Web-Based Collaborative Care Improves Glycemic Control in Type 2 Diabetes

Giving patients with type 2 diabetes the opportunity to manage their care online can substantially improve their long-term glucose control.

BY JAMES D. RALSTON, MD, MPH

Traditional health care, which is limited to clinic visits, is not enough to care for the needs of the many patients with diabetes, according to James D. Ralston, MD, MPH, and colleagues. Dr. Ralston, from the Center for Health Studies, Group Health Cooperative in Seattle, and colleagues tested a Web-based program managing glycemic control among patients with type 2 diabetes, using a shared electronic medical record. The intervention gave patients access to the same medical records used by their primary care physician, as well the ability to e-mail health care providers. The program also provided feedback on blood glucose readings, a Web site with educational information on diabetes, and an interactive diary that allowed the patients to keep track of their diet, exercise, and medications. The results were published in *Diabetes Care* (2009;32:234–239); this article provides a summary of those findings.

BACKGROUND

Using the Internet as an adjunct to providing health care allows the focus to be on patients' homes and their daily lives, rather than the office or clinic setting. Previous research has suggested that when patients use online care plans and electronic medical records, care for chronic conditions is more effective.[1,2] It is not known however, if the use of Web communications and shared electronic medical records can be beneficial in the primary care of diabetes patients.

Our study was a randomized trial that examined a Web-based diabetes support program aimed at improving glycemic control. Type 2 diabetes patients in the program were able to access their own electronic medical record, have secure electronic communications with their providers, and use interactive disease management tools—from their home. We hypothesized that glycemic control would improve in the group receiving the intervention.

Patients in the program were able to access their own electronic medical record, have secure electronic communications with their providers, and use interactive disease management tools—from their home.

STUDY DESIGN

We enrolled participants between August 2002 and May 2004 in the 12-month open, randomized, single-center, controlled trial with a parallel-group design. The trial was conducted at the University of Washington General Internal Medicine Clinic (GIMC), a teaching clinic that provides care to 7,707 patients. Twenty-five faculty and 48 resident providers staff the clinic, and a nurse practitioner provides case management services to chronic disease patients.

We used electronic medical record data to identify potential participants aged 18 to 75 years, whose most recent A1C level in the prior 12 months was ≥7%, and who had made at least two visits to GIMC during the preceding year. Exclusion criteria included patients who participated in our pilot study, those with major psychological illnesses, non-English speaking, if they had a resident as a primary physician, or were followed primarily in a specialty clinic. After potential participants were contacted by phone, additional exclusion criteria included lack of Internet access and cognitive, lan-

TABLE 1. DESIGN OF WEB-BASED COLLABORATIVE CARE INTERVENTION	
Domain[4]	**Intervention**
Self-management support	Promoted patient review of the electronic medical record at home over the Web through "My Health Record," a real-time view of the same record and interface used by providers and containing all clinical data since January 1994
	Provided remote collaboration and interactive feedback on automatically uploaded blood glucose readings over the Web through "My Upload Meter"
	Provided remote collaboration and interactive feedback on nutrition, medications, and exercise using a Web-based self-management tool, "My Diabetes Daily Diary"
	Promoted and integrated secure e-mail into ongoing care with diabetes case manager
	Provided general diabetes educational Web site with links to information endorsed by the medical director of the UW Diabetes Care Center
Delivery system design	Used case manager model
	Provided initial weekly follow-up over the Web for blood glucose levels and other self-management needs
	Provided subsequent proactive follow-up based on patient needs
	Promoted and integrated secure e-mail exchanges into ongoing care
	Promoted and integrated patients' blood glucose and lifestyle information into ongoing care
Clinical information systems	Provided ongoing tracking and documentation of patients' needs and care
	Used secure e-mail integrated as part of the record
Decision support	Used an interactive electronic medical record for collaborative decision support shared by both patient and provider
	Clinical reminders visible to both patient and provider
	Single-page summary of patients' clinical information relevant to diabetes
	Established provider decision support through patients' remote transmission of blood glucose readings, daily diary inputs, and secure e-mail exchanges

Table adapated from Diabetes Care. *2009;32:234–239.*

guage, or hearing impairment severe enough to preclude participation. Baseline data for all participants were from automated data in the electronic medical records.

INTERVENTION

The main goal of the intervention was to improve glycemic control. For the study, we used a care manager[3] and targeted four key domains in Wagner's Chronic Care Model: self-management support for patients, delivery system design, clinical information systems, and clinical decision support (Table 1).

Patients assigned to the care management group met with the care manager for a 1-hour visit. During the visit, the care manager used a collaborative-care approach consisting of four components: (1) defining problems, (2) setting goals, (3) providing access to services that teach skills needed to carry out medical regimens, guide health behavior change, and provide emotional support, and (4) following up actively. The care manager reviewed the patient's electronic medical record with the patient and then created an action plan with the patient's input.

Participants were introduced to the Web-based program by the care manager and were encouraged to review online medical records, send blood glucose readings weekly, and send e-mail (secure) as needed. The care manager responded to patients' messages Monday through Friday, reviewed blood glucose levels at least once per week, adjusted hypoglycemic medications, and conferred with the primary care provider as needed.

The patients received primary care from a physician who was board certified in internal medicine at the UW GIMC, and all providers used the same electronic medical record, which included patient-specific reminders for measurement of A1C levels <7.0%.

TABLE 2. STUDY OUTCOMES AND SERVICE USE AT 12 MONTHS AFTER INTERVENTION BY RANDOMIZATION GROUP				
	Usual-Care Group	Intervention Group	Mean Group Difference	
n	35[a]	39[a]		
Mean A1C (%)				
Baseline	7.9	8.2	0.3	0.12
Follow-up	8.1	7.3	−0.8	0.01
Change	0.2	−0.9	−1.1	<0.01
Adjusted analysis	—	—	−0.7	0.01
A1C <7% (%)				
Baseline	0	0	0	—
Follow-up	11	33	22	0.03
Change	11	33	22	0.03
Any contacts (%)				
E-mail with case manager	0	69	NA	
Blood glucose level uploads	0	43	NA	
Review of electronic medical record	0	76	NA	
Outpatient visits				
Pre	10.3 ± 7.7	9.6 ± (9.6)	−0.7	0.71
Post	8.2 ± (9.1)	10.2 ± (10.1)	2	0.36
Change	−2.1 ± (7.0)	0.6 ± (10.7)	2.7	0.18
Primary care provider visits				
Pre	3.3 ± 2.2	4.3 ± 3.8	1	0.15
Post	3.1 ± 3.0	4.3 ± 4.5	1.2	0.16
Change	−0.2 ± 2.8	0.0 ± 2.9	0.2	0.76
Specialty physician visits				
Pre	7.0 ± 7.9	5.3 ± 7.1	−1.7	0.3
Post	5.1 ± 8.7	5.9 ± 7.4	0.8	0.66
Change	−1.9 ± 5.9	0.6 ± 9.0	2.5	0.14
Inpatient days				
Pre	0.7 ± 1.8	0.3 ± 1.5	−0.4	0.31
Post	0.4 ± 1.2	0.5 ± 2.0	0.1	0.77
Change	−0.3 ± 1.8	0.2 ± 2.6	0.5	0.32

Data are mean, mean ± SD, or % unless otherwise indicated; analysis adjusted for age, sex, and baseline A1C.
[a] *Six patients in the usual-care group and three in the intervention group did not have follow-up A1C measures at 12 months.*
Table adapted from Diabetes Care. *2009;32:234–239.*

OUTCOMES

The primary outcome was absolute change in A1C between baseline and end of the 12-month study period. Total cholesterol and blood pressure were analyzed as secondary outcomes. A1C tests were performed using rapid immunoassay tests from a Bayer Laboratories DCA-2000+ analyzer (Siemens Medical Solutions Diagnostics, Tarrytown, NY), and we did a secondary analysis of the percentage of patients who had A1C <7%.

Post hoc analyses evaluated secondary outcomes related to overall care of diabetes but not targeted by the intervention (blood pressure and total cholesterol).

We measured health care utilization by the total number of outpatient encounters with health care providers and inpatient days at the UW Medical Center and affiliated hospitals and clinics during a 2-year period that included the 12 months before study enrollment and the 12-month intervention period. Outpatient encounters were further divided into specialty and primary care encounters.

We also measured electronic medical record access by counting the number of page views by section of the Web-based medical record, and we kept track of e-mail use by participants.

RESULTS

Among the 83 patients randomized to the usual-care and intervention groups, the difference in percentage of whites between groups approached significance (73.0% usual care vs 89.7% intervention group; *P*=.06); 54 participants (65%) had all three diagnoses of diabetes, hyperlipidemia, and hypertension. Six patients assigned usual care group and three individuals assigned to the intervention did not have follow-up A1C measurements. No adverse events were attributed to study participation.

Primary outcomes. We observed a significant decline in A1C in the intervention group compared with the usual-care group (change –0.7%; *P*=.01) at 12 months after adjusting for age, sex, and baseline A1C (Table 2). Unadjusted analysis increased the effect size (–1.1%; *P*=.003). Adjustment for non-Hispanic white race/ethnicity did not change effect size.

Secondary outcomes. More participants in the intervention group versus the usual-care group had A1C <7% after 12 months (33 vs 11%; *P*=.03 for difference between groups; Table 2). There was no difference between the intervention and usual-care groups with regard to baseline systolic blood pressure (133.0 vs 133.3 mm Hg; *P* .93), diastolic blood pressure (76.0 vs 76.3 mm Hg; *P*=.91), or total cholesterol (192.7 vs 188.8 mg/dL; *P*=.70). At 12 months, mean changes in systolic blood pressure (–0.9 mm Hg; *P*=0.84), diastolic blood pressure (0.1 mm Hg; *P*=.96), and total cholesterol (7.6 mg/dL; *P*=.38) were not significantly different between groups.

Health care utilization, medication changes. There were no statistically significant differences between groups with regard to utilization measures significant. The care manager spent about 4 hours per week updating care plans and using the Internet to communicate with patients assigned to the intervention group.

We found that in the intervention group, 76% of patients accessed their electronic medical record, 69% e-mailed, 43% uploaded blood glucose readings, and 33% entered medication, nutrition, or exercise data. The participants viewed 1,146 Web pages of the electronic medical record distributed as follows: transcribed notes (26%), lab results (20%), problem lists (9%), reminders to receive indicated care (6%), cardiology diagnostic reports (4%), and radiology reports (4%). There was no relationship between the number of page views of the electronic medical record (n = 1,146) and improvement in A1C. Uploads of blood glucose levels (n = 189), however, showed a trend toward improvement with each additional 10 uploads associated with an estimated 0.4% reduction in A1C (*P*=.09).

Patients who were assigned to the intervention group who had a follow-up A1C <7% were older (mean age 62 years) than those with follow-up A1C ≥7% (56 years) (*P*<.05). Mean age, baseline A1C, and percentage non-Hispanic white were similar among those with follow-up A1C <7% compared with those with follow-up A1C 7%. Comparisons within the intervention group were limited by small sample sizes.

CONCLUSIONS

This investigation revealed that Web-based collaborative care of diabetes using a shared electronic medical record improved glycemic control in type 2 diabetes patients. The 0.7% decrease in A1C observed in the intervention group is in agreement with telephone and in-person interventions that use care managers who are integrated with primary care teams,[3,4] focused on self-management support,[5] and able to modify a patient's medication regimen.[4,6] We found that previous studies of Web-based and telemedicine methods for management of these patients showed modest improvements in A1C levels (0.3–0.6%) but lacked full integration with primary care teams.[7-9] Our intervention's use of Web-based communications to extend the connection to primary care outside the office is consistent with the vision of the Institute of Medicine[2] and the Patient-Centered Advanced Medical Home.[10]

We believe that ours is the first trial of Web-based support for diabetes care that included complete patient access to the same electronic medical record used by a patient's providers. The value of promoting patient review of the paper medical record as part of multifaceted interventions in diabetes and other chronic diseases has been shown in several studies.[11-13] Our work extends previous evidence by connecting patients and providers through a shared electronic medical record.[1,14,15] We think future studies should continue to determine how best to share electronic records with patients who have diabetes.

The intervention did not lead to significant changes in health care utilization, however, it was not designed to reduce costs or powered to detect changes in use of services and costs. The Web technology used in our study was relatively low cost and already in use by many patients in other aspects of their daily lives. Future interventions may also become more efficient as care managers' skills further develop. If larger trials determine that collaborative care management over the Web is cost-effective, reimbursement for providers will need to be reformed to support electronic communication.

We conclude that current health care systems do not sufficiently support the needs of patients with diabetes and other chronic conditions. As a result, patients suffer the consequences in morbidity and mortality. In keeping with the vision of the Institute of Medicine and the Patient-Centered Advanced Medical Home, this study improved glycemic control with Web-based care management using a shared electronic medical record. Should this intervention prove generalizeable and cost effective, it will support the case for reimbursement reform.

COMMENT FROM AADE PRESIDENT

Review of Endocrinology invited Marcia Draheim, RN, CDE, President of the American Association of Diabetes Educators to comment on the use of Web-based initiatives and their role in the management of patients with diabetes. In an e-mail, she said, "Current and evolving technology can be very helpful and efficient as a support tool to enhance communications between health providers and their patients. However, allowing patients limitless access to and review of their own medical record and then providing most of the communication in the form of e-mail exchanges between provider and patient to make changes in the patients' therapy and/or provide conversation/explanations does not guarantee optimal understanding from the patient perspective relating to self-management of their health. Therefore, technology should be utilized as a support for immediate communication needs; however, it should not take the place of live face-to-face visits with a certified diabetes educator.

Commenting specifically on this investigation, Ms. Draheim said, "Although the population was screened for study prerequisites to meet study guidelines, it should be noted that although the patients may have met language criteria, they may not have necessarily understood medical terminology. If those entering information into the electronic record utilized a significant amount of medical terminology and phrasing, the patient who does not understand this 'type of language' would not necessarily benefit from 'access and review of their own electronic medical record.' The study found that patient review of their medical record did not have that great of an impact on goal attainment.

Finally, Ms. Draheim concluded, "Populations will vary on their learning and communication styles and preferences regardless of their generation/age. We need to embrace the value of technology for its considerable strengths in furthering/enhancing health care but also be careful not to overassign strengths in its application in place of human interface of providers with their patients throughout the entire health provision process." ■

James D. Ralston, MD, is from the Center for Health Studies, Group Health Cooperative, Seattle. He may be reached at ralston.j@ghc.org.

1. Ralston JD, Revere D, Robins LS, Goldberg HI. Patients' experience with a diabetes support programme based on an interactive electronic medical record: qualitative study. BMJ. 2004;328:1159.
2. Institute of Medicine: Crossing the Quality Chasm: A New Health System for the 21st Century . Washington, D.C., National Academy Press, 2001
3. Aubert RE, Herman WH, Waters J, et al. Nurse case management to improve glycemic control in diabetic patients in a health maintenance organization: a randomized, controlled trial. Ann Intern Med. 1998;129:605–612
4. Bodenheimer T, Wagner E H, Grumbach K. Improving primary care for patients with chronic illness: The Chronic Care Model, Part 1. JAMA. 2002;288:1775–1779.
5. Norris SL, Lau J, Smith SJ, et al. Self-management education for adults with type 2 diabetes: a meta-analysis of the effect on glycemic control. Diabetes Care. 2002;25:1159–1171.
6. Shojania KG, Ranji SR, McDonald KM, et al. Effects of quality improvement strategies for type 2 diabetes on glycemic control: a meta-regression analysis. JAMA. 2006;296:427–440.
7. Bond GE, Burr R, Wolf FM, et al. The effects of a web-based intervention on the physical outcomes associated with diabetes among adults age 60 and older: a randomized trial. Diabetes Technol Ther. 2007;9:52–59.
8. McMahon GT, Gomes HE, Hickson Hohne S, et al. Web-based care management in patients with poorly controlled diabetes. Diabetes Care. 2005;28:1624–1629.
9. Shea S, Weinstock RS, Starren J, et al. A randomized trial comparing telemedicine case management with usual care in older, ethnically diverse, medically underserved patients with diabetes mellitus. J Am Med Inform Assoc. 2006;13:40–51.
10. Blue Ribbon Panel of the Society of General Internal Medicine: Redesigning the practice model for general internal medicine: a proposal for coordinated care: a policy monograph of the Society of General Internal Medicine. J Gen Intern Med. 2007;22:400–409.
11. Greenfield S, Kaplan SH, Ware JE Jr, et al. Patients' participation in medical care: effects on blood sugar control and quality of life in diabetes. J Gen Intern Med. 1988;3:448–457.
12. Greenfield S, Kaplan S, Ware JE Jr. Expanding patient involvement in care: effects on patient outcomes. Ann Intern Med. 1985;102:520–528.
13. Kaplan SH, Greenfield S, Ware JE Jr. Assessing the effects of physician-patient interactions on the outcomes of chronic disease. Med Care. 1989;27(Suppl. 3):110–127.
14. Ralston JD, Carrell D, Reid R, et al. Patient web services integrated with a shared medical record: patient use and satisfaction. J Am Med Inform Assoc. 2007;14:798–806.
15. Tang PC, Lansky D. The missing link: bridging the patient-provider health information gap. Health Aff (Millwood). 2005;24:1290–1295.