (6) in increments of \$20,000.

Web site activity analysis. Participant program use was collected at each logon and for the duration of the session via the web servers log file. In addition, verbatim transcripts of all peer-to-peer and coach participant interactions in forums and live chat areas were automatically captured, and use of any interactive behavioral health tools (e.g., blood glucose tracking) was captured to the database.

Physiological. Participants had their blood drawn for a total cholesterol and glycosylated hemoglobin (HbA_{1c}) assay at baseline and 3 months. The Bio-Rad Micro Column Test was used to assess the percentage of HbA_{1c} in whole blood, which produces a measure reflecting the mean blood glucose concentration over the preceding 2 months.

Diet and eating behavior. Two measures comprised this construct: (a) Block Fat Screener and (b) Kristal Fat and Fiber Behavior Questionnaire (FFB). The Block Fat Screener is a brief 15-item dietary questionnaire (Block, Clifford, Naughton, Henderson, & McAdams, 1989) that is a subset of items from the 98-item Full Block Food History Questionnaire that contribute most to fat intake. This instrument correlates highly with the Kristal FFB (Kristal, Shattuck, & Henry, 1990) and with criterion measures of percent of calories from fat and from

saturated fat derived from the Full Block National Cancer Institute instrument as well as 4-day food records (Glasgow, Perry, Toobert, & Hollis, 1996). The Food Habits Questionnaire measures reported behaviors related to high- and low-fat eating patterns. This 40-item instrument measures five dimensions of fat-related dietary habits: substituting specially manufactured low-fat foods, modifying meat choices, modifying commonly used foods to be lower in fat, replacing high-fat foods with low-fat foods, and avoiding fats as a flavoring. The psychometric properties of this instrument have been reported by Kristal et al. (1990). We have found that the test-retest reliability for the FHQ compared favorably with measures from a 4-day food record; that the FFB was significantly correlated both with other dietary measures (4-day food record) and with three biologic measures including cholesterol, body mass index, and HbA_{1c} (Glasgow, Perry, et al., 1996).

Mental health status. Two measures were used to assess mental health status: the Short-Form General Health Survey (SF-12) and the Center for Epidemiologic Studies Depression Scale (CES-D). The SF-12 (Stewart, Hays, & Ware, 1988) measures health-related quality of life and has extensive normative data with which to compare results for patients with diabetes, other chronic diseases, and the general population (Stewart et al., 1989; Ware, Sherbourne, Davies, & Stewart, 1988). The mental health subscale assesses the emotional status component of health and general well-being. The CES-D is a general measure of depressive symptoms that has been used extensively in epidemiological studies. It measures dimensions of depressed mood, hopelessness, appetite loss, sleep disturbance, and energy level. Patients are asked to report on a 4-point scale how often they experienced a particular symptom during the past week. Radloff (1977) has presented extensive data on the reliability and validity of the CES-D.

RESULTS

Transformation of Outcome Variables

Table 2 shows the means and standard deviations for all (untransformed) outcome variables at baseline (T1) and at the 3-month assessment (T2) by experimental condition. To normalize the dependent variables, a logarithmic transformation was used on HbA_{1c} values, a square root transform was used on the fat screener data, and a reciprocal function was used for the cholesterol data.

Attrition Analyses

Of the 160 participants randomized (40 to each condition), 16% failed to complete the 3-month (T2) assessment procedures that measured total cholesterol

Table 2. Means and Standard Deviations of Criterion Variables at Baseline (Time 1) and 3-Month Assessment (Time 2)

Criterion variable	Information-only condition (<i>n</i> = 33)		Peer support condition (<i>n</i> = 30)		Personal self-management coach condition (<i>n</i> = 37)		Combined condition (<i>n</i> = 33)	
	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2
Fat intake (estimated grams per day)								
<i>M</i>	42.64	31.58	50.72	38.73	47.61	33.49	37.86	31.31
<i>SD</i>	24.76	13.52	43.40	34.92	38.55	28.02	24.92	28.71
Poor dietary practices (Kristal)								
<i>M</i>	2.27	2.14	2.22	2.06	2.29	2.08	2.04	1.89
<i>SD</i>	0.42	0.34	0.52	0.50	0.36	0.43	0.57	0.59
Depression symptoms (CES-D)								
<i>M</i>	15.27	15.31	15.83	13.86	18.11	16.42	16.61	14.87
<i>SD</i>	12.25	9.15	12.79	12.62	11.79	12.98	11.67	9.69
Psychological well-being (SF-12)								
<i>M</i>	49.13	48.20	46.96	47.26	44.39	46.51	46.38	51.51
<i>SD</i>	10.51	11.47	12.14	12.54	10.29	12.10	13.29	10.02
Total cholesterol								
<i>M</i>	184.48	192.06	201.27	195.78	217.03	215.54	218.36	207.19
<i>SD</i>	30.98	38.47	27.67	28.23	49.23	87.32	45.84	36.47
HbA1c								
<i>M</i>	7.20	7.37	7.64	7.59	7.75	7.73	7.46	7.28
<i>SD</i>	1.36	1.49	1.71	1.66	1.33	1.42	1.35	1.28

Note. CES-D = Center for Epidemiological Studies—Depression scale; SF-12 = Short-Form General Health Survey-12.

and HbA_{1c}; these participants were treated as missing cases. The four conditions did not significantly differ in their number of missing cases (7 in the IOC, 10 in the PSC, 3 the PSMCC, and 7 in the CC). Analyses were conducted to determine whether dropouts differed from those completing T2 assessments in a way that threatened either internal or external validity of the study. Several 2×2 (missing–not missing) analyses of variance (ANOVAs) were conducted on T1 measures of outcome criteria. Results showed no significant effects for condition, missingness, or their interaction for five of the six measures: Characteristics of participants who dropped out did not differ across conditions. In the analysis of total cholesterol scores (adjusted by a reciprocal transformation), there was a significant effect such that participants in the PSMCC conditions had significantly higher baseline levels of total cholesterol than those who did not receive personalized self-management. Because baseline scores on the outcome criteria were used to adjust T2 scores in the outcomes analyses, these pretest differences were not problematic.

Analyses of Outcomes at the 3-Month Assessment

Inspection of the data in Table 2 suggests little change in the biological measures, but general improvements in dietary practices, substantial reductions in fat intake, and very slight improvements in quality of life. It should be noted that all conditions reported no change or a very slight decrease in depression levels over the course of the intervention. Participants in the PSC and CC appeared to have slightly larger reductions in cholesterol levels, but there were no other apparent trends favoring one intervention condition over the others on most other measures. It does appear that the personalized and support conditions produced somewhat greater improvements in quality-of-life scores on the SF-12 than those not randomized to these conditions.

Multivariate general linear model procedures were used to evaluate the effects of personalized self-management and of peer support and to adjust for baseline values for three groups of conceptually similar criteria: (a) physiological outcomes (total cholesterol and HbA_{1c}), (b) dietary behavior (dietary practices FFB and fat screener), and (c) mental health outcomes (CES-D and SF-12).

These three analyses showed no significant effects for either PSMCC or PSC. There was one marginally significant multivariate effect favoring the personalized self-management conditions when SF-12 scores and the CES-D were the criteria (Wilks's lambda, $p < .08$). The follow-up univariate test for personalized self-management was marginally significant only when the SF-12 was the criterion, $p = .10$. This effect is apparent in Table 2, which shows no noticeable improvement for the control or peer support conditions but obvious improvements for the PSMCC and CC.

Participation in the Intervention Conditions

Automated information was collected on program participation via the average number of separate logons per participant. The mean number of total logons varied across condition, as illustrated in Table 3. The two support conditions generated significantly more logons ($M_s = 61$ and 70 , respectively, for PSC and the CC) than those in PSMCC ($M = 44$) and the IOC ($M = 25$; $p < .02$).

DISCUSSION

The purpose of this study was to evaluate the feasibility and short-term effects of a diabetes self-management support intervention conducted entirely over the Internet. With the caveats discussed in this section, we conclude that this Web-based intervention was feasible and that it produced improvements in some outcomes but not others. The following section discusses our interpretation of the results to date and implications for future research and practice.

To our knowledge, this is the first randomized control trial of an Internet-based diabetes self-management intervention. Although others have used the Internet to transfer diabetes management information or as part of a complex, largely in-person intervention and have studied other modalities of diabetes self-management interactive technology (Glasgow & Toobert, 2000), self-management education over the Internet has not previously been evaluated (Glasgow, McKay, Boles, & Vogt, 1999). Therefore, it is important to understand the unique features, strengths, and limitations of this modality. It was possible to work with novice Internet users having type 2 diabetes and to have them understand and complete web-based self-management assessments, receive and act on personalized feedback recommendations to set personal goals, and develop and carry out action plans to overcome barriers to self-management. This basic sequence of self-management, problem-solving-based intervention activities was accomplished quite efficiently over the Internet, and users did not become more depressed.

It is also apparent that the majority of participants enjoyed the interactions with the computer, their coach, and other participants. As reported elsewhere, over 60% of type 2 primary care patients were willing to participate in this intervention (Feil et al., 2000), a substantially higher proportion than are willing and able to attend more traditional group education classes or in-person interventions requiring considerable investments of time (Glasgow, Vogt, & Boles, 1999; Harris et al., 1994). Use of the D-Net resources varied over time, across conditions, and among the different activities. It is clearly necessary to regularly update the web site and provide new information to keep users coming back to an Internet self-management site. One component of the site that was not used as often as we had hoped was the self-management area that guided participants in tracking blood glucose levels throughout the day, entering these personal data,

Table 3. Means and Standard Deviations of Web Site Logons From Baseline (Time 1) to the 3-Month Assessment (Time 2)

Variable	Information-only condition (<i>n</i> = 33)	Peer support condition (<i>n</i> = 30)	Personal self-management coach condition (<i>n</i> = 37)	Combined condition (<i>n</i> = 33)
Number of logons				
<i>M</i>	25	61	44	70
<i>SD</i>	23	109	52	113
Logons per week				
<i>M</i>	1.8	4.6	3.2	5.4
<i>SD</i>	1.8	8.4	4.2	9.0

and graphing them. This aspect of the intervention might have been too complex or demanding for participants to use regularly.

Although most participants assigned to the support conditions logged into the conferences and chat room, use of this aspect of the web site varied considerably across participants. Some participated only sporadically; others logged in fairly regularly, but usually only to observe activity and read messages posted by others, a pattern commonly found on other types of web sites, called "lurking." Finally, there was a small group of very regular posters for whom the peer contact seemed especially reinforcing.

Overall, the amount of web site use (an average of 93 logons per month) was modest, and not as frequent as reported by Gustafson et al. (1999) in their study of a web site for HIV patients. It might be that providing participants with explicit expectations or a contract regarding frequency of web use is important to generate high usage, but this could in turn reduce the percentage of persons willing to enter a program. The drop-out rate was 16%, somewhat higher than observed in our previous research using a similar intervention approach with a similar population, but conducted in-person (Glasgow et al., 1992; Glasgow, Toobert, & Hampson, 1996). It was encouraging that in general the characteristics of participants versus nonparticipants (Feil, Glasgow, Boles, & McKay, 2000) and of those who completed the study versus those who dropped out were similar. It is difficult to tell how much of this attrition was due to the considerable amount of data collection involved with the research aspects of the study.

The PSMCC intervention produced encouraging effects on dietary behavior change, especially on the fat screener measure. These results were encouraging, especially on the fat screener measure. It does not appear, however, that these changes translated into improvements in biological outcomes or improvements in mental health over the limited time frame of this study. It is possible that a longer period of consistent behavior change, larger modifications in dietary intake, or

the additional alteration of physical activity patterns are necessary to affect biological outcomes.

It was disappointing that the PSC did not produce significant short-term incremental effects. This might have been because group interactions did not occur immediately after the start of the intervention. Future programs might want to more actively prompt or “seed” group discussions. An encouraging result was that group participants used the chat rooms and conferences very appropriately. In contrast to fears of some authors, in over 3,146 patient messages, we did not observe a single instance of information or advice being given by participants that was dangerous or contained serious misinformation.

This research had both strengths and limitations. Strengths include the randomized factorial design; the inclusion of a comparison condition that controlled for receipt of a computer, web-access, and provision of diabetes related information; the efforts to remove barriers to participation and to document participation rates; the collection of assessment data over the Internet; and the breadth of process–use and outcomes measures collected. Limitations include the short time frame of the study, the modest sample size, the relatively homogenous sample of participants (who were, however, representative of the primary care practices and community from which they were drawn, but not of the nation), and the necessity to use brief measures of dietary and other outcomes.

Directions for future research include collection of larger samples to be able to identify characteristics of those who most benefit from web-based intervention, the study of longer term usage patterns and results, and both comparison of and greater integration of web-based interventions with usual care and alternative intervention modalities.

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