

A systematic review of studies of web portals for patients with diabetes mellitus

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Abstract: Patient web portals are password-protected online websites that offer patients 24-hour access to personal health information from anywhere with an Internet connection. Due to advances in health information technologies, there has been increasing interest among providers and researchers in patient web portals for use by patients with diabetes and other chronic conditions. This article, which is based upon bibliographic searches in PubMed, reviews web portals for patients with diabetes mellitus including patient web portals tethered to electronic medical records and web portals developed specifically for patients with diabetes. Twelve studies of the impact of patient web portals on the management of diabetes patients were identified. Three had a cross-sectional design, 1 employed mixed-methods, one had a matched-control design, 3 had a retrospective cohort design, and 5 were randomized controlled trials. Six (50%) of the studies examined web portals tethered to electronic medical records and the remainder were web portals developed specifically for diabetes patients. The results of this review suggest that secure messaging between adult diabetic patients and their clinician is associated with improved glycemic control. However, results from observational studies indicate that many diabetic patients do not take advantage of web portal features such as secure messaging, perhaps because of a lack of internet access or lack of experience in navigating web portal resources. Although results from randomized controlled trials provide stronger evidence of the efficacy of web portal use in improving glycemic control among diabetic patients, the number of trials is small and results from the trials have been mixed. Studies suggest that secure messaging between adult diabetic patients and their clinician is associated with improved glycemic control, but negative findings have also been reported. The number of randomized controlled trials that have examined the efficacy of web portal use in improving glycemic control among diabetic patients is still small. Additional research is needed to identify specific portal features that may impact quality of care or improve glycemic control.

Keywords: Diabetes; electronic health record; glycemic control; health information technology; hemoglobin-A1c; patient web portals

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Background

Diabetes affects over 29 million Americans and is the sixth leading cause of death (1,2). Diabetes is the leading cause of kidney failure, lower-limb amputations, and blindness in adults (2). In 2012, the total economic cost of diabetes in the U.S. was between \$245 billion and \$322 billion (3). Diabetes accounts for over 20% of health care spending. Although good glycemic control is associated with improved health outcomes and lower morbidity and premature mortality, almost half of patients with type 2 diabetes do not meet recommended targets for glycemic control, blood pressure control, or low density lipoprotein (LDL) cholesterol control (4). Many patients with type 2 diabetes cared for in the community do not meet recommended treatment goals (5,6).

Type 2 diabetes requires effective patient-provider communication and patient self-management to manage side effects, monitor blood test results, and screen for potential complications (7). Studies have shown that increasing patients' knowledge about their risk factors can lead to improved clinical outcomes (8,9). Moreover, evidence shows that fostering a collaborative relationship between patients and their health care providers can also improve clinical outcomes (10,11).

To improve diabetes care and health outcomes, there has been increasing interest by care providers in utilizing information technology to support patient-provider communication and patient self-management. Patient portals provide health care information that is linked to a patient's electronic medical record (EMR) (12,13). Patients are able to view their health care information such as medications, laboratory test results, doctor visits, discharge summaries, and results of diagnostic tests (14,15). Many patient portals also allow patients with diabetes and other chronic conditions to request refills of prescription medications, schedule appointments, and exchange e-mail with their health care provider (12).

The goal of the current article was to review the evidence on patient web portals for diabetes mellitus including patient web portals tethered to EMRs and web portals developed specifically for patients with diabetes.

Methods

This review is based upon PubMed bibliographic searches and appropriate search terms. Articles published in English from 1993 through February 2017 were identified using

Boolean algebra commands and MeSH search terms: (web portal or patient web portal) and diabetes. The references of review articles were also reviewed (12,13,16,17). Information obtained from the bibliographic searches (information presented in abstract, key words, and study design) was used to determine whether to retain each identified article. Only studies with a randomized controlled trial, retrospective cohort, or cross-sectional study design were included.

A total of 94 articles were identified. After screening the full texts or abstracts of the 94 articles and reviewing review articles (12,13,16,17), 12 studies met the eligibility criteria.

Results

Of the 12 studies identified in this review, three had a cross-sectional design, one employed mixed-methods, one had a matched-control design, three had a retrospective cohort design, and 5 were randomized controlled trials. Six of the studies examined web portals tethered to EMRs and six were web portals developed specifically for diabetes patients.

Studies of web portals tethered to EMRs and used for diabetes management are summarized in *Table 1*. None had a randomized controlled trial design. Sarkar *et al.* (15) examined web portal use by adult diabetics who were included in the Kaiser Permanente Northern California Diabetes Registry. Among 14,102 participants, 6,099 (62%) had a limitation in health literacy. A total of 5,671 respondents (40%) registered for the web portal. Those with lower health literacy were more likely to not sign on to the patient portal [adjusted odds ratio (OR) =1.7; 95% CI: 1.4–1.9] than those who did not have a health literacy limitation. Wade-Vuturo *et al.* (18) examined patient web portal use by 54 adults with type 2 diabetes seen at a Nashville, Tennessee hospital. Secure messaging between patient and their health care provider was positively associated with patients' glycemic control ($P=0.04$). In a retrospective cohort study of patients registered for the U.S. Department of Veteran's Affairs My HealtheVet patient web portal, Shimada *et al.* (7) evaluated the use of web-based prescription refill, secure messaging and laboratory tests used in the management of type 2 diabetes. Patients with elevated hemoglobin A1c (HbA1c) at baseline who used secure messaging were more likely than those who did not use secure messaging to achieve glycemic control after age and sex were controlled for [OR =1.24; 95% confidence interval (CI): 1.14–1.34]. Patients with elevated

Table 1 Studies of web portals tethered to electronic medical records and used for diabetes management

Study	Sample	Design	Results	Limitations
Sarkar <i>et al.</i> 2010	Adult diabetics (n=14,102) in the Kaiser Permanente Northern California Diabetes Registry (28% non-Hispanic white, 14% Latino, 21% African American, 21% Asian, and 17% multiracial or other ethnicity)	Cross-sectional survey and review of electronic records on patient portal use	About 40% of respondents (n=5,671) registered for the web portal. Those with limited health literacy were less likely to sign on to the web portal [adjusted odds ratio (OR) =1.7, 95% confidence interval (CI) =1.4–1.9] compared with those who did not have a limitation in health literacy	The study findings may not be generalizable to uninsured patients.
Wade-Vuturo <i>et al.</i> 2013	54 adult patients with type 2 diabetes seen at a Nashville, TN hospital	Mixed-methods study that included a cross-sectional patient survey	Secure messaging between patient and clinician was positively associated with glycemic control (P=0.04)	Small sample size, uncertain generalizability
Shimada <i>et al.</i> 2016	Diabetic patients registered for the Veterans Health Administration My HealtheVet patient portal	5-year retrospective cohort study of the link between use of My HealtheVet for refilling prescription medications, secure messaging, and lab tests used for managing type 2 diabetes	Patients with elevated hemoglobin A1c (HbA1c) at baseline who used secure messaging were more likely than nonusers to achieve glycemic control (adjusted OR =1.24; 95% CI: 1.14–1.34). Patients with elevated blood pressure at baseline who used web-based refills were more likely than nonusers to achieve blood pressure control (OR=1.08; 95% CI: 1.02–1.14).	Non-randomized design, uncertain generalizability
Harris <i>et al.</i> 2009	Group Health Cooperative diabetic patients (n=15,427) aged ≥18 years	Cross-sectional study. The outcomes were diabetes-related quality-of-care indicators [HbA1c <7%, blood pressure <130/80 mmHg, and low density lipoprotein (LDL) cholesterol <100 mg/dL]	About 19% of diabetic patients used secure messaging to communicate with their health care providers. Use of secure messaging was positively associated with HbA1c <7% [adjusted relative risk (RR) =1.36; 95% CI 1.16–1.58]. Frequent use of secure messaging was positively associated with increased outpatient visits.	Nonrandomized design. The study findings may not be generalizable to uninsured patients.
Zhou <i>et al.</i> 2010	Adult Kaiser Permanente patients (n=35,423) in Southern California with diabetes or hypertension	Matched-control analysis	Secure messaging was positively associated with improved HbA1c screening and control (P<0.0001), LDL-C screening and control, retinopathy screening, and nephropathy screening. Secure messaging was also associated with improvement in blood pressure (P<0.001)	Non-randomized design. The study findings may not be generalizable to uninsured patients
Tenforde <i>et al.</i> 2012	Adult diabetics followed at the Cleveland Clinic (n=10,746) aged 18–75 years	Retrospective analysis. The outcome measures were dilated retinal exam, pneumococcal vaccination, test for microalbuminuria, foot exam, smoking cessation, HbA1C, systolic and diastolic blood pressure, LDL cholesterol, and body mass index	Personal health record users had better diabetes quality measure profiles than non-users. The adjusted OR of HbA1c testing was 2.06 (P<0.01). Among personal health record users, increasing number of login days was not associated with more favorable diabetes quality measures	Non-randomized design, lack of information about care received outside the Cleveland Clinic health system

blood pressure at baseline who used My HealtheVet to refill prescription medications were more likely than nonusers to achieve blood pressure control at follow-up (OR =1.08; 95% CI: 1.02–1.14). Studies of Group Health Cooperative diabetic patients found positive associations between the use of secure messaging and improvements in HgbA1c testing and glycemic control (19,20). Positive associations between portal use and improvements in cholesterol were also observed among Kaiser Permanente patients with diabetes or hypertension in Southern California (21). Secure patient-physician messaging was associated with an improvement in performance ($P<0.0001$) on HbA1c screening and control, LDL-C screening, LDL-C control, retinopathy screening, and nephropathy screening of 2.4–6.5%. Tenforde *et al.* (22) examined use of electronic personal health records by adult patients with diabetes who were treated at the Cleveland Clinic ($n=10,746$). Compared to non-users, personal health record users had improved diabetes quality measures. The adjusted OR of HbA1c testing was 2.06 ($P<0.01$).

Studies of web portals developed specifically for patients with diabetes are summarized in *Table 2*. Grant *et al.* (23) conducted a 12-month cluster randomized controlled trial of a personal health record linked to the patient's EMR, which enabled patients to access and read guidelines, review their lab results and medication lists, write comments to the EMR, and edit their medication lists. The primary outcomes were changes from baseline in HbA1c, blood pressure, and LDL cholesterol. More patients in the intervention group had their diabetes treatment regimens adjusted compared with controls (53% *vs.* 15%, $P<0.001$). However, there were no significant differences in risk factor control between study groups ($P=0.053$). Ralston *et al.* (24) conducted a randomized controlled trial that compared usual care plus Living with Diabetes program Web-based care management (patient access to EMR, secure e-mail with providers, feedback on blood glucose readings, an online diary for physical activity and nutrition, and an educational site) *vs.* usual care. On average, HbA1c levels declined by 0.7% (95% CI: 0.2–1.3) among patients in the intervention arm compared with the usual care group. McCarrier *et al.* (25) conducted a 12-month pilot randomized controlled trial of usual care plus Web-based collaborative care (Living with Diabetes program) *vs.* usual care alone. A non-significant decrease in average HbA1c was observed in the intervention group compared to the usual care group (-0.48 ; 95% CI: -1.22 to 0.27 , $P=0.160$). Tang *et al.* (26) conducted a 12-month randomized controlled trial of an online diabetes management system that included home

glucometer readings, nutrition and exercise logs, secure messaging with the patient's providers, comprehensive patient-specific diabetes status report, advice and medication management from a nurse care manager and dietitian, and brief educational videos. Compared with usual care patients, the intervention group patients had reduced HbA1c at 6 months (-1.32% *vs.* -0.66% , $P<0.001$). No significant differences were observed at 12 months (-1.14% *vs.* -0.95% , $P=0.133$). In a retrospective cohort study, Lau *et al.* (27) found that, compared to patient web portal non-users, a higher proportion of users achieved HbA1c $<7\%$ at follow-up (56% *vs.* 32%, $P<0.031$). Tutino *et al.* (28) conducted a randomized controlled trial comparing web portals for diabetic patients alone *vs.* patient web portal plus nurse-coordinated follow-up visits. The primary outcomes was proportion of patients achieving ≥ 2 treatment targets (HbA1c $<7\%$, blood pressure $<130/80$ mmHg, and LDL cholesterol <2.6 mmol/L). The proportion of participants attaining >2 treatment targets increased in both groups and there similar absolute reductions in HbA1c and LDL cholesterol, with no between-group difference.

Discussion

Although results-to-date have been mixed, this review suggests that secure messaging between adult diabetic patients and their clinician is associated with improved glycemic control. Improvements in LDL cholesterol and blood pressure have also been observed in some studies of web portals used by patients with diabetes and hypertension (7). The specific portal features that may impact quality of care or improve glycemic control (e.g., patient-provider secure messaging, online access to lab test results or instructions, other patient supports) has not been clearly distinguished by studies completed to date. Secure messaging may facilitate coordination of diabetes care and make it easier for providers to refer patients to related services such as weight loss programs and advice from a dietician (7).

A further issue is that results from observational studies indicate that many diabetic patients do not take advantage of web portal features such as secure messaging, when offered, perhaps because of a lack of internet access or to a lack of experience in navigating web portal resources (18). Patient concerns about confidentiality may also play a role. Because observational studies are subject to selection bias and uncontrolled confounding, results from retrospective cohort studies do not establish that diabetic patient use

Table 2 Studies of diabetes-specific web portals

Study	Sample	Design	Results	Limitations
Grant <i>et al.</i> 2008	244 diabetes patients (mean age 56.1 years) seen at 11 primary care practices in Massachusetts	12-month cluster (clinic) randomized controlled trial of a personal health record linked to the patient's electronic medical record (EMR), which enabled patients to access and read guidelines, review their lab results and medication lists, write comments to the EMR, and edit their medication lists. The primary outcomes were changes from baseline in HbA1c, blood pressure, and LDL cholesterol	More patients in the intervention arm had their diabetes treatment regimens adjusted compared with active controls (53% vs. 15%, $P < 0.001$). However, there were no significant differences in risk factor control between study arms ($P = 0.053$)	Only a small proportion of eligible patients signed up for access to the personal health record, patients with poor metabolic control were less likely to enroll in the study
Ralston <i>et al.</i> 2009	83 adult patients in Seattle, WA with type 2 diabetes	Randomized controlled trial compared usual care plus Living with Diabetes program Web-based care management (patient access to EMR, secure e-mail with providers, feedback on blood glucose readings, an educational site, and an interactive online diary for entering information about exercise, diet, and medication) vs. usual care alone. The primary outcome was change in HbA1c	HbA1c levels declined by 0.7% (95% CI: 0.2–1.3) on average among intervention patients compared with usual care patients. Systolic blood pressure, diastolic blood pressure, total cholesterol levels, and use of in-person health care services did not differ between the two groups	The study used a single case manager and did not control for greater attention paid by the case manager to intervention participants. The study population had limited ethnic, racial, and socioeconomic diversity. Small sample size
McCarrier <i>et al.</i> 2009	77 patients aged 21–49 years with type 1 diabetes, in Seattle, WA	12-month pilot randomized controlled trial of usual care plus Web-based collaborative care (Living with Diabetes program) vs. usual care alone. The outcomes were changes in HbA1c and self-efficacy measured with the Diabetes Empowerment Scale	A non-significant decrease in average HbA1c was observed in the intervention group compared to the usual care group (–0.48, 95% CI: –1.22 to 0.27, $P = 0.160$). The intervention group had a significant increase in diabetes-related self-efficacy compared to usual care ($P = 0.04$)	Small sample size, use of a single case manager
Tang <i>et al.</i> 2013	415 adult patients with type 2 diabetes treated at a large, integrated group practice in Palo Alto, CA	12-month randomized controlled trial of an online diabetes management system including wirelessly uploaded home glucometer readings with graphical feedback, comprehensive patient-specific diabetes summary status report, nutrition and exercise logs, insulin record, online messaging with the patient's health team, nurse care manager and dietitian providing advice and medication management, and brief educational videos. The primary outcome was glucose control measured by HbA1c	Compared with usual care, patients in the intervention group had significantly reduced HbA1c at 6 months (–1.32% vs. –0.66%, $P < 0.001$). At 12 months, the differences were not significant (–1.14% vs. –0.95%, $P = 0.133$)	The results may not be generalizable to smaller, independent practices
Lau <i>et al.</i> 2014	157 adult diabetes patients in Vancouver, British Columbia	Retrospective cohort	Compared to patient web portal non-users, a higher proportion of users achieved HbA1c <7% at follow-up (56% vs. 32%, $P < 0.031$)	Uncertain generalizability, small sample size
Tutino <i>et al.</i> 2017	3,586 Chinese patients with type 2 diabetes from 6 sites in China	Randomized controlled trial comparing web portals for diabetic patients alone vs. patient web portal plus nurse-coordinated follow-up visits. The primary outcomes was proportion of patients achieving ≥ 2 treatment targets (Gba1c <7%, blood pressure <130/80 mmHg, and LDL cholesterol <2.6 mmol/L)	The proportion of participants attaining >2 treatment targets increased in both groups and there similar absolute reductions in HbA1c and LDL cholesterol, with no between-group difference	The findings may not be generalizable to rural Chinese populations

of web portals has a positive effect on glycemic control. Although results from randomized controlled trials provide stronger evidence of the efficacy of web portal use in improving glycemic control among diabetic patients, only 5 trials have been reported and, of these, 2 were pilot trials with a small sample size. In addition, results from the randomized controlled trials have been mixed (*Table 2*).

With respect to limitations of this review, not all eligible published studies may have been identified by the bibliographic search process. We minimized this potential source of bias by reviewing the references of review articles.

Limited health literacy is relatively common among patients with type 2 diabetes and is likely to contribute to poorer diabetes outcomes (15,29-31). Studies indicate that patients with lower health literacy are less likely to use web portals to help manage a chronic illness (14,15). Patients with lower health literacy or computer literacy may have difficulty learning how to use a web portal or they may have difficulty navigating a portal. This may represent a contributing factor that compromises exploring the true impact and valid effects of patient portal use and improvement of diabetes management. Educational outreach efforts for potential web portal users may be helpful in overcoming these perceived barriers.

In summary, studies suggest that secure messaging between adult diabetic patients and their clinician is associated with improved glycemic control, but negative findings have also been reported and the causality of this association is uncertain. The number of randomized controlled trials that have examined the efficacy of web portal use in improving glycemic control among diabetics is still small. Additional research is needed to identify specific portal design features and patient demographic characteristics that may impact quality of care and improvement in specific and comprehensive elements of diabetes care.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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