

Developing and Using Interactive Health CD-ROMs as a Complement to Primary Care: Lessons From Two Research Studies

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Abstract

Interactive health technologies (IHTs), whether used as an adjunct to clinical care or as a stand-alone program, provide a means to efficiently deliver both standardized information and tailored health interventions to a large number of patients. This article describes the benefits and drawbacks to the use of read-only memory compact disks (CD-ROMs) to facilitate diabetes self-management, using the experience from two efficacy trials with CD-ROMs as the primary modality for intervention. The CD-ROMs were designed to promote health behavior change and prevent complications by

increasing attention to diabetes care guidelines and providing tailored self-management plans to patients with type 2 diabetes.

Lessons learned from these two studies are shared to answer the question: does the use of CD-ROMs as an intervention tool address the key barriers to using a self-management approach in primary care? We conclude by discussing the advantages and limitations of using CD-ROMs to deliver health interventions, along with recommendations for maximizing the potential of IHTs.

Interactive health technologies (IHTs) have much to offer, particularly if they incorporate theory-based principles and provide feedback and tailored information for users.¹⁻³ Whether used to enhance clinical care or as a stand-alone tool, they simultaneously offer an efficient means of implementation and individualized tailoring for care delivery. In these times of rising health care costs and more stringent reimbursement policies, IHTs may be cost-effective supplements to “usual” care, helping to inform patient-clinician interactions when staff time is constrained or knowledge of a particular area is limited. IHTs, such as websites, read-only memory compact disks (CD-ROMs), and personal digital assistants (PDAs) can also free clinicians to focus on other care priorities, such as medications or treatment of acute conditions. IHTs may also assist diabetes educators by reducing time spent on assessment and goal-setting to allow more time for tailored counseling and problem solving.⁴ Furthermore, IHTs may

be easy to disseminate because of their portability, although we have yet to see large-scale studies testing dissemination of any one IHT.

In the past decade, awareness of the value that computer technologies offer for health promotion has increased considerably. Recently, Piette¹ discussed the promise of CD-ROMs, the Internet, and automated telephone delivery methods; other researchers have described the utility of interactive health technologies for increasing provider adherence to medical guidelines,⁵ increasing access to social support,⁶⁻¹⁴ and increasing knowledge about and actions toward healthy behaviors with the goal of preventing disease or managing chronic conditions.¹⁵⁻²⁰ Buller, et al.,²¹ showed that children exposed to a CD-ROM on sun protection had significantly higher knowledge about the importance of prevention than those not exposed, and the CD-ROM may have indirectly improved children’s sun protection behavior. Health-related CD-ROMs on a wide variety of

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topics have been implemented in schools and workplaces but may be less widely used in health care settings.²²

Concerns have been raised repeatedly of a “digital divide,” that is, differential access to computers and the Internet that may affect how widely IHTs can be disseminated. IHT researchers have worked to show that computers are used by and are acceptable to diverse populations.^{11–13,23} Much of the research on IHTs, however, has focused on the Internet. Less attention has been paid to other computer technologies having interactive components, such as CD-ROMs, a medium with unique strengths and limits. Brodie et al.²⁴ demonstrated that for non-Internet technology such as CD-ROMs, the issue also appears to be access. Once people have computer and technology access, they will use it, and the “digital divide” (i.e., differences in use related to factors such as age or race/ethnicity) disappears.

If and when access to computers and computer technology is ensured, the potential for using IHTs for health promotion is immense. Eighty percent of adult Internet users have searched for health-related information.²⁵ Some investigators suggest that IHTs be used only as an adjunct to clinic services to enhance information received in medical settings, whereas others suggest that IHT interventions may be implemented to reach a nonclinic

audience in a completely nonclinical setting.^{21,23} With the increasing prevalence of diabetes and wide recognition of the need to help people with diabetes better manage their condition to prevent its serious complications, IHTs have the potential to provide both standardized and tailored health behavior interventions to improve diabetes self-management.

This article describes the benefits and drawbacks of using CD-ROMs for delivering health promotion interventions 1) within primary care settings by clinic staff, and 2) in a centralized community setting by trained research staff with varied education and experience. Lessons learned from these two studies are shared to answer the question: does the use of CD-ROMs as an intervention tool address the key barriers to using a self-management approach in primary care?

While we will present data from our own research—two randomized, controlled trials—to help answer the question, our intent is not to discuss the efficacy of any one CD-ROM program, but rather to identify the benefits and limitations of CD-ROMs as a modality when considering technological interventions of any kind. The programs we will describe are highlighted as examples of how CD-ROM technology has been used. The strengths and limitations of using CD-ROMs in diverse settings are discussed along with recommendations for future applications.

THE SELF-MANAGEMENT MODEL: THE “FIVE AS” APPROACH TO DIABETES CARE

The self-management model proposed by Glasgow et al.²⁶ parallels a smoking cessation counseling methodology developed by the National Cancer Institute to guide physicians in counseling their patients to quit.²⁷ This smoking cessation method, now endorsed by the U.S. Preventive Task Force²⁸ is called the “Five As.” It guides clinicians through a counseling session, with each “A” corresponding to a brief behavioral intervention—assess, advise, agree, assist, arrange²⁸—which together have been shown effective. The self-management model follows the Five As model, with each “A” corresponding to a key step (Figure 1).

The self-management model also includes concepts from Anderson et al.²⁹ on patient empowerment and from Lorig et al.³⁰ on self-management education. The model differs from more didactic educational approaches by promoting collaborative goal-setting and identifying specific behaviors to be adopted or changed. It emphasizes patient choice and the importance of individual relevance to making sustainable behavior change.

Successful self-management programs encourage patients to identify barriers that may impede goal accomplishment and strategies for avoiding or overcoming barriers. Follow-up support is also a key component of

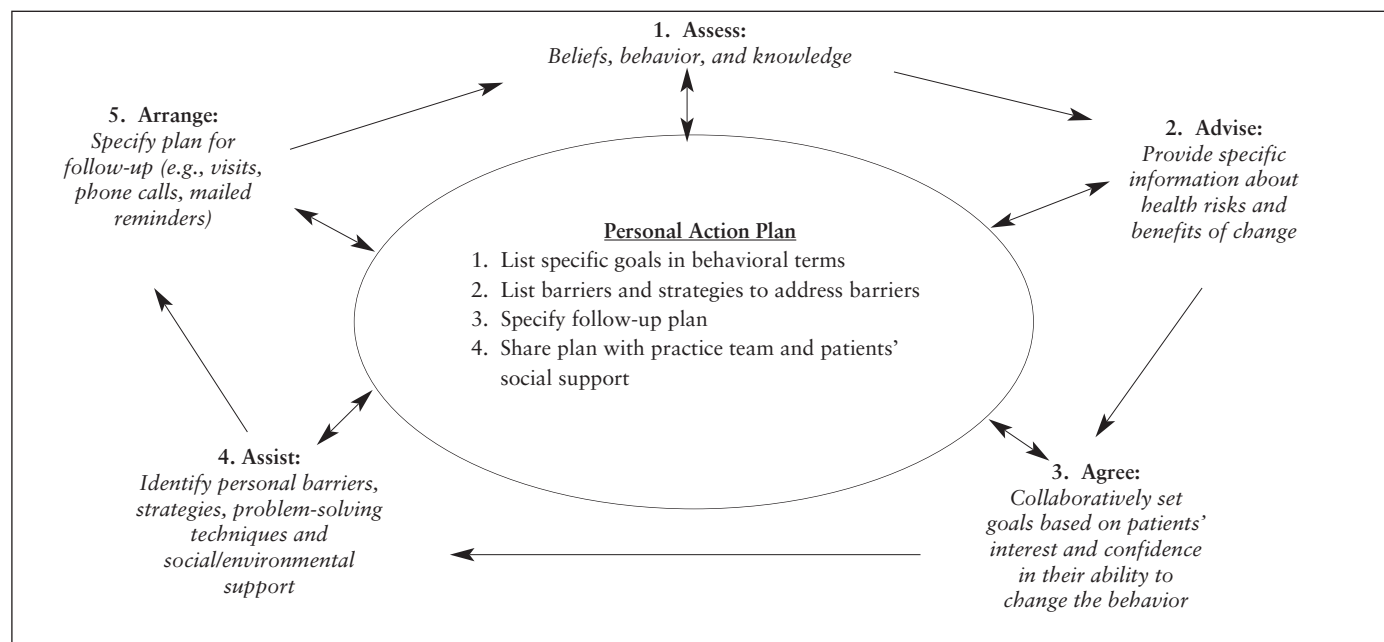


Figure 1. Self-Management Model With Five As^{26,28}

the model to encourage long-term adoption of health behaviors. The self-management model assumes that the role of health care is to educate, empower, and provide realistic choices for patients to manage their health and to support collaboration between patients and their health care team to assure optimal diabetes care.³¹

PRIMARY CARE BARRIERS TO ADOPTING A SELF-MANAGEMENT APPROACH

Studies have shown that physician endorsement of health behavior change promotes both change and adherence to healthier lifestyle regimens. This has been demonstrated in tobacco cessation studies in which brief advice from the physician, particularly when reinforced by other members of the health care team, resulted in significantly higher quit rates among smokers.^{28,32,33} More complex lifestyle behavior changes, such as improved eating habits and increased physical activity, have also met with success when endorsed by primary care professionals, including nurses, health educators, and dietitians.^{34,35}

Addressing health behavior issues in the primary care setting allows for large numbers of individuals to be reached cost-effectively³⁶ and has demonstrated significant improvements in glycemic control, foot health, and reductions in diabetes-related costs.^{37,38} Yet, a self-management approach to health behavior change often is not adopted in primary care because of five important barriers: 1) lack of time and/or staff support during already-constrained patient visits; 2) lack of reimbursement for self-management counseling; 3) unclear methods for reaching treatment goals; 4) lack of provider expertise in health behavior change; and 5) lack of provider confidence in using a self-management approach to chronic care.^{39,40}

IHTs can at least partially address barriers to using a self-management approach in primary care by enhancing efficiency during office visits. For example, a CD-ROM-driven self-management program can save provider time by quickly performing assessments of a variety of domains (e.g., diet and physical activity) and providing immediate feedback to both

patients and providers. Such a program can ensure that a consistent high-quality message is delivered to patients, and it can inform patient-provider interactions. IHTs can also supplement clinician knowledge and skills in a wide variety of health behavior domains, such as tobacco use, nutrition, and physical activity. Thus, IHTs can provide a streamlined, consistent method for conducting many aspects of self-management counseling, including assessing current health behaviors, identifying patients' barriers to change, and allowing patients to set goals and select relevant activities. All of this frees up providers' time to focus on other care priorities.⁴¹

A TALE OF TWO CD-ROM DIABETES SELF-MANAGEMENT INTERVENTIONS

Our two research studies described below employed a conceptually based self-management intervention program that involved collaborative goal-setting, identification of barriers to these goals, personalized problem-solving, and follow-up support. This intervention model, consisting of computer-assisted assessment, goal-setting, brief counseling, and follow-up telephone calls, has previously been found effective for type 2 diabetes patients in group treatment settings, with older adults, when translated into a brief medical office-based intervention, and across multiple offices and interventionists.^{18,42-44}

The Diabetes Priority Program: A Primary Care-Based Intervention

This randomized, controlled trial tested the impact of an interactive diabetes care program compared to a general health risk appraisal program on improving physician adherence to the American Diabetes Association (ADA) diabetes care performance standards. The ADA standards include clinical procedures such as conducting diabetes eye and foot exams and assisting patients in setting behavior change goals to improve self-management of their diabetes.⁴⁵ The program was offered to patients during a regular diabetes checkup with their primary care provider.

Thirty Colorado primary care practices participated, including two community health centers; 886 adults with type 2 diabetes were included in

the study. Individual clinics participated in the study for ~ 15 months, with the first 3 months dedicated to scheduling patient baseline visits, and the next 12 months dedicated to patient follow-up visits. Patients participated for ~ 12 months. Enrollment of clinics and patients was staggered over the course of the 4-year study. Of the 886 patients participating, 733 stayed in the study for the full year. Recruitment methods are described elsewhere.⁴⁶

Clinics were matched and randomized to receive either a tailored diabetes care and self-management program (treatment group) or a general health risk appraisal program (comparison group), which were installed on a study-provided computer with a touchscreen monitor located at each participating practice. Enrolled patients used the computer in conjunction with three regular diabetes office visits: the baseline study visit, plus two follow-up visits at 6 and 12 months postbaseline. The average number of visits completed for the study was 2.6.

The intervention was effective in improving provider adherence to ADA diabetes care performance standards when compared to the comparison group ($P = 0.001$). In addition, significantly more intervention patients reported that they received support from their health care team for self-management activities ($P < 0.001$). Glasgow et al.⁴¹ have published details of this study.

The interactive CD-ROM was programmed to automate some of the components of the Self-Management (Five As) Model (Figures 1 and 2) to help patients create a personalized action plan to improve their diabetes self-management. To do this, the program briefly *assessed* users on receipt of specific diabetes medical care procedures as recommended by the National Committee on Quality Assurance/ADA Provider Recognition Program⁴⁵ (e.g., "How long has it been since your feet were checked in your doctor's office?"), as well as on their current diet, physical activity, and smoking behaviors.

The program provided feedback and recommendations based on their answers (*advise*). It then helped them set a specific self-management goal in one of three broad goal areas (i.e.,

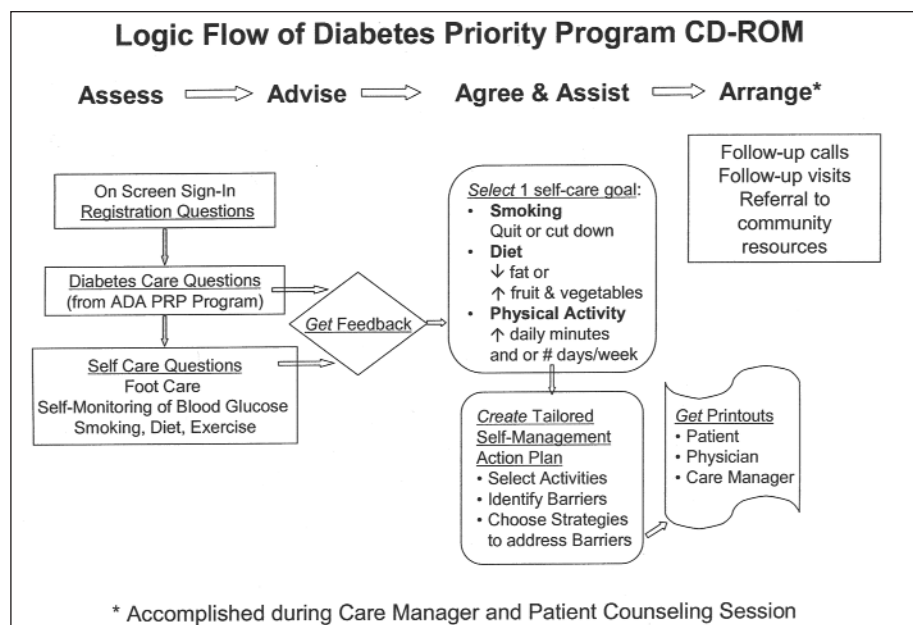


Figure 2. Logic Flow of DP Program CD-ROM. PRP, Provider Recognition Program.

smoking, diet, and physical activity) and choose two related activities from a predetermined list (e.g., walking and gardening) with an “other” option for activities not listed (*agree*). Users next selected from a list of barriers to achieving their goal and from a list of strategies that could help them overcome the barriers (*assist*).

When they finished, users received a two-page printout containing their personal action plan, a one-page summary of their plan for their provider to review and endorse, and a four-page detailed printout of their session (including assessment responses) to be used by a designated “care manager” who was a clinic staff member trained in the role by the research team (usually a nurse or medical assistant). The care manager reviewed the plan and counseled the patient for 10–15 minutes before departure. Finally, the care manager *arranged* a follow-up call and next visit.

Each patient repeated the intervention at 6 and 12 months to review the previous plan and make changes within the same goal area or choose a different goal area.

Patients receiving the comparison CD-ROM program completed a general health risk appraisal on a touchscreen computer and also received a printout. However, they did not create a tailored self-management plan or receive any specific self-management advice or counseling.

Integrating CD-ROM technology into primary care. To enhance patient and clinic staff acceptance for the program, the following criteria were used: 1) content relevant to the demographics of the targeted users; 2) simple and brief design to minimize disruption to clinic flow and address time and cost barriers without losing the ability to tailor action plans; and 3) well-organized, easy-to-understand printouts that address knowledge and confidence barriers and are appropriate to three different users (i.e., patients, providers, and care managers). Participants in the study were diverse with regard to sex, age, income, and ethnic background. (Table 1 summarizes participant characteristics.) Participating clinics were

also heterogeneous, ranging from small, privately owned rural and urban practices to large, nonprofit community health centers. Creating a program that was appropriate for such a wide range of users was challenging and necessitated compromises.

Attention was paid primarily to removing barriers to use based on lack of computer experience or physical limitations. Designing the CD-ROM to work with a touchscreen monitor eliminated the need for a mouse or keyboard, a key perceived obstacle to new users. Large type size and minimal on-screen text helped to minimize touch errors (i.e., selection of an unintended item) by users with impaired eye-hand coordination. Brief text instructions accompanied by audio narration were provided to help accommodate visual and hearing impairments. Finally, all study participants were instructed to arrive at least 30 minutes in advance of their appointments to complete the computer program so as to minimize disruptions to patient flow.

Satisfaction data regarding use of the CD-ROM during the office visit were collected from patients using a self-administered satisfaction survey when they completed their 12-month visit. Patient satisfaction results are summarized in Table 2.

In addition, extensive qualitative data were collected from clinic staff and providers by conducting open-ended interviews at two data collection points, the first during the study and the second after the clinic’s participation was completed (~ 15 months after their enrollment in the study). Detailed telephone and site

Table 1. Summary of Participant Characteristics

	DP Program (n = 886)	DHC Program (n = 280)*
Mean age (years)	63	61
Age range (years)	25–97	27–89
Percent female	52	49
Percent Latino	13	19
Income level:		
Percent earning at least \$30,000	59	74
Education level:		
Percent with some college	60	70
Computer experience:		
Percent novice users	35	not reported

*Total patients enrolled in the DHC study at the time of this writing.

visit contact notes between research staff members and clinic staff were entered into a qualitative database for later content analysis. The qualitative data provide some information about the subjective experience of both patients and clinic staff with regard to receiving and delivering the intervention. Quotes from clinic staff are included below, in order to highlight some important themes.

Despite concerted efforts to make the CD-ROM easy to use, we have anecdotal evidence that suggests some patients were reluctant to use the computer. As one clinic staff member put it, "A lot of our acute, older people have found the DP Program an annoyance. I think they're intimidated by the computer." However, once they sat down at the computer and used the CD-ROM, some users found that it was easy to use. One doctor who participated in the study said, "A lot of patients, the elderly, [say], 'I don't want to do a computer.' When they came in, they found out it was very easy."

Limiting the amount of on-screen text and eliminating the keyboard made electronic tailoring of action plans challenging. Users were presented with lists of common activities, barriers, and strategies along with a write-in option for other ideas.⁴⁷⁻⁵² Writing in other ideas was accomplished through a touchscreen alphabet keypad. This tradeoff resulted in mixed satisfaction for participants. Most patients (89%) agreed the program was easy to use, but there was less agreement (60%) that the plans and strategies suggested by the computer were personally relevant.

Feedback was continually solicited from the clinic staff about the CD-ROM and the program in general. One clinic staff member said, "I would ask them how beneficial it was to them. And they said it heightened their awareness as far as their diabetes." Another nurse mentioned, "After the computer program, we see them focused more on one or two issues [that need] to be addressed and it makes it more real." Some of the practitioners said the CD-ROM helped them improve their care to diabetes patients. One participating doctor said, "I think a fair number of [the patients] are like me. You can have a big goal, but you don't actually want to make the little steps. And, so I think the program has been good for the patient."

An important objective of the study was to integrate use of the CD-ROM during a regular diabetes appointment instead of requiring an extra visit. Despite a desire to keep the program simple and brief, most users took 20-45 minutes to complete the program because of cumbersome touchscreen alphabet keypads, the length of the research questionnaires, and the interactive action-planning process. To accommodate the length, a feature was added to allow patients to interrupt the session and finish later.

For the Diabetes Priority (DP) Program, the printouts produced by the CD-ROM served as the primary self-management intervention tools, providing structure and supplemental information that the care manager could use during the "nonautomated" component of the intervention. Thus, the printout of patients' action plans had to be clear and concise, with suffi-

cient space to write in other ideas and notes during discussion with the care manager (a sample printout is shown in Figure 3.) The provider printout was no more than one page, included instructions for use, and highlighted the items of most concern to the patients. The care manager printout provided more detailed data from patients' assessments of smoking, diet, and physical activity behaviors.

The Diabetes Health Connection Study: Linking Self-Management to Primary Care

The Diabetes Health Connection (DHC) study, a randomized, controlled 5-year trial, also used CD-ROM-based interactive diabetes self-management programs. A recruitment goal was set at 360 adults with type 2 diabetes, drawn from both private primary care and health maintenance organization offices in the Denver, Colo., metropolitan area. Patient recruitment was still underway at the time of this writing, so results reported here are for a subset of patients.

As in the DP Program, eligible patients were at least 25 years old, had received a diagnosis of type 2 diabetes, and were able to read and write in English. Participant characteristics are summarized in Table 1.

Randomization to study groups occurred at the patient, rather than the clinic, level, and patients were randomized twice within a 2-month period to test and control for interaction effects between various components of the intervention. Participants were then followed for 18 months. The four study conditions were: 1) tailored self-management (TSM) followed by a maintenance program focusing on community resources and support (Maint); 2) TSM followed by a general health risk appraisal (HRA) program similar to the program used by "usual care" clinics in the DP Program; 3) HRA followed by Maint; or 4) HRA followed by HRA. The latter group was considered the control condition.

A unique challenge of the DHC study was its use of focused, in-depth health counseling on multiple behavioral targets within the same session. After each session, patient goals and action plans were communicated to the referring primary care provider via fax and electronic communication sys-

Table 2. Participant Satisfaction with Diabetes Self-Management CD-ROM Programs

	Percent satisfied with DP Program* (n = 357)	Percent satisfied with DHC Program† (n = 154)
Was the computer easy to use?	89	97
Did the plans and strategies suggested by the computer fit you and your situation?	60	Not measured
Did you find the printouts to be helpful?	68	85

*Percentage of intervention participants who answered 4 or 5 on a scale of 1 to 5, in which 1 = "not at all" and 5 = "very much." †Percentage of intervention participants who had completed a satisfaction survey at the time of this writing and answered 5, 6, or 7 on a scale of 1 to 7, in which 1 = "not at all" and 7 = "completely."

DIABETES PRIORITY PROGRAM

Personalized Action Plan for MS ADMIN 9/27/2004

MY MEDICAL ACTION PLAN (tests you may be due for)

HEMOGLOBIN A1C TEST	Scheduled for	Date: _____	Time: _____	Date Completed: _____
DILATED EYE EXAM	Scheduled for	Date: _____	Time: _____	Date Completed: _____
FOOT EXAM/RISK ASSESSMENT	Scheduled for	Date: _____	Time: _____	Date Completed: _____
ALBUMIN, MICRO-ALBUMIN	Scheduled for	Date: _____	Time: _____	Date Completed: _____

MY SELF CARE ACTION PLAN (between now and my next doctor's appointment, I will):

1) I will reduce my intake of saturated fats

In order to reach the above goal, I will do the following activities:

- Use non-stick pan or non-fat cooking spray (e.g. PAM) for cooking)
- Broil or grill meats and fish, boil or poach eggs, versus frying

I will begin these activities on: 10/01/2004

PATIENT REPORT PAGE 1 OF 2

BARRIERS that get in my way	How I will overcome these barriers
<ul style="list-style-type: none"> • I have no self-discipline. <p>Comments or Other Plans:</p>	<ol style="list-style-type: none"> 1) Find a partner to support you. 2) Join a support group like TOPS or Weight Watchers. 3) Keep track of successes and reward yourself for even small accomplishments.
<ul style="list-style-type: none"> • I don't have time to cook so we buy a lot of fast food. <p>Comments or Other Plans:</p>	<ol style="list-style-type: none"> 1) Many fast food restaurants, list the fat and calorie content on their menu, so try to choose a lower fat meal. A Hint, choose broiled or grilled over fried, and hold the cheese and mayo. Try a side salad, baked potato, or baked potato chips. Avoid fries. 2) Plan ahead for preparing quick recipes at home like tuna noodle casserole, bean burritos, vegetable omelets, pasta and vegetables with tomato sauce. 3) Make a sack lunch the night before.

PATIENT REPORT PAGE 2 OF 2

Figure 3: Sample Printout: DP Program

tems. This linkage to primary care was a key feature of the study design.

The DHC study differed in several key ways from the DP Program. These differences were considered in the CD-ROM designs. First, unlike the DP Program, DHC participants met at a location external to their doctors' offices. Thus, the pressures of time and lack of reimbursement—two key barriers to self-management delivery noted in primary care—were less critical. Second, health educators (called DHC coaches) who were part of the research team conducted the intervention instead of clinic staff, which helped address two other barriers: lack of knowledge about behavioral

issues and lack of confidence in delivering a self-management intervention. Time commitment for health care teams was minimal, but the commitment for participants increased, because the program required a visit that was separate from and lengthier than a regular doctor's appointment.

Developing the DHC CD-ROM.

Two separate, yet related, CD-ROM programs were created for this study, to be used sequentially by patients. Both programs involved the interactive creation of action plans to improve multiple health behaviors. One program focused on evaluating both diet and physical activity to develop an integrated, tailored self-

management plan that addressed both of these behaviors. The other evaluated use of community and personal resources (i.e., family, friends, work, community organizations, media, and self) as a way to maintain positive self-management behaviors. In both cases, the program design allowed users to move quickly through the assessments in each area, receive feedback, select domain-specific strategies, and design an integrated action plan that was printed out for users and coaches to review.

Linking community-delivered prevention services with primary care.

While the study had many similarities to the DP Program in its target population, focus on tailored self-management, and use of interactive CD-ROM technology combined with health counseling as an intervention technique, the differences described above had significant design implications for the CD-ROM. First, while personal relevance and engagement remained important, the time barrier emphasized in primary care was reduced because participants used the program with research staff during a study-specific appointment. Second, user self-sufficiency was less critical, since help was readily available from DHC coaches. Since both mouse and keyboard could be utilized, the program could be more flexible to individual user needs. Users who failed to find personally relevant options among the on-screen choices could simply type in their own ideas for activities and strategies. Third, well-organized, clear printouts were especially critical because the provider printouts would be used as a communication mechanism linking patients' study activities to their primary care. This study-specific need to communicate with remote care providers required an added program feature; follow-up letters were automatically generated to patients and providers to reinforce patient goals and communicate lab test results. Last, removing the intervention from the clinic environment allowed for a more detailed assessment component, which in turn provided more specific patient feedback and more finely tuned goal-setting.

DISCUSSION

Using CD-ROMs as a modality for delivering a self-management inter-

vention was demonstrated to be feasible both within a variety of primary care settings and at an external community location.

Adapting CD-ROM technology to address specific barriers and maximize fit in different settings presented a number of challenges and tradeoffs. The primary care setting required a program that was brief, self-operating, and complementary to practice protocols. Although the touchscreen technology fit many of the needs in the primary care setting, there were tradeoffs. The touchscreen limited the ability to tailor action plans, requiring more forced choices. The CD-ROM that was used in the community setting permitted greater dedicated staff support and fewer time constraints, allowing for the inclusion of features such as drop-down menus and write-in strategies that resulted in a higher degree of tailoring. Again, there were tradeoffs. The length of the CD-ROM and the visit itself, scheduled in addition to a regular appointment, increased patients' burden.

Participation rates for both studies suggested a difference in relative burden between practices and patients that may have been related to the program's perceived convenience. Provider enrollment for the less demanding DHC program was more than threefold the provider enrollment for the DP Program (18 vs. 4.9% of providers contacted). Conversely, patients who were able to complete the program at their provider's office at the time of a regularly scheduled appointment (i.e., DP Program participants) were nearly twice as likely to participate than if they needed to commit to a more time-intensive program that required them to travel to a different location to use the computer (75 vs. 41% of eligible patients).

Thus, it is important to consider how reducing barriers for practices may create barriers for patients. Use of the Internet to allow patients to track progress, revise goals, and update action plans from their home, as well as e-mail information to their provider before their visit, may be one way to minimize the time burden for both users, assuming patients have access.

Advantages of CD-ROMs

There are many clear advantages to using IHTs for health interventions.

CD-ROMs, for instance, are portable, cost-effective (after development and if able to reach a large number of users), flexible, and—because they run on a desktop, laptop, or kiosk computer—have no bandwidth or connectivity restrictions that can arise with Internet applications. CD-ROMs are capable of delivering high-performance media, including video, audio, and animation elements that can engage users and provide clear instructions and examples. When used in the context of a busy medical practice, they can also save clinician and staff time, providing health information and self-management guidance efficiently and consistently. Production of paper printouts provides both patients and health care team members with a tangible communication tool that focuses discussion, is portable, and can be easily tailored.

CD-ROMs are also less vulnerable to external interference than web-based programs subject to viruses or network interference. With new patient privacy regulations in effect, use of CD-ROM programs on a non-networked computer may be perceived by patients and clinic staff as safer and more confidential than web-based applications. However, secure websites and secure file transport protocol may provide the best of both worlds when it comes to data security, ease of data transfer, and data compilation from remote sites.⁵³

Finally, from a marketing perspective, CD-ROMs can be more easily packaged for dissemination and controlled via password and serial number than can open Internet sites.

Limitations of CD-ROMs

All technologies, including CD-ROMs, have limitations. Compared with the Internet, they are more rigid in terms of making alterations.⁵⁴ For the DHC study, revisions to the program were included in the budget to refine and possibly disseminate the program after it had been tested. Ease of revision will depend on study outcomes and the features that warrant change. Planning for CD-ROM revision is difficult, given the unknowns. Conceptually, the structure of the program was deliberately kept flexible enough to allow for a cost-effective revision at a later date. That being

said, flexibility and ease of revision is a key limitation of the CD-ROM medium as compared to website technology or even print materials.

Users familiar with the Internet may be less knowledgeable about installing CD-ROM software. Access to CD-ROM programs is more limited than to programs available through the Internet. This is an advantage for targeting and controlling use of the program, but it is a deterrent to widespread use. Providing CD-ROM programs in medical offices and community sites is one way to increase access.

CD-ROMs require specific hardware and software to be functional, which may be their biggest limitation. Users may be required to purchase extra computer memory capacity and specific devices needed to support the video components. Information contained on CD-ROMs may become dated or obsolete at a time of rapid change in medicine and technology. Finally, use of CD-ROM programs alone cannot easily provide the social or group support, such as that found in chat rooms, a key advantage of the Internet.

Capitalizing on the strengths while minimizing the limitations of CD-ROMs is an important part of the media development process. Many pitfalls can be avoided through careful planning and up-front discussion with the multimedia team. For example, design rigidity can be offset by creating rough, content-based designs for the most visible elements of the program (e.g., printouts) for rapid-cycle testing. This allows the research team an opportunity to pilot and modify key components and enables the programmers to determine what data must be extracted from the program. Once content is agreed upon, designs can be created, reviewed, and tested, allowing for final revisions.

Protection of user identity and data, a key advantage of CD-ROMs over web-based technologies, also requires thorough up-front planning. The multimedia team must design and build smart set-up screens that prohibit duplication of user names or identification numbers and avoid data entry errors. Similarly, with proper planning, a CD-ROM that contains elements useful to research but not necessary for general dissemination can be designed to allow for later

extraction of specific components. These components could be left in the program, but hidden from view, or saved in separate modules for later removal.

When developing CD-ROM programs, staying focused on key objectives and instituting decision-making mechanisms for weighing options pays off. Cost/benefit considerations include: 1) what is best for today versus what is best for future applications; 2) specific content versus fancy features (This may depend on whether the program will be used once, is a component of a program series, or is used multiple times by the same user.); and 3) design for all users without assistance versus design for most users, with novices probably needing some assistance.

A future consideration for IHT applications are hybrid programs that combine the best features of both CD-ROMs and the Internet to maximize the unique advantages of the different interactive technologies. High-performance media components, such as video, audio, animation, and complex graphics, could be located on a CD-ROM in combination with delivery of real-time information via the Internet. Web links could be built into the CD-ROM program itself to enhance program content, and live aspects, such as bulletin boards or "chat," could be included. Combining the use of these technologies could also prolong the shelf life of CD-ROMs by allowing for updates that keep up with the pace of medical knowledge.

CONCLUSIONS

IHTs have a clear role in diabetes self-management interventions.^{3,17,38} For users wanting a prepackaged intervention with proven efficacy, CD-ROMs' consistency, portability, and data safety features are appealing. Our studies to date have shown that it is possible to integrate use of CD-ROM technology into busy clinical practices. A CD-ROM intervention also can work well at an external, centralized location (e.g., health resources center) with links to primary care. Where and how a CD-ROM intervention is delivered depends on the objectives, setting, patient population, and health issue the program means to address. In any case, the ability to customize programs and printouts to address the

needs of a particular setting is important and critical for addressing the key barriers to implementing self-management interventions in primary care.

The intervention protocols described here have used CD-ROMs to provide consistent health information and initiate the interactive process of setting tailored goals for diabetes self-management. The computer printouts have provided a structure for communication between patients and counselors, either clinical or research staff. Our experiences to date have suggested that for patients with type 2 diabetes—a complex chronic condition that affects multiple lifestyle domains—CD-ROMs provide useful intervention tools for use in clinical practice, either in the office setting or at another location with links to the provider.

CD-ROMs show promise as adjuncts to care and as stand-alone resources. It is important to note that the programs described in this article have not been tested as stand-alone education tools. Future research is needed to compare the effectiveness of CD-ROM technology as a substitute for human interaction rather than as an adjunct to primary care.

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