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Patient Web Portals to Improve Diabetes Outcomes: A Systematic Review

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Abstract

Patient web portals (PWPs), defined as the integration of electronic medical records and patient health records, have been related to enhanced patient outcomes. A literature review was conducted to characterize the design and evaluation of PWPs to improve health care processes and outcomes in diabetes. A summary of 26 articles revealed the positive impact PWPs have on patient outcomes, patient-provider communication, disease management, and access to and patient satisfaction with health care. Innovative and useful approaches included the evaluation of specific components of the PWPs, assessing the impact of PWPs on mediators of health behaviors, such as patient distress, identification of barriers to use, and patient willingness to pay for access. Future research should focus on relevant processes that mediate patient and provider use, impact on health care utilization, and a patient-centered approach to the design and integration of educational opportunities afforded through PWPs.

Keywords

Patient web portal; Systematic review; Diabetes; Evaluation; Usability; Electronic health record; Personal health record; Glycemic control; Satisfaction; Type 1; Type 2; Providers; Caregivers; Self-care; Behaviors; Quality of life; Diabetes distress; Management; Communication

Introduction

There has been an explosive increase in the number of patients with diabetes around the world [1]. The human and economic burden is substantial; diabetes complications increase morbidity and mortality, and produce significant strains on the global economy [2].

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However, these negative consequences are preventable [3] and effective diabetes care and management is the only available solution.

The management of diabetes is complex, requiring health care access; coordinated care between primary care providers, endocrinologists, nutritionists, dieticians, etc.; patient education, including lifestyle modification to optimize nutrition and physical activity; as well as the addition of pharmacologic therapy to facilitate glycemic control [4]. Yet, with the growing number of individuals with diabetes, fewer primary care providers, and increasing health care costs, face-to-face medical visits may become a less viable option for ongoing diabetes care.

In 2001, the Institute of Medicine report, *Crossing the Quality Chasm* [5], called for improved communication among patients with chronic conditions and their health care providers, provision of patient education in self-management skills, and accessible web-based monitoring, information, and decision support systems. The response over the past decade has been to leverage existing and develop new technology-based care and disease management support systems for diabetes and other chronic diseases [6,7].

Clinical Decision Support Systems

Health information technology [8] designed to support provider decision making, including alerts and prompts suggesting specific actions, has become an increasingly prevalent component of electronic health records (EHRs) and thus clinical care [9•,10]. However, recent evidence suggests the use of EHRs is insufficient for ensuring high-quality diabetes care [11]. Providers may be slow to adapt to these systems, not use them as intended, perceive threats to autonomy and potential extra workload due to excessive reminders [12], and be constrained by limited system functionality within a given clinical care context.

In a recent review of systems to support team-based care of chronic illness, including diabetes, only 67% of 104 studies yielded positive outcomes on processes of care (e.g., guideline adherence, visit frequency, referral rate, appropriate testing, and treatment adherence) [13]. Those systems that were effective had connections to an EHR, computerized prompts, specialized decision support, electronic scheduling, and a personal health record (PHR) [13].

PHRs are an emerging trend in health care. By definition, a PHR is a health record initiated and maintained by a patient [14]; provides a complete and accurate summary of the health and medical history by gathering data from many sources; and makes information accessible online to anyone who has the necessary credentials to view it. PHRs are more than just static repositories for patient data; they combine data, knowledge, and software tools, which help patients to become active participants in their own care [15].

Patient Web Portals

When PHRs are integrated with EHR systems, they provide even greater benefits [15]. Integrated systems communicate much more information to patients, and, pending the accuracy of patient inputs, could supplement or improve provider decision support systems. PHRs integrated with EHRs, either through tethering or interconnectivity, are called patient web portals (PWPs). A handful of recent studies suggest PWPs benefit both patients and health care providers by increasing the efficiency and productivity of care. For example, patients can complete online registration forms, schedule appointments, refill prescriptions, pay medical bills, view laboratory results, message their provider, and in some instances, receive targeted patient education.

Although PWPs have been touted as a transformative technology that may facilitate disease self-management and patient-centered health care [16], little is known about their impact on diabetes care and outcomes. The objective of this systematic review was to evaluate the evidence on the impact of PWP-delivered interventions in improving health behaviors, health outcomes, care, and/or processes of care for persons with diabetes. We systematically reviewed studies to evaluate the impact of diabetes interventions via PWPs in improving patient self-care behaviors, glycemic control, and other health outcomes and/or provider care and processes of care for persons with type 1 or type 2 diabetes mellitus (DM).

Methods

Data sources

Our systematic review covered studies published from January 2000 through June 2010. The investigators searched MEDLINE (PubMed interface) and PsycInfo databases for eligible studies using a combination of five key words (diabetes, portal, electronic, patient, provider) in conjunction with each of the following search terms: web, online, messaging, communication, self-care, behavior, glycemic control, care, education, and health information. We also systematically searched the reference lists of included studies and relevant reviews.

Study selection and data extraction

We reviewed the titles and abstracts of the identified citations and identified eligible articles based on prespecified criteria. Inclusion criteria included any empirical evaluation of the use of PWPs for delivering health information to persons with diabetes. Many of these studies were randomized controlled trials (RCTs), quasi-experimental studies, pre-post study evaluations, or qualitative assessments of PWP usability. Included studies were required to measure patient self-care behaviors, clinical outcomes, provider care or processes, or factors influencing PWP use by patients and/or providers. Studies published in a language other than English with a complete English abstract were included if they met the specified inclusion criteria. The investigators collected the following information from each article that was eligible: descriptions of the sample, including diabetes type, sample size, patient age; and descriptions of the study design, including country where the study was performed, study duration, frequency, intervention and control groups, educational content and delivery, process and outcome measures, and statistical significance.

Comprehensive literature searches yielded 133 articles containing combinations of our primary and secondary search terms from 2000 to 2010. Two study authors read the titles and abstracts of these articles to determine if they were appropriate for inclusion, resulting in 51 articles containing content or functionality specific to a PWP. Of these, reviewers excluded systematic reviews and meta-analyses ($n = 2$), editorials ($n = 4$), cross-sectional studies ($n = 2$), concept or theoretical papers ($n = 2$), and articles describing a PWP's technological functions and features or implementation without presenting evaluation data ($n = 15$). After reading the remaining 26 articles, study authors concluded all 26 satisfied eligibility criteria.

Results

Of the 26 articles included that met study criteria, 15 articles assessed the impacts of PWPs on clinical, behavioral, or psychosocial outcomes (Table 1). Evaluation studies used predominately quantitative analyses, with a focus on RCTs ($n = 8$), pre-posttest evaluations ($n = 4$), and quasi-experimental evaluations ($n = 1$). One evaluation article represents two separate qualitative studies that report descriptive data on the impact of the implementation.

The remaining 11 articles assessed the usability of PWP systems, features, and functions from the perspectives of diabetes patients and/or health care providers (Table 2). Researchers predominately used qualitative or mixed-methods approaches to assess the usability of PWPs and specific PWP tools for both patients and providers. Focus groups (*n* = 5), interviews (*n* = 4), surveys (*n* = 5), and "think aloud" procedures (*n* = 2) allowed researchers to understand the barriers to PWP use and specify aspects of PWPs that are most beneficial from provider and patient perspectives (results include 4 studies employing more than one method).

These 26 articles included a total of 23 unique studies and 2436 unique participants (impact evaluations *N* = 2165; usability evaluations, *N* = 271; two studies shared a subset of participants [17••,18], four studies [19–22] shared the same sample of participants). Nineteen articles included only adult patients, three articles included only providers, three articles included both adult patients and providers, no articles included pediatric or adolescent patients, and one article included parents of children with chronic health conditions. Of the 17 studies that focused on diabetes exclusively, one included only patients with type 1 DM, eight included only patients with type 2 DM, and eight included patients with both type 1 and type 2 DM. Four studies included patients with diabetes plus patients with other chronic conditions. Seven studies were conducted in, or in collaboration with, countries outside of the United States. Sample sizes ranged from 6 to 511 and longitudinal studies lasted from 3 to 12 months, with a modal length of 12 months.

The following studies represent the most recent and interesting research on PWP impact and usability. They are featured in our review because they 1) have been published in the past 3 years, 2) do something differently to advance the empirical findings on PWPs, and 3) push this field of research in new directions.

Evaluation studies

Fonda et al. [17••] performed an RCT to examine whether changes in diabetes distress were associated with PWP usage and changes in glycemic control. Patients with poor glycemic control were randomly assigned to usual care or access to a PWP-delivered diabetes self-management program, and were followed for 1 year. Diabetes distress declined in both groups. However, patients assigned to the PWP who actually used the PWP had a significant decline in diabetes distress during the study period, whereas patients assigned to this group who did not use the PWP did not. PWP usage varied by initial diabetes distress, with patients who reported less initial distress using the PWP more over the course of the study, and there was a significant relationship between changes in diabetes distress and glycemic control. The lessons learned are twofold. First, given the finding that certain patient characteristics (e.g., diabetes distress) may better match patients with a PWP-delivered management program, future programs should match patients to an appropriate delivery system (e.g., face-to-face, Internet-based, PWP-delivered). Second, programs that effectively improve glycemic control are also likely to improve psychosocial well-being, which, in turn, may create the opportunity for individuals to become more actively involved in managing their diabetes via a PWP or other tools that "fit" them, and sustain these benefits over time.

The majority of the evaluation studies in this review examined the effect of a PWP on clinical outcomes and patient satisfaction. Unlike these studies, Holbrook et al. [9•] performed an RCT to examine the effect of a PWP on quality of diabetes care (e.g., clinical monitoring behaviors) in patients and providers over 6 months. During this time frame, a composite score reflecting the quality of monitoring these behaviors improved for 61.6% of patients in the PWP group, compared to 42.6% of patients in the control group. Despite provider reports that technical difficulties had a negative effect on their perceived usefulness of the PWP, 48% felt their knowledge of diabetes targets had improved, 33% felt patients' adherence with appointments had improved, and 36% felt patients' access to high-quality diabetes care had improved (as opposed to no change). Unique design features of this study included the focus on patients and providers, delivering the intervention in a community setting rather than an academic medical center, and leveraging multiple communication channels (e.g., electronic, telephone, paper) simultaneously to maximize feasibility and reach. Future studies should both include these design features and extend the current findings by evaluating the effect of PWPs on patient morbidity (e.g., cardiovascular and renal events) and the cost-effectiveness of PWPs.

In an effort to identify what improves communication between patients and providers and, in turn, patient health outcomes, Quinn et al. [23••] recently randomly assigned 36 provider practices in geographically diverse areas to four conditions: 1) treatment as usual, 2) patient-only access to a PWP, 3) patient and provider communication with a PWP, and 4) patient and provider access to a PWP plus treatment algorithms, and are following these practices for one year [23••]. By using three different treatment conditions, the study authors will assess multiple components of a PWP to identify what specific functions yield the greatest impact on clinical outcomes. To our knowledge, few PWP evaluation studies to date have involved more than one treatment group, and thus have been limited in the ability to attribute change to a given PWP function. Results from this study are forthcoming.

Usability studies

PWP usability studies have collected input from patients on barriers to using a PWP, how users use a PWP, utility of specific PWP features, and/or a PWP's capacity to meet its intended purpose. In one study, Hess et al. [20] performed pre- and post-PWP implementation focus groups to understand the barriers to successful PWP use among diabetes patients [20]. Patients reported on aspects of the PWP that were most daunting and the most helpful. Features that were most valued were secure electronic communication and tracking tools. Patients reported several barriers to use, including lost or unknown user names and passwords, and some patients were unaware of certain PWP features that they said (after learning about them in the focus group) they would have found useful, such as glucose tracking. Patients less frequently discussed diabetes educational resources, suggesting that simply placing resources within a PWP environment is inadequate to stimulate patient use. Overcoming these patient-reported barriers is necessary to fully implement a patient-centered PWP that takes full advantage of technology innovations to improve diabetes self-management. An evidence-based understanding of how to leverage PWPs for educational purposes (i.e. promoting diabetes self-care), increasing compliance with diabetes screening tests (e.g., retinal and foot examinations), and monitoring diabetes outcomes (e.g., hemoglobin A_{1c} and lipid profiles) is needed and currently absent in the literature.

With the same sample, Bryce et al. [21] had patients rate the potential or actual usefulness of 15 PWP features, and whether patients would be willing to pay user fees for access to a PWP that provides electronic communication capabilities and diabetes educational and self-management resources [21]. Pre-PWP users rated the PWP more favorably for features targeting information, self-management, and education than actual PWP users, suggesting that PWPs should improve these types of features to meet patient expectations. Conversely, actual PWP users rated the PWP more favorably than pre-PWP users for features related to emailing providers, scheduling appointments, and receiving reminders, suggesting that a PWP can work well for addressing communication-based needs. However, regardless of the utility of a PWP, most patients were opposed to paying for access. Survey data suggested economic self-interest was the main reason for this, whereas focus group data suggested patients have a sophisticated understanding of the potential cost savings to the health care system if a PWP were successful in enhancing diabetes self-management and that access to a PWP should be equitable to all who might benefit from it. Thus, a mixed qualitative-quantitative methods approach offered critical insights into the interpretation of these findings, and should be used in future PWP usability testing studies.

Discussion

We reviewed the literature on PWP-delivered interventions and disease management support targeting persons with diabetes and or enhancing diabetes care and found that PWP systems enhance patient-provider communication [20,22,24,25], increase overall satisfaction with care [9•,23••,26–28], expand access to health information [21,24,29,30], and improve disease management [9•,26,27,29,31–36] and patient outcomes [29,32–34,36] in diabetes. The recent body of PWP evaluation studies has established the usefulness of PWPs for improving care and clinical outcomes, but many of the studied PWPs have unique functionalities.

It is difficult to determine which specific aspects of PWPs are necessary for patients and providers to benefit most. For example, feedback on aggregated results over time may be presented in many ways, which could impact utility and use by providers and patients, and the studies do not directly contrast specific design decisions. Several studies, showcased in this article, have begun to analyze which specific functionalities of PWPs are necessary and which tools are most useful to patients [21,23••]. Future PWP evaluation studies should follow suit, and evaluate the impact of specific PWP functions and tools (e.g., frequency and quality of provider feedback, personalized patient education, provider decision algorithms, visual graphing of clinical data trends, and cell phone messaging and reminders) on diabetes care and outcomes.

As a supplement to PWP evaluation studies, PWP usability studies have helped illuminate the processes through which diabetes patients choose to use or not use PWPs. Usability and user choice are critical to delivering PWP tools to patients. Usability studies have found that many patients are open to the use of technology in their disease management, regardless of their age. However, more extensive training and assistance may be needed to increase PWP use among older, less computer-literate populations [37]. Other sociodemographic variables, such as sex, race, and socioeconomic status, are glaringly absent from PWP usability studies with diabetes patients. It is possible that this oversight is attributable to the qualitative nature and small samples of many of the usability studies. However, explorations of sociodemographic factors in general patient populations have found substantial differences in access to and use of web-based health tools based on age, health literacy, socioeconomic status, and gender [38–40]. Future PWP research and usability testing should identify sociodemographic differences in access and use, and explore ways to effectively deliver PWPs to all patients.

Usability studies have also highlighted the value patients and providers place on relationships. Patients value the continuation of personalized relationships with their providers, and some fear that PWPs will come to replace personal office visits and educational conversations with their providers [20,22]. Providers also stress the importance of a personal relationship and continued office visits [24,25]. In the current health care environment, PWP interest and use is linked to the quality of the relationship between patient and provider. Interestingly, patients who have a strong relationship with their provider may fear the PWP will replace that relationship, whereas patients who feel the communication with their provider is insufficient may view PWPs as a welcome method for obtaining access to personal health information and education [22]. When introduced correctly and well received by patients, PWPs can be a powerful supplement to the patient-provider relationship [41]. PWPs can also help diabetes patients normalize their lifestyle changes by framing recommendations as healthy choices for all people instead of diabetes-specific restrictions [19].

Most importantly, usability studies have demonstrated the importance of assessing usability before implementing a PWP. Each specific PWP, in each population of use, had different strengths and weaknesses. Usability studies allowed PWP developers to better understand the needs of the patients and address concerns to make PWP tools more effective [41,42]. Additionally, providers reported an enhanced sense of community and renewed focus after collaborating to develop and improve a PWP [41]. Each health care organization implementing a PWP to improve diabetes disease management would be wise to include usability assessments in their development procedures.

Studies of PWPs have evaluated added functionality [22,43], population of use [30,44], and perceived ratio of cost to benefit. New functions have been tested, including screening prior to medical appointments [45] and suggested health reminders. Patient education [46] and engagement using PWPs have been shown to improve patient-provider communication [47,48], patient satisfaction [47,48], and the quality of the patient visit [48]. Investigators have also evaluated patient and provider acceptance of and attitudes about PWPs [41,49,50]. Although studies are typically supportive, the effectiveness and acceptance of PWPs into patients' health monitoring and clinical practice has been mixed [44,47]. Widespread acceptance of PWPs may be limited because patients are concerned about privacy, the relevance and validity of the information within a PWP, ease of use, and barriers to availability [22,51]. However, as more health care organizations adopt EHR systems [52,53], the acceptance of PHRs and even PWPs will likely increase.

Limitations

Despite our use of a thorough search strategy, some PWP-delivered intervention studies may not have been identified and included in this review. Specifically, we did not examine unpublished documents and reports on this topic. Instead, we focused on peer-reviewed publications. Importantly, a meta-analysis was not possible due to scant intervention outcome research on PWPs in diabetes, and the few published articles available had various data collection methods and outcomes reported. In addition, it was unclear throughout the studies examined herein whether improvements in outcomes (e.g., patient satisfaction, perceptions of health care quality, health behaviors, and glycemic control) were the direct result of using a PWP or due to other mechanisms, such as improved patient-provider communication during office visits, the type of educational content delivered through the PWP, and/or unlimited access to such educational material. Future research should explore the mechanisms through which PWPs have their impact.

In spite of these limitations, this is the first systematic review to our knowledge that specifically examines the impact of PWPs on diabetes care and outcomes and addresses critical success factors associated with such interventions. Insights regarding clinical outcomes of this emerging platform for intervention delivery and possible ways of making it more effective are presented in an organized manner, and future research directions in this area are recommended based on this systematic review.

Future directions

According to the recent National Research Council report “Computational Technology for Effective Healthcare” [54], health information technologies (HIT), including PWPs, must be designed and implemented to fit the needs of patients and providers. Although HIT research in other areas has identified patient age, socioeconomic status, and health literacy as barriers to using web-based health tools, PWP research in diabetes has not explicitly related those factors to use or outcomes. The impact of PWPs on health care utilization in diabetes has also not been explored, and should be included in future research. The keys to successful implementation, reiterated in the National Research Council report, are to 1) understand the complex interacting factors affecting care; 2) measure critical processes and outcomes; 3) design innovative and robust PWPs focused on improving those outcomes; and 4) measure the overall feasibility, sustainability, and utilization of PWPs and their specific functions across a broad range of patient populations. The challenge remains for developers and researchers to create and evaluate integrated systems of care that includes a diverse sample of patients in the design and usability processes, permits transparency, enhances collaboration between providers and patients, emphasizes a patient-centered approach to care, and maps onto improved clinical outcomes.

Conclusions

The ability of tethered medical knowledge and technology, and specifically PWPs, to improve diabetes outcomes is dependent on the details of their actual application, workflow, interface, and evaluation. Ensuring that adequate attention is paid to user characteristics and needs is critical as different PWP systems are deployed with varying functions, patient populations, evaluation approaches, quality indicators, and patient and provider measures of usability, functionality, feasibility, and success in varied settings and contexts.

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Table 1

Evaluation studies of PWPs targeting patients with diabetes and/or care providers

Study	Study design	Sample, age	Duration, *mo*	Clinical area	Country	Control	Intervention	Measures	Results: C vs I or pre-post
Kobb et al. [26]	Quasi-experimental; mixed-method	N = 281, 71 y N = 57	12	Type 1 and 2, other chronic health conditions Providers	USA and Puerto Rico	Nonequivalent groups with usual care	Rural Home Care Project; uses home telehealth devices to prevent health crises	Hospital admissions Bed days of care Emergency room visits Prescriptions Patient satisfaction Provider satisfaction	+27 vs −60% +32 vs −68% +22 vs −66% +37 vs −59% 97% satisfied 100% satisfied
Tang et al. [27]	Qualitative	N = 305 adults	N/A	Type 1 and 2	Taiwan	N/A	Implementation of Chronic Disease Management Portal Platform	Quality of health care	69.8% of patients report improved quality of health care
Tang et al. [27]	Qualitative	N = 16, NR	N/A	Providers	Taiwan	N/A	Implementation of Chronic Disease Management Portal Platform	Health care burden Efficiency of care	− 12.75% + 87.5%
Bellazzi et al. [31]	Pre-post	N = 22, 43 y	7	Type 1 and 2	Italy	N/A	M2DM system; organizes health information from patients, creates a risk index, and alerts providers when patients are at high risk for microangiopathic complications	# of automatically generated messages # of reminders sent Relative risk index over time	29.44 ± 9.83 16.44 ± 4.39 Decrease in badly controlled values from 33% to 27%
Noel et al. [34]	RCT	N = 104, 71 y	12	Single and comorbid diagnoses: heart failure, chronic lung disease, diabetes	USA	Usual home health care services plus nurse case management	Home telehealth (electronic monitoring and alert system) plus nurse case management	HbA_{1c} levels Quality of life: • Cognitive status • Functional level • Patient satisfaction • Self-rated health Health resource use: • Urgent visits • Total visits	+0.8% vs −1.0%, $P < 0.01$ 19.4 vs 20.0, $P < 0.01$ Nonsignificant Nonsignificant Nonsignificant +5 vs −83, $P < 0.05$ Nonsignificant

Study	Study design	Sample, age	Duration, *mo*	Clinical area	Country	Control	Intervention	Measures	Results: C vs I or pre-post
Smith et al. [36]	Pre-post	*N* = 16, 41 y	9	Type 1 and 2	USA	N/A	MyCareTeam Program	HbA_{1c} levels BP, diastolic BP, systolic HDL LDL Triglycerides	−2.2%, *$P < 0.001$* greater reduction for heavy users Nonsignificant Nonsignificant Nonsignificant Nonsignificant Nonsignificant
McMahon et al. [33]	RCT	*N* = 104, 63 y	12	Type 1 and 2	USA	Diabetes education class and usual care	Diabetes education class and web-based care management (glucose and BP monitoring devices and access to care management website)	HbA_{1c} levels • C vs I • High vs low users BP, systolic BP, diastolic HDL LDL Triglycerides	−1.2 vs −1.6%, *$P < 0.05$* −1.9 vs −1.2%, *$P = 0.05$* −7 vs −10, *$P < 0.01$* Nonsignificant 3 ± 6 mg/dL, *$P < 0.05$* Nonsignificant −38 ± 99 mg/dL, *$P < 0.01$*
Kim et al. [32]	Pre-post	*N* = 44 43 y	3	Type 2	Korea	N/A	Short message service by cell phone and Internet	HbA_{1c} levels Exercise Medication adherence Foot care	−1.1%, *$P < 0.01$* + 30 min/wk, *$P < 0.05$* +1.1 d/wk, *$P < 0.05$* +1.1 d/wk, *$P < 0.05$*
Ross et al. [30]	RCT	*N* = 328, 59 y	9	Type 2	USA	PWP conveying generic diabetes self-management information	Diabetes-STAR: PWP conveying personalized information	Portal usage amounts	319 vs 772 d of usage, *$P < 0.001$*
Kollmann et al. [29]	Pre-post	*N* = 10, 37 y	3	Type 1	Austria	N/A	Diab-Memory cell phone and PWP: patient information on trends in their data	HbA_{1c} levels BG levels Usage	7.9% vs 7.5%, *$P < 0.02$* Nonsignificant 14 uploads/patient/d
Faridi et al. [55]	RCT	*N* = 30, 55 y	3	Type 2	USA	Self-care and treatment as usual	1-day training workshop and NICHE (daily cell phone messages)	HbA_{1c} levels BP, systolic BP, diastolic Self-efficacy Exercise Usability	Nonsignificant Nonsignificant Nonsignificant 0.0 vs −0.5, *$P < 0.05$* Nonsignificant Low usage due to technical complications
Quinn et al. [35]	RCT	*N* = 30, 51 y	3	Type 2	USA	Asked to fax or call in BG levels every 2 weeks, usual standard of care	WellDoc: cell phone–based software with feedback	HbA_{1c} levels SDSCA • Diet • Medications • Exercise Provider satisfaction	−0.7% vs −2.0%, *$P < 0.05$* • +0.6 vs +2.4, *$P < 0.05$* • Nonsignificant • Nonsignificant

Study	Study design	Sample, age	Duration, *mo*	Clinical area	Country	Control	Intervention	Measures	Results: C vs I or pre-post
								Patient satisfaction Correction of medications	100% satisfaction 91% satisfaction 23.3% vs 84.6%, $P < 0.01$
Fonda et al. [17••]	RCT	$N = 104$, 61 y	12	Type 1 and 2	USA	Usual care	Internet-based care management (included BG/BP readers, and MyCareTeam website)	HbA_{1c} levels Diabetes distress	Time-varying analyses: Decreases in HbA_{1c} and diabetes distress depending on level of usage; distress scores lower among users than nonusers
Holbrook et al. [9•]	RCT	$N = 511$, 61 y	5.9	Type 2	USA	Usual care	COMPETE II: web-based color-coded diabetes tracker, messaging	Process composite score Clinical composite scores Quality of life Program satisfaction Continuity of care	0.1 vs 1.3, $P < 0.001$ 0.0 vs 0.6, $P < 0.01$ Nonsignificant 75.9% satisfaction Nonsignificant
Quinn et al. [23••]	RCT	$N = 260$, 18–64 y	12	Type 2	USA	Usual care plus annual supply of BG testing materials	Diabetes communication system (cell phone, PWP, and treatment algorithms)	HbA_{1c} levels BP BMI Lipid levels Symptom measure Diabetes distress	Ongoing study

BG—blood glucose; BMI—body mass index; BP— blood pressure; C—control group; COMPLETE II—Computerization of Medical Practice for the Enhancement of Therapeutic Effectiveness; HbA_{1C}—glycated hemoglobin A_{1C}; HDL—high-density lipoprotein; I—intervention group; LDL—low-density lipoprotein; M2DM—multi-access services for telematic management of diabetes mellitus; N/A—not applicable; NICHE—Novel Interactive Cell Phone Technology for Health Enhancement; NR—not reported; PWP—patient web portal; RCT—randomized controlled trial; SDSCA—summary of diabetes self-care activities; USA—United States of America.

Table 2

Usability studies of PWPs targeting patients with diabetes and/or providers

Study	Study design	Sample, age	Clinical area	Country	Study description	Findings
Beaudoin et al. [56]	Within-subject "think aloud" protocol	*N* = 16, adults	Web portal users	USA	Usability of different PWP formats: serial vs menu-driven	Greater user satisfaction with menu-driven format
Ma et al. [24]	Mixed-method: surveys and interviews/focus groups	*N* = 12 patients, 51 y *N* = 5 providers	Type 2 and providers	USA	Introduction to PWP, reminder calls to use the system, and follow-up focus groups and satisfaction surveys	Patients found portal usable, reported positive feedback Providers reported both positive and critical feedback All providers would recommend portal to patients Prioritization of educational information based on patient characteristics may have limited benefit for patients who have very well-controlled diabetes, and for those who are very confident in their diabetes knowledge
Hess et al. [20]	Qualitative: focus groups	*N* = 39, 54 y	Type 1 and 2	USA	Assessed barriers and successes of PWP via pre and post implementation focus groups. Compared number of patient/provider communications pre and post implementation	No significant change in the number of phone calls, post implementation. Significantly more email messages through PWP Patients report a belief that PWP would increase communication with providers Patients appreciate remote access to laboratory results, and are generally receptive to technology Patients expect quick responses from providers through PWP
Ross et al. [25]	Qualitative: interviews	*N* = 37, adults	Type 1 and 2	USA	Interviewed users of Diabetes-STAR PWP	User preferences include the following: Addressing differences in types of users (ADA guideline concordant vs non-concordant users) Sending out alerts when new information is available Providing more oversight of user diary data
Bryce et al. [21]	Mixed-method: focus groups and surveys	*N* = 39, 54 y	Type 1 and 2	USA	Rated usefulness of 15 features of PWP for diabetes management. Assessed patients' willingness to pay for PWP services	Patients rated online calculator to estimate BG control, appointment reminder systems, email access to providers, personal tracking logs, and online scheduling as most useful features Patients are not willing to pay for PWP services Patients feel that the health care system benefits from disease management and should provide PWP services to patients for free
Fonda et al. [18]	Mixed-method: "think-aloud" protocol, interviews, and surveys	*N* = 6	Providers (NPs and care managers)	USA	Assessed usability of Internet-based informatics application, CDMP	Providers rated usability of CDMP as neutral to favorable Reported problems with ease of use, performance, and support features Reported satisfaction with visual appeal and educational content Areas for improvement include navigation and terminology

Study	Study design	Sample, age	Clinical area	Country	Study description	Findings
Olshansky et al. [19]	Qualitative: focus groups	*N* = 39 adults	Type 1 and 2	USA	Explored perceptions of people with diabetes about their experiences with disease management in focus groups, pre and post portal implementation	Patients stressed the importance of "normalizing an identity as a person with diabetes" Education through PWP can help normalize diabetes for patients by framing life changes as healthy changes for all people, as opposed to diabetes specific changes.
Zickmund et al. [22]	Qualitative: focus groups	*N* = 39, 54 y	Type 1 and 2	USA	Assessed the role of the patient-provider relationship in patient interesting using a PWP	Interest in portal use was linked to dissatisfaction with provider-patient communication/responsiveness Interest in portal use was linked to dissatisfaction with current access to information and/or laboratory results Patients feared that they would have difficulty using the PWP, that they might lose personal relationships with their providers Patients who had fears about email use transferred those fears to the PWP
Britto et al. [42]	Quantitative: time for task completion and surveys	*N* = 16, 39 y	Parents of pediatric patients with diabetes, cystic fibrosis, and arthritis	USA	Measured the time it took parents to complete or give up on PWP tasks. Analyzed themes in PWP use, and results from Computer Usability Satisfaction Questionnaire	Mean task completion ranged from 73 seconds to locate a document to 431 seconds to graph laboratory results Challenging tasks include: graphing data, locating data, requesting access, and interpreting data Usability assessments can help improve patient use and satisfaction, as mean satisfaction scores improved as changes were made to PWP based on assessment results
Nordqvist et al. [41]	Qualitative: interviews	*N* = 20, NR	Providers	Sweden	Practitioners assessed PWP	PWP development can enhance a sense of community among health care providers Providers view PWP as complement to the care they provide Providers expect email communication to save them time, but emphasize the importance of face-to-face visits
Wald et al. [28]	Quantitative: surveys	*N* = 126, 59 y	Type 2 and providers	USA	Patient Gateway; pre-visit electronic journal linked with PWP	60% of patients reported feeling more prepared for their appointments after using the electronic journal 53% of patients reported that they provided more accurate information to their provider after using electronic journal 44% of patients reported that the electronic journal improved communication with their provider Providers reviewed the journal before the appointment in 61% of the cases

ADA—American Diabetes Association; BG—blood glucose; CDMP—Comprehensive Diabetes Management Program; NP—nurse practitioner; NR—not reported; PWP—patient web portal; USA—United States of America.