

Electronic Patient Portals: Evidence on Health Outcomes, Satisfaction, Efficiency, and Attitudes

A Systematic Review

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Background: Patient portals tied to provider electronic health record (EHR) systems are increasingly popular.

Purpose: To systematically review the literature reporting the effect of patient portals on clinical care.

Data Sources: PubMed and Web of Science searches from 1 January 1990 to 24 January 2013.

Study Selection: Hypothesis-testing or quantitative studies of patient portals tethered to a provider EHR that addressed patient outcomes, satisfaction, adherence, efficiency, utilization, attitudes, and patient characteristics, as well as qualitative studies of barriers or facilitators, were included.

Data Extraction: Two reviewers independently extracted data and addressed discrepancies through consensus discussion.

Data Synthesis: From 6508 titles, 14 randomized, controlled trials; 21 observational, hypothesis-testing studies; 5 quantitative, descriptive studies; and 6 qualitative studies were included. Evidence is mixed about the effect of portals on patient outcomes and satisfaction,

although they may be more effective when used with case management. The effect of portals on utilization and efficiency is unclear, although patient race and ethnicity, education level or literacy, and degree of comorbid conditions may influence use.

Limitation: Limited data for most outcomes and an absence of reporting on organizational and provider context and implementation processes.

Conclusion: Evidence that patient portals improve health outcomes, cost, or utilization is insufficient. Patient attitudes are generally positive, but more widespread use may require efforts to overcome racial, ethnic, and literacy barriers. Portals represent a new technology with benefits that are still unclear. Better understanding requires studies that include details about context, implementation factors, and cost.

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Health care systems are increasingly offering patients electronic methods to communicate with providers and learn about their health problems. Some have stand-alone systems for secure messaging between patients and providers. Others, particularly those with existing electronic health record (EHR) systems, have developed companion applications called patient portals, which are designed to give patients secure access to various health information and allow secure methods for communication and information sharing. This development has been driven in part by the belief that these systems will enhance patient satisfaction, improve care, and make care more efficient (1).

Use of patient portals is also spurred by financial incentives created by the Health Information Technology for Economic and Clinical Health Act of 2009 and outlined in the Centers for Medicare & Medicaid Services meaningful use rules. Stage 1 meaningful use criteria include providing patients with an electronic copy of their health information, whereas proposed stage 2 criteria are broadened to include enabling patients to view online, download, and transmit information about a hospital admission. Although policy already ties provider and hospital reimbursement to these criteria, little is known about which functionalities are included in patient portals and their observed effects—information that could inform optimal design and implementation of portals to improve patient outcomes.

We conducted a systematic review to evaluate the patient portal literature, specifically investigating the evidence that these systems improve health outcomes, patient satisfaction, health care utilization and efficiency, and adherence. We also evaluated evidence about patient attitudes and characteristics and barriers or facilitators to portal use. Given the expectation that EHR use will continue to increase over time, we restricted our review to patient portals that are “tethered” to existing health care institutions as opposed to those that are standalone.

METHODS

This systematic review is reported according to Preferred Reporting Items for Systematic Reviews and Meta-analyses guidelines (2). Although a formal protocol was not developed, the key questions, search strategy, and inclusion and exclusion criteria were developed with input from a technical expert panel.

Data Sources and Searches

We conducted 3 searches. The first 2 were broad-based searches of health information technology (IT) between 1 January 1990 and 3 December 2010. We used standard search terms, such as *electronic health record*, *patient messaging*, and *computerized reminder* on the basis of the original search strategy used by Chaudhry and colleagues (3) in their 2006 review on health IT and searched PubMed or Web of Science. The second search was also

part of a separate but related health IT review (4). The third search was targeted specifically to personal health records and patient portals between 1 November 2011 and 24 January 2013 (**Appendix Table 1**, available at www.annals.org). We obtained additional references from key articles (“reference mining”) and from content experts. Culture is an important context for understanding the effect of patient portals, so we limited the search to peer-reviewed articles published in English because of our primary interest in the U.S. context.

Study Selection

Articles were eligible if they pertained to patients having access to their records through a patient portal and if the study design was “descriptive, qualitative”; “descriptive, quantitative”; or “hypothesis testing” (including randomized, controlled trials [RCTs]) or if they were systematic reviews, following classifications first used by Chaudhry and colleagues (3). Descriptive, qualitative studies that provided only a description of a patient portal application were not included, but those that used qualitative methods to evaluate barriers or facilitators were included. Descriptive, quantitative or hypothesis-testing papers were included if they focused on clinical or health outcomes, patient satisfaction, adherence, efficiency, utilization, attitudes, and patient characteristics.

Data Extraction and Quality Assessment

We assessed the quality of studies that evaluated the effect of patient portals on health outcomes, satisfaction, adherence, efficiency, and utilization using a modification of criteria developed to assess patient safety strategies that included health IT applications (5). These criteria cover study design and execution, as well as context, implementation, and use of theory or logic models. More specifically, context includes organizational characteristics, such as size; location; academic status; financial status; existing infrastructure; and information about culture, teamwork, and leadership. Components of implementation include staff or patient education, a description of barriers or facilitators, local tailoring of the intervention, and an assessment of how patients used the portal and how providers responded to communication requests. The use of theory or logic models is an explicit statement of what the functionalities in the portal are expected to achieve in terms of outcome.

Studies of patient characteristics and attitudes were assessed for response rate and population.

Data Synthesis and Analysis

Because of the variability in portals and patient populations, we determined that a meta-analysis was inappropriate. Instead, we constructed evidence tables showing the study characteristics and results for all included studies, organized by outcome measure, and critically analyzed studies to compare their characteristics, methods, and findings. We compiled a summary of findings for each combination of functionalities and general class of outcome and used them to draw conclusions. Primary importance was

given to studies based in the United States, followed by studies in other English-speaking countries and Western Europe.

Role of the Funding Source

Funding was provided by the U.S. Department of Veterans Affairs (VA). The funding source formulated the initial study questions but otherwise had no role in the design, analysis, or interpretation of the data or the decision to submit the manuscript for publication.

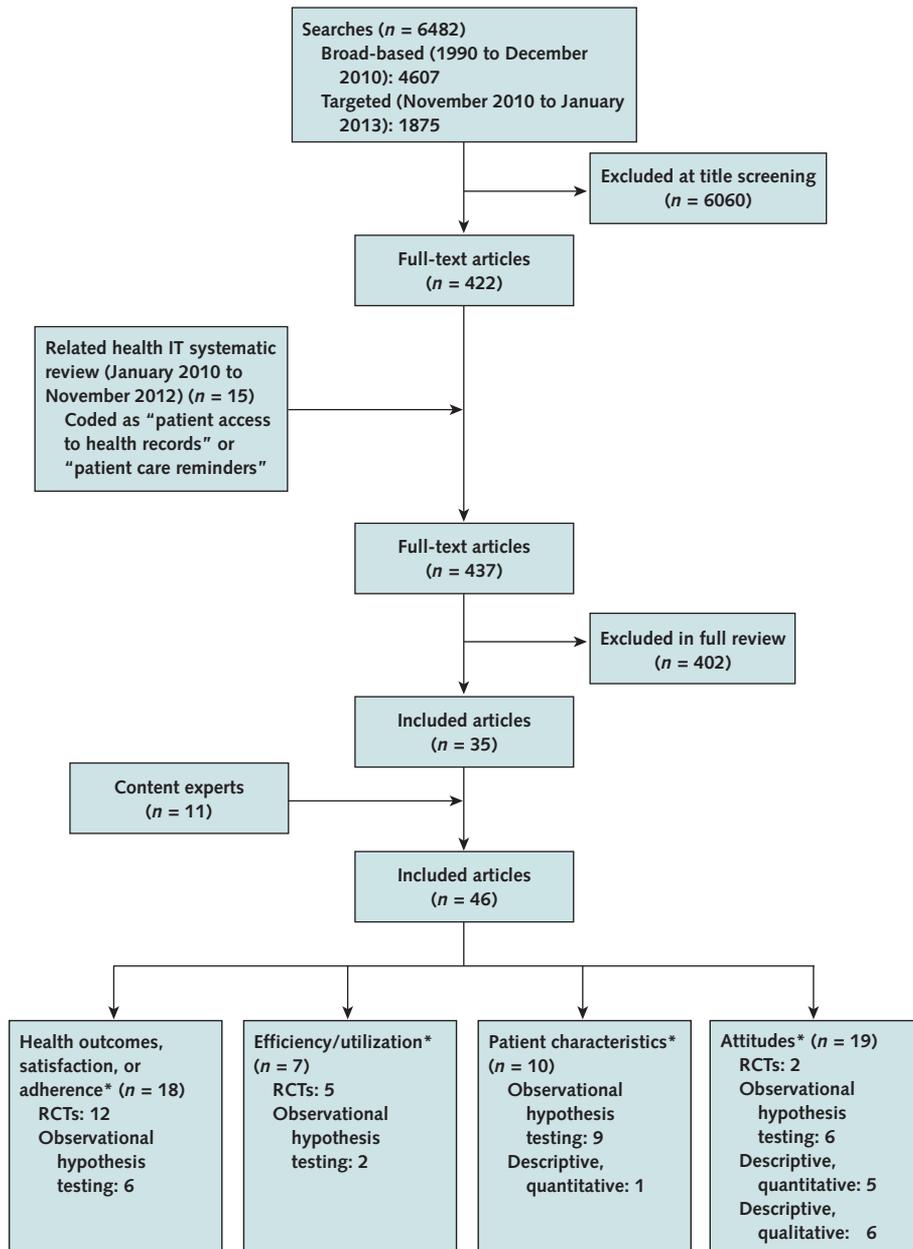
RESULTS

Study Flow and Study Quality Assessment

We reviewed 6482 titles and abstracts from the electronic search, 11 articles from content experts, and 15 articles categorized as “patient access to health record or patient care reminders” from the related systematic review, for a total of 6508 references. From this, we identified 46 papers on tethered patient portals that addressed health outcomes, patient satisfaction, and adherence ($n = 18$); efficiency or utilization ($n = 7$); patient characteristics ($n = 10$); or attitudes, barriers, or facilitators ($n = 19$). Studies could address more than 1 category. The **Figure** details the inclusion of studies and the number of studies related to each key question. The abstracted data for the included articles can be found in **Appendix Table 2** (available at www.annals.org).

We identified 14 RCTs (6–19) of tethered patient portals; 21 observational, hypothesis-testing studies (20–40); 5 descriptive, quantitative studies (41–45); and 6 descriptive, qualitative studies (46–51). The systems described in these studies included various functionalities as part of their intervention (**Table 1**). Some core functionalities, including access to test results, secure messaging, access to notes or visit summaries, and education or disease management information, are present in almost all systems so that the individual effects of these characteristics are not easily disentangled. For studies of the effect of patient portals on health outcomes, satisfaction, adherence, or efficiency or utilization, the best described features were the study design (14 of 21 were randomized trials) and system descriptions (10 of 21 classified as adequate). The rationale for the portal was referenced with an explicit theory or logic model in 5 of 21 studies (for example, “universal models of behavior change that include individual differences, perceived severity of a health threat, relevant values, skills, and perceived barriers to action guided design of the intervention” [18]), whereas 13 studies provided some rationale for its use. Description of implementation and context was poor: Only 2 studies described 2 or more implementation components beyond “staff education,” and 9 studies described contextual domains beyond academic status, size, and location (**Table 2**). For reports of patient characteristics or attitudes, no study reported data from a national or large regional population and had 80% or greater participation or response rate. Hence, all available

Figure. Summary of evidence search and selection.



IT = information technology; RCT = randomized, controlled trial.

* Categories are not mutually exclusive.

studies represent varying portions of a national population (Table 3).

Health Outcomes, Satisfaction, and Adherence

Eighteen articles (12 RCTs) evaluated health outcomes, health status, satisfaction, or adherence with respect to a tethered portal (7–9, 11–19, 22, 29, 30, 37, 38, 40). We first discuss the 12 RCTs by health condition (diabetes, heart failure, hypertension, depression, and preventive services) and patient experience and then the 6 observa-

tional studies that assess diabetes, patient experiences, and medication use.

Four randomized studies evaluated patients with diabetes mellitus (DM). In the first study (8), 83 patients with DM from a University of Washington (Seattle, Washington) general internal medicine clinic were randomly assigned to receive usual care versus care augmented by Web-based and in-person nurse care management for 12 months. Hemoglobin A_{1c} levels were significantly lower in

Table 1. Tethered Personal Health Record Systems and Functionalities

Study, Year (Reference)	Setting	Test Results	Secure Messaging
Ralston et al, 2007 (22) Green et al, 2008 (12) Weppner et al, 2010 (20) Simon et al, 2011 (14) Tom et al, 2012 (36) Lyles et al, 2012 (25)	Group Health Cooperative: MyGroupHealth	X	X
Grant et al, 2008 (15) Wald et al, 2010 (6) Yamin et al, 2011 (27) Volk et al, 2005 (41) Emani et al, 2012 (35) Wright et al, 2011 (17) Wald, 2010 (49) Schnipper et al, 2012 (37) Schnipper et al, 2008 (42) Wald et al, 2009 (45)	Partners HealthCare: Patient Gateway	X	X
Roblin et al, 2009 (26) Sarkar et al, 2010 (28)	KP: KP.org	X	X
Palen et al, 2012 (31)	KP Colorado: My Health Manager	X	X
Zhou et al, 2007 (24)	KP Northwest: KP HealthConnect		X
Ralston et al, 2004 (48) Ralston et al, 2009 (8) McCarrier et al, 2009 (13)	University of Washington	X	X
Wagner et al, 2013 (19)	Southern U.S. academic family and internal medicine practices		X
Tang et al, 2012 (18)	Palo Alto Medical Foundation	X	X
Hassol et al, 2004 (44)	Geisinger Health System: MyChart	X	X
Tenforde et al, 2012 (29)	Cleveland Clinic: MyChart	X	X
Burke et al, 2010 (23)	Miami Children's Hospital	Imaging	
Ross et al, 2004 (11) Earnest et al, 2004 (10)	University of Colorado: SPPARO	X	X
Lin et al, 2005 (7)	University of Colorado: My Doctor's Office		X
Cho et al, 2010 (21) Haggstrom et al, 2011 (50) Tsai and Rosenheck, 2012 (32) McInnes et al, 2013 (38)	Veterans Health Administration: My HealtheVet	X	X
Wade-Vuturo et al, 2013 (30) Delbanco et al, 2012 (33)	Vanderbilt University Medical Center: MyHealthAtVanderbilt Beth Israel Deaconess Medical Center, Geisinger Health System, and Harborview Medical Center: OpenNotes	X	X X
Goel et al, 2011 (34) Krist et al, 2012 (16)	Northwestern University: MyChart Primary care practices in northern Virginia: Allscripts Enterprise EHR	X Limited	X
Wiljer et al, 2010 (40) Eklund and Joustra-Enquist, 2004 (43)	Princess Margaret Hospital (Toronto, Ontario, Canada) Sweden, County of Uppsala: SUSTAINS	X X	X
Tuil et al, 2007 (9) Zickmund et al, 2008 (47) Hess et al, 2007 (46)	The Netherlands UPMC: UPMC HealthTrak	X X	X X
Jung et al, 2011 (39) Day and Gu, 2012 (51)	UPMC: MyChart Wellington, New Zealand, general practice	X X	X

EHR = electronic health record; KP = Kaiser Permanente; SPPARO = System Providing Patients Access to Records Online; SUSTAINS = Support Users to Access Information and Services; UPMC = University of Pittsburgh Medical Center.
* This functionality was only included in Wright and colleagues (17).

the intervention group (change, -0.7%). The same institution also studied the intervention in a DM specialty clinic, randomly assigning 77 patients with type 1 DM (13). Hemoglobin A_{1c} levels did not significantly differ after 1 year of follow-up, although the intervention group demonstrated an increase in patient empowerment in diabetes self-management. Partners HealthCare (Boston, Massachusetts) studied patients with DM who had active accounts with Partners' patient portal (15). Intervention patients (n = 126) came from 11 practices and were given access to a DM-specific personal health record ("eJournal") that also allowed them to generate a "Diabetes Care Plan"

to share with their primary care providers. Control patients from the remaining practices (n = 118) had access to non-diabetes-related eJournals. After 1 year of follow-up, there were no differences in hemoglobin A_{1c} levels, blood pressure, or low-density lipoprotein cholesterol levels between groups, although patients who completed a Diabetes Care Plan were more likely to have a medication adjustment for diabetes, hypertension, or hyperlipidemia than patients in the control group (53% vs. 15%). The fourth study randomly assigned 415 primary care patients with type 2 DM to a disease management program that included a patient portal and intensive case management, including

Table 1—Continued

Access to Progress Notes/Visit Summaries	Educational Materials/Disease Management	Medication Renewal	Make Appointments	Patient Uploads/Diary	Online Reminders
X	X	X	X	Health assessment tools	
	X	X	X	X	X*
	X	X	X	X	
Care plans, problem lists		X	X		
X	X		X		
X	X			X	X
	X			X	
X	X			X	
X		X	X		
X	X	X	X		X
X	Discharge instructions				
X	X				
X	X	X	X	X	X
X		X	X		
X		X	X		X
X	X				X
X	X			X	
X	X			X	
X	X			X	
		X	X		X
		X			

in-person visits and monitoring by a nurse and pharmacist (18). Intervention patients had lower hemoglobin A_{1c} levels at 6 months (−1.32% vs. −0.66%) that did not persist after 12 months. Intervention patients had lower low-density lipoprotein cholesterol levels at 12 months (−0.2 mmol/L [−6.1 mg/dL] vs. 0 mmol/L [0 mg/dL]), lower treatment distress scores, greater treatment satisfaction, and more intensive medication management. There were no differences in blood pressure or other measures of diabetes distress.

Patients with congestive heart failure (*n* = 107) from a specialty clinic at the University of Colorado Hospital (Denver, Colorado) were randomly assigned to receive usual care or usual care plus access to a secure, Web-based patient portal and were surveyed at baseline, 6 months, and

12 months (11). The study found no significant difference in the self-efficacy domain of the Kansas City Cardiomyopathy Questionnaire (the primary end point) or in other measures of health status or patient satisfaction despite some trends favoring the patient portal group. General adherence to medical advice (but not medication adherence) was improved in the intervention group.

Group Health Cooperative (Washington) investigators randomly assigned patients with hypertension to 1 of 3 groups, all of whom had access to the tethered portal (12). The control group received usual care, the second group received a home blood pressure monitor and patient portal training, and the third group also had access to pharmacist-initiated case management by secure messaging and face-to-face visits. Only the third group demonstrated signifi-

Table 2. Quality Criteria: Studies of Health Outcomes, Satisfaction, and Adherence or Efficiency/Utilization

Study, Year (Reference)	Study Design	Description of System*	Description of Implementation†	Description of Contexts‡	Theory or Logic Model
Ross et al, 2004 (11)	●	●	○	○	●
Grant et al, 2008 (15)	●	●	○	○	●§
McCarrier et al, 2009 (13)	●	●	○	○	●
Simon et al, 2011 (14)	●	●	●	●	●
Tang et al, 2013 (18)	●	●	●	●	●
Wagner et al, 2012 (19)	●	●	●	○	●
Lin et al, 2005 (7)	●	●	○	○	○
Tuil et al, 2007 (9)	●	●	○	○	●
Green et al, 2008 (12)	●	●	●	●	●
Wijler et al, 2010 (40)	○	●	●	○	●
Ralston et al, 2007 (22)	○	●	○	●	○
Ralston et al, 2009 (8)	●	●	●	●	●
Wald et al, 2010 (6)	●	●	●	○	●
Wright et al, 2012 (17)	●	●	●	○	●
Zhou et al, 2007 (24)	●	●	○	●	●
Krist et al, 2012 (16)	●	●	○	●	●
Palen et al, 2012 (31)	●	●	●	●	●
Tenforde et al, 2012 (29)	●	●	●	○	●
Schnipper et al, 2012 (37)	●	●	○	○	●
Wade-Vuturo et al, 2013 (30)	●	●	○	○	●
McInnes et al, 2013 (38)	●	●	○	●	●

Key	● = RCT ● = Strong observational study ○ = Other	● = Adequate ● = Partial ○ = Insufficient	● = ≥2 components ● = ≥1 component beyond "staff education" ○ = Nothing beyond "staff education"	● = Describes ≥3 domains ● = Describes 2 domains ○ = Describes 1 or 0 domains	● = Explicit ● = Mentioned ○ = None
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RCT = randomized, controlled trial.

* System domains: functionalities included (such as test results, secure messaging, and access to progress notes), what/how the portal or personal health record interfaces with electronic health record (response times), and what is required for the consumer to operate it.

† Implementation components: a description of education and content beyond "staff education," description of barriers or facilitators, description of an assessment to see whether/how patients used portal or physicians responded to communication request, and tailoring.

‡ Context domains: size, location, or academic status; financial status, existing infrastructure, or past information technology experience (beyond existence of electronic health record and portal, which are requirements for inclusion); and information about culture, teamwork, and leadership.

§ Vague theory but good logic model.

|| Due to mention of current performance, a proxy for existing quality infrastructure.

cant improvements in blood pressure control; 25% more patients had controlled blood pressure compared with usual care (mean decrease, -8.9 mm Hg) and 20% more compared with group 2 (mean decrease, -6.0 mm Hg). In a second study of hypertension, providers and their patients from a family medicine or internal medicine academic clinic were randomly assigned to usual care versus access to a tethered personal health record, which included limited provider EHR data, secure messaging, and the ability to upload blood pressure measurements and keep a health diary (19). Having access to this portal did not result in any clinically significant differences in outcomes, including blood pressure, patient empowerment, or satisfaction. Only 26% of intervention patients frequently used the portal.

In a Group Health study (14), 48% of patients with a new prescription for an antidepressant already registered for secure messaging were randomly assigned to usual care with their prescribing physician versus usual care augmented by 3 planned secure messaging contacts with a mental health nurse care manager who did structured assessments and communicated with the patients' providers. Intervention patients had lower depression severity at

the end of the evaluation period, and higher proportions had decreases of 50% or greater in depression symptom severity.

In a randomized study that involved 8 primary care practices in northern Virginia that shared an EHR (16), intervention patients had access to a preventive services portal with individualized prevention recommendations. Proportions of patients who were up-to-date with recommended preventive services increased by 3.8% in intervention patients compared with 1.5% in control participants, although the differences were much larger when intervention patients who used the portal were compared with nonusers and control participants. Users were more likely than nonusers to be older, male, non-Hispanic, college-educated, and daily Internet users and have more comorbid conditions. A study from Partners HealthCare (17) randomly assigned patients to receive health maintenance reminders and access to an eJournal for health maintenance and family history compared with patients who had access to an eJournal for medication, allergy, and diabetes management. After adjustment for patient and practice characteristics, intervention patients (excluding women's clinics) were approximately 2 times more likely to receive influenza

vaccination and 3 times more likely to receive mammograms; there was no difference in receipt of bone density measurement, cholesterol testing, Papanicolaou smear screening, or pneumonia vaccination (9). A study from a University of Colorado, Denver, academic internal medicine clinic randomly assigned 606 patients with experience using an Internet browser to usual telephone care versus access to the patient portal with secure messaging and found that patient satisfaction was significantly greater in the intervention group in the areas of communication with the clinic and ratings of nonurgent messaging, prescription refills, referral requests, and appointment scheduling (7). A final study randomly assigned couples having in vitro fertilization in the Netherlands to usual care versus access to an Internet-based personal health record for fertility treatment and found no differences in patient empowerment (such as self-efficacy and knowledge) or secondary outcomes, such as patient satisfaction, change in anxiety, or change in depression between the 2 groups (9).

Six observational studies examined the association of portal use with outcomes (22, 29, 30, 37, 38, 40). A Cleveland Clinic (Cleveland, Ohio) study evaluated the association of patient portals and diabetes quality measures and

found that users did better on many measures, although differences were small and probably not clinically significant (29). Another study from Vanderbilt University (Nashville, Tennessee) found an association between the use of patient portal secure messaging and better glycemic control and satisfaction with care in patients with diabetes (30). In a pre-post study from Toronto, Ontario, Canada, patients with breast cancer who had access to a portal that provided test results, educational resources, and appointment and medication lists had modestly lower anxiety scores after intervention but no change in self-efficacy ratings (40). In a cross-sectional survey study from Group Health, investigators randomly surveyed 2002 users of Group Health's Web-based patient record system. Respondents generally reported high satisfaction with the portal (94% satisfied or very satisfied) and particularly with specific functionalities, such as medication refills, patient-provider messaging, and medical test results (22). The Veterans Aging Cohort Study of patients with HIV and matched patients without HIV found that after investigators controlled for sociodemographic characteristics and health behaviors, use of the VA patient portal was associated with 90% or greater adherence to antiretroviral ther-

Table 3. Quality Criteria: Studies of Patient Characteristics or Attitudes

Study, Year (Reference)	Population	Response Rate
Hassol et al, 2004 (44)	●	○
Burke et al, 2010 (23)	○	●
Tsai and Rosenheck, 2012 (32)	●	●
Yamin et al, 2011 (27)	●	NA
Sarkar et al, 2010 (28)	●	●
Roblin et al, 2009 (26)	●	○
Lyles et al, 2012 (25)	●	●
Earnest et al, 2004 (10)	○	○
Emani et al, 2012 (35)	○	○
Haggstrom et al, 2011 (50)	○	●
Goel et al, 2011 (34)	○	●
Tom et al, 2012 (36)	●	○
Day and Gu, 2012 (51)	○	●
Jung et al, 2011 (39)	○	NA
Delbanco et al, 2012 (33)	●	○
Wade-Vuturo et al, 2013 (30)	○	●
Weppner et al, 2010 (20)	●	NA
Wald et al, 2010 (6)	○	●
Cho et al, 2010 (21)	○	○
Ralston et al, 2007 (22)	●	●
Volk et al, 2005 (41)	○	○
Wald, 2010 (49)	○	NA
Ralston et al, 2004 (48)	○	●
Zickmund et al, 2008 (47)	○	NA
Eklund and Joustra-Enquist, 2004 (43)	○	○
Hess et al, 2007 (46)	○	NA
Schnipper et al, 2008 (42)	○	●
Wald et al, 2009 (45)	○	●

Key

- = Representative of a national or large regional (multistate) population
- = Representative of a smaller geographic population or a specific clinical population (e.g., HIV or diabetes) at the national or large regional level
- = Selected sample, such as that in a specific clinical setting (e.g., clinic or hospital) or enrolled in a randomized trial
- = ≥80%
- = ≥60% but <80%
- = <60% or not stated

NA = not applicable.

apy (38). Finally, a study from Partners HealthCare evaluated the effect of a medication reconciliation eJournal module compared with a health maintenance module on the proportion of medications per patient with unexplained discrepancies and found that it was lower in the intervention group (42% vs. 51%) (37).

Efficiency or Utilization

Five RCTs evaluated tethered portals and their effect on efficiency or utilization (6, 8, 11, 12, 14). The University of Colorado study of a portal for patients with congenital heart failure (described previously) found a significant increase in overall emergency department visits in the intervention group compared with the control group (20 vs. 8 visits) but no differences in hospitalizations (11). The University of Washington study of patients with DM (described previously) found no differences among the 3 groups in outpatient visits, primary care or specialty visits, or inpatient days, although the care manager self-reported an average of 4 hours per week of patient management (8). The Group Health study of patients with hypertension (described previously) found that the intensive intervention group with access to the Web system and a pharmacist averaged more secure messaging threads (4.2 compared with 2.7 in the Web-only group and 1.8 in the usual care group) and more telephone encounters (mean of 7.5 compared with 3.8 in the Web-only group and 4.0 in the usual care group) (12). Primary care visits, inpatient and urgent care, or emergency department use did not differ significantly. In the Group Health study of depression care, rates for visits, telephone encounters, and nonstudy secure messaging did not differ between groups (14). A study from Partners HealthCare surveyed primary care patients who were randomly assigned to receive access to medication, allergies, or diabetes eJournal modules (group 1) or health maintenance, family history, or personal history eJournal modules (group 2) and were periodically prompted to submit an eJournal before provider visits (6). Providers in group 1 reported no change in visit length, whereas 47% of providers in group 2 believed that the visits were longer.

Two observational studies from Kaiser health care systems had opposite findings (24, 31). In a matched cohort study from Kaiser Permanente Colorado, investigators found that after adjustment for age, sex, and baseline rates of visits and specific chronic illnesses, users of its portal had statistically significantly higher rates of office visits, telephone encounters, after-hours clinic visits, emergency department visits, and hospitalizations compared with previous rates, whereas nonuser rates generally declined (31). In a pre-post matched control study from Kaiser Permanente Northwest, investigators found that visit rates decreased more (difference, 6.7%) and telephone contacts increased less (difference, 13.7%) in the portal users than in the matched control participants (24).

Patient Characteristics

Ten studies evaluated patient characteristics associated with tethered portal use (20, 22, 23, 25–28, 32, 39, 44). In the first of 2 studies from Group Health (described previously), patients who were enrolled in their integrated delivery system (as opposed to contracted network) were more likely to be female, have commercial insurance, and have higher-than-expected clinical need (22). In the second study, 6185 enrollees were followed over an average of 2.8 years (20). Approximately one third of enrollees used the portal, and younger age, male sex, higher socioeconomic status, and higher use of secure messaging by primary care physicians were significantly associated with use. Greater illness rates were associated with earlier registration and ongoing use (rate ratio, 1.3). The third study surveyed 718 patients with DM, 53% of whom had used the patient portal (25). In a model adjusted for age, sex, health need, education, income, and provider factors, blacks were 82% less likely and Asians were 60% less likely to use the patient portal. When restricted to those who used the Internet, blacks were still 75% less likely to use the portal. Kaiser Permanente Georgia surveyed a cohort of racially diverse enrollees and subsequently evaluated registration rates for its portal (26). Of the 1777 patients included in the evaluation, 35% registered with the portal during the study period, and these patients were significantly more likely to be white than black (42% vs. 30%), have diabetes or elevated lipid levels compared with low-risk adults (36% and 38% vs. 30%), and have a higher level of education (greater than high school). Kaiser Permanente Northern California evaluated 14 102 patients with DM and their use of a portal, focusing specifically on health literacy (28). Forty percent registered, but blacks, Latinos, and Filipinos were more than twice as likely not to sign on to the portal than whites. Persons with lower self-reported health literacy were 1.7 times less likely to sign on.

Partners HealthCare compared 75 056 primary care patients who had activated their portal account with those who had not as of September 2009 (27). Forty-three percent of patients were portal “adopters,” and rates of adoption were lower among all racial or ethnic minorities but higher in patients with 2 or more comorbid conditions. The University of Pittsburgh (Pittsburgh, Pennsylvania) evaluated characteristics of portal users who also utilized “eVisits” for nonurgent health conditions; 3.2% used an eVisit and were more likely than nonusers to be female, younger, not retired, and in poorer health, as indicated by greater numbers of diagnoses and medications (39). A national survey of U.S. veterans in 2010 found that 22% of VA users accessed the VA’s portal, and utilization was no different between those using mental health services at the VA and other groups of veterans (32). There were no statistically significant predictors of portal use among survey respondents.

A study of a portal for patients with congenital heart disease found that 93% of the first 270 patients who were

offered access became users, and use was more common while the patients (mostly infants having cardiac surgery) were hospitalized than after discharge (median logins, 6 vs. 4) (23). Finally, Geisinger Health System (north central Pennsylvania) conducted an online survey of active users of their patient portal with a 33% response rate and found that 3% of users were doing so on behalf of a spouse or parent (44).

Attitudes, Barriers, and Facilitators

Nineteen studies assessed attitudes about patient access to their own medical records or related issues (6, 10, 21, 30, 33–36, 41–51). This group of articles was heterogeneous and discussed a range of attitudes and barriers. Some findings included more acceptance of portals by patients who were younger and had more trust in the Internet or computer literacy, more enthusiasm for portals by patients than physicians, and that administrative and human factors in the interface were cited as barriers to use. Full details are presented in the **Appendix** (available at www.annals.org).

DISCUSSION

The primary finding of this systematic review is that evidence is insufficient at this time about the effect of patient portals on health outcomes. We identified a limited number of high-quality studies evaluating outcomes of care, and these studies often lacked detail about context and implementation. The limited number of studies and variations in study design, portal functionalities, and implementation processes make it difficult to draw strong conclusions or generalizations about this relatively new technology. We did identify examples in which portal use was associated with improved outcomes for patients with chronic diseases, such as diabetes, hypertension, and depression, but these studies generally used the portal in conjunction with case management. Evidence was mixed about the effect of portals on health care utilization and efficiency.

Several observational and survey studies suggest that uptake of portals may differ by patient-specific factors with lower use by racial and ethnic minorities, lower use with lower education level or literacy, and greater use with increased numbers of medical problems. This conclusion differs from that of another recently published systematic review, but that review identified only 5 publications from 4 studies that met their eligibility criteria (52).

Although the evaluation of patient portals can be complicated by the diversity of applications and interfaces, our review indicates that most tethered portals share commonalities, including the ability to view test results and progress notes or visit summaries, view and refill medications, view and make appointments, access educational materials, and send secure messages to providers. Portals are now conceptualized as part of an overall package intended to facilitate information exchange with patients and patient communication with providers and health care institutions. Based on

the studies reviewed, portals are also increasingly being aligned with a larger patient management system that includes case management, remote health care delivery, and non–face-to-face care (53). New functionalities (such as online reminders) were the subject in only a few articles, but the number of studies in which this was present was too small to draw important conclusions about the specific functionality.

Portals are being created as part of a movement to make patients more active participants in their care. Our review suggests some potential barriers to achieving this goal, including disparities in who accesses these portals and instances of suboptimal patient attitudes of their worth. More widespread acceptance will require attention to overcoming these disparities and addressing usability and patient-perceived value to engage certain populations that are not readily embracing personal health record systems.

The primary limitation of this review is the quantity and quality of the original studies. Evidence was sparse for most of the outcomes evaluated. Some studies had methodological problems. There was a striking absence of reporting on organizational and provider context and implementation processes for the patient portal. This last issue makes it challenging to distinguish between failure of the intervention versus failure of the implementation in studies reporting no effect; and, for studies that do report beneficial effects, it leaves providers and policymakers at other institutions unclear about how to replicate the success.

Patient portals are relatively new applications in the health IT armamentarium, and optimal ways to use and evaluate them are still being developed. Preliminary evidence suggests that, like many health IT tools, enhanced outcomes are realized when the tools are implemented as elements of more comprehensive programs that link the tool with other approaches, such as case management. On the basis of current evidence, we consider it unlikely that patient portals will have substantial effects on utilization or efficiency, at least in the near term, and more studies are needed to evaluate their cost implications. Additional information about context and implementation processes will help organizations and policymakers better understand how successful portals have been implemented and whether that success may be achievable in other environments. Finally, finding ways to overcome racial, ethnic, and literacy barriers to portal use should be an important policy goal.

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APPENDIX: ATTITUDES ABOUT PATIENT PORTALS, INCLUDING BARRIERS AND FACILITATORS

Nineteen studies assessed attitudes about patient access to their own medical records or related issues (6, 10, 21, 30, 33–36, 41–51). In the 1 RCT of eJournal use from Partners HealthCare previously described, more participants with eJournal access for medications, allergies, and diabetes than participants with eJournal access to health maintenance, family history, and personal history reported submitting an eJournal (46% vs. 25%), discussing it with their provider (59% vs. 46%), and feeling more prepared for their visit (59% vs. 51%) (6). A second study related to the same intervention surveyed 31 patients who had used the diabetes eJournal and reported that 60% felt more prepared for the visit, but 81% did not believe that it improved the quality of care of the visit (45). In the hypothesis-testing study of the University of Colorado portal, before the intervention, physicians were much more likely than patients to endorse concerns that users would have more questions (71% vs. 37%), worry more (71% vs. 5%), find reports confusing (57% vs. 13%), and find notes offensive (29% vs. 3%), with concerns decreasing, although not significantly, over the course of the trial (10). The final hypothesis-testing study surveyed veterans with diabetes from a Durham VA clinic (Durham, North Carolina) about their Internet use and interest in various aspects of the VA's portal (21). In multivariate analyses, age and trust in the Internet were independent predictors of interest in using the portal for diabetes management, with odds of being "very interested" increasing by 1.4 for each decade younger a respondent was and by 2.3 if the respondent had "a lot/some" trust in the Internet. Investigators affiliated with Beth Israel Deaconess Medical Center (Boston, Massachusetts), Geisinger Health System, and Harborview Medical Center (Seattle, Washington) surveyed primary care patients and their providers on the effect of giving patients access to their providers' progress notes (OpenNotes) by a portal (33). Compared with their expectations before the intervention, physicians

did not generally find that visits took longer (23% before intervention and 3% after intervention) or that they spent more time addressing patient questions outside of visits (40% before intervention and 8% after intervention). Physician anticipation that they would need to change how they addressed specific sensitive topics persisted after the intervention. Patients were more positive about benefits and risks and believed that OpenNotes would improve adherence. They were generally not worried about being offended or confused. A study from Northwestern University (Chicago, Illinois) surveyed patients from a general medicine clinic who did not enroll in the patient portal despite receiving an electronic invitation (34). Sixty percent of respondents reported lack of information or motivation, and 30% reported negative attitudes. Blacks were significantly less likely to believe that many of the health self-management features of the portal (such as getting test results) were important.

A study from Partners HealthCare assessed the perceived value of the patient portal for communicating with the physician's office by surveying patients who adopted the portal at differing rates and found that ease of use and relative advantage (the degree to which the portal is perceived as being better than the alternative, such as calling the physician's office) were the top predictors of adoption (35). A study from Group Health surveyed parents of young children with chronic diseases to evaluate whether users and nonusers of their patient portal differed in their assessment of their health care providers and systems and found no statistically significant differences in ratings (36). Examples of domains included receiving needed care, receiving care quickly, and coordination of care.

In a study from Geisinger Health System of portal users, respondents (60% of whom were women) reported high rates of understanding medical information and test results, with higher rates of understanding for more highly educated respondents, and only 30% of respondents had concerns about confidentiality and security (44). In a survey of Partners HealthCare portal users, respondents most highly rated administrative features, such as the ability to renew prescriptions, ask administrative questions, or obtain referral approvals (41). Thirty-eight percent believed that the portal improved communication with the provider practice, whereas 30% disagreed and 32% were unsure. Another study from Partners evaluated patient attitudes about an eJournal to improve medication safety (42). Among the 466 respondents, 56% felt more prepared for their visit. In the final study from Sweden, investigators piloted a portal and found that 82% of users had no worries about security, whereas 15% expressed "some concern" and only 2% were very concerned about the security risks for "full-scale service" (43).

Seven articles evaluated specific barriers or facilitators to the success of personal health records (30, 46–51). In interviews with 9 patients with type 2 DM from a University of Washington general internal medicine clinic, the portal provided a means for patients to discuss nonurgent matters related to their health, but frustrations with the system (such as technical and lack of timely response) could result in the patient feeling devalued (48). Focus groups of 39 patients from a University of Pittsburgh evaluation

of a diabetes-focused patient portal identified potential barriers as forgotten passcodes, lack of knowledge about all aspects of the system, and an inability to view all records of interest (46, 47). Facilitators included an enhanced sense of patient empowerment and ability to communicate with providers between scheduled appointments. Patients with greater satisfaction with their existing patient-provider relationship were less interested in using the portal. At 4 primary care practices affiliated with Partners HealthCare, the addition of an incentive for patient enrollment was associated with 3- to 6-fold increases in portal adoption (49). In a usability study of the VA's portal, most participants had trouble with the registration process and using tools designed to allow them to track their health and self-report health informa-

tion, indicating that portal interfaces may present a barrier to use (50). In a study from Vanderbilt, patients reported that preconceived beliefs about technology or secure message content rules, initial negative experiences, and perceptions that providers did not endorse use of secure messaging were barriers to its use through a portal (30). In a qualitative focus group study of 10 patients from a New Zealand general practitioner practice, investigators identified factors that could influence patient use of the portal, including whether patients perceived that the portal makes care more efficient and effective, whether the patient had adequate computer and health literacy to realize the potential benefits, and what the costs would be to the patient for using the portal (51).

Appendix Table 1. Search Strategy

Search 1: Broad-Based Search

Consumer Health Information Technology

Search Methodologies

Database Searched and Time Period Covered:

PubMed: 1990 to 3 December 2010

Language: English

Search strategy 1a:

"Electronic Health Records"[MeSH] OR "electronic health record" OR "electronic health records" OR "electronic medical record" OR "electronic medical record" OR messaging OR email* OR "computerized alert" OR "computerized alerts" OR "computerized reminder" OR "computerized reminders" OR "computerised reminder" OR "computerised reminders" OR electronics, medical OR informatic*[tiab] OR computerized physician order entry OR computerised physician order entry OR computer provider order entry OR cpoe OR e-prescrib* OR e-prescription* OR electronic prescrib* OR electronic prescription* OR e-health

AND

patient*[ti] OR consumer*[ti] OR patient*[mh] OR consumer*[mh] OR tether* OR secure OR self-report* OR self report*

NOT

case report OR case reports OR case report[pt] OR case reports[pt]

Number of Results: 2381

Search strategy 1b:

"Electronic Health Records"[MeSH] OR "electronic health record" OR "electronic health records" OR "electronic medical record" OR "electronic medical record" OR messaging OR email* OR "computerized alert" OR "computerized alerts" OR "computerized reminder" OR "computerized reminders" OR "computerised reminder" OR "computerised reminders" OR electronics, medical OR informatic*[tiab] OR computerized physician order entry OR computerised physician order entry OR computer provider order entry OR cpoe OR e-prescrib* OR e-prescription* OR electronic prescrib* OR electronic prescription* OR e-health

AND

reminder*

NOT

case report OR case reports OR case report[pt] OR case reports[pt]

NOT

Results of Search Strategy 1a

Number of Results: 353

Search strategy 1c:

["Electronic Health Records"[MeSH] OR "electronic health record" OR "electronic health records" OR "electronic medical record" OR "electronic medical record" OR messaging OR email* OR "computerized alert" OR "computerized alerts" OR "computerized reminder" OR "computerized reminders" OR "computerised reminder" OR "computerised reminders" OR electronics, medical OR informatic*[tiab] OR computerized physician order entry OR computerised physician order entry OR computer provider order entry OR cpoe OR e-prescrib* OR e-prescription* OR electronic prescrib* OR electronic prescription* OR e-health OR "Medical Records Systems, Computerized"[MeSH]

AND

patient*[ti] OR consumer*[ti] OR patient*[mh] OR consumer*[mh] OR tether* OR secure OR self-report* OR self report*

NOT

case report OR case reports OR case report[pt] OR case reports[pt]

OR

["Electronic Health Records"[MeSH] OR "electronic health record" OR "electronic health records" OR "electronic medical record" OR "electronic medical record" OR messaging OR email* OR "computerized alert" OR "computerized alerts" OR "computerized reminder" OR "computerized reminders" OR "computerised reminder" OR "computerised reminders" OR electronics, medical OR informatic*[tiab] OR computerized physician order entry OR computerised physician order entry OR computer provider order entry OR cpoe OR e-prescrib* OR e-prescription* OR electronic prescrib* OR electronic prescription* OR e-health OR "Medical Records Systems, Computerized"[MeSH]

AND

reminder*

NOT

case report OR case reports OR case report[pt] OR case reports[pt]

NOT

Results of Search Strategy 1a

Number of Results: 2804

Total of All Searches After Removal of Duplicates: 4607

Search 2: Targeted Update Search

Search Methodologies

Database Searched and Time Period Covered:

PubMed: 1 November 2011 to 24 January 2013

Language: English

Search Strategy:

electronic health record* OR "electronic notes" OR "patient portal" OR "patient portals" OR personal health record*

Number of Results: 1875

Appendix Table 2. Tethered Patient Portals Evidence

Study, Year (Reference)	Study Design; Sample; Study Date	Health IT Intervention	Setting	Outcome Measures	Findings
Health outcomes, satisfaction, and adherence					
Ralston et al, 2009 (8)	RCT; 83 patients with DM; August 2002–May 2005	Web-based diabetes care management using a case manager for training, review of blood source readings, communication with patients, adjustment of diabetes medications, and discussion with the patient's PCP. Patients could review electronic clinical data, upload data to portal, and send secure messages.	University of Washington General Internal Medicine Clinic	Primary: Change in hemoglobin A _{1c} levels Secondary: Total plasma cholesterol levels, BP, and health care utilization	After adjustment for age, sex, and baseline hemoglobin A _{1c} levels, intervention patients had significantly greater decreases in hemoglobin A _{1c} levels after 1 y (change, -0.7%; <i>P</i> = 0.01). There were no differences between groups in BP control or lipid levels or the numbers of outpatient visits, primary care visits, specialty physician visits, or inpatient days. Care manager self-reported an average of 4 h/wk of working with the intervention group.
McCarrier et al, 2009 (13)	RCT; 77 patients with type 1 diabetes; 12-mo trial, unknown dates	Web-based diabetes care management using a case manager for training, review of blood source readings, communication with patients, adjustment of diabetes medications, and discussion with the patient's PCP. Patients could review electronic clinical data, upload data to portal, and send secure messages.	University of Washington Diabetes Care Center	Primary: Change in hemoglobin A _{1c} levels Secondary: Psychosocial self-efficacy	Hemoglobin A _{1c} levels did not differ significantly after 1 y of follow-up. There was an increase in psychosocial self-efficacy as measured by the Diabetes Empowerment Scale in the intervention group (difference, 0.3 [95% CI, 0.01–0.59]; <i>P</i> = 0.04).
Grant et al, 2008 (15)	RCT; 11 primary care practices (126 intervention patients and 118 control patients with diabetes); September 2005–March 2007	Intervention practices gave patients access to a DM-specific personal health record with modules for medication review, clinical data, and the ability to create a diabetes care plan. Control patients had access to non-diabetes-related modules (family history, preventive services).	Partners HealthCare	Primary: Changes in hemoglobin A _{1c} levels, BP, and LDL cholesterol levels Secondary: Diabetes-related medication initiation or intensification	After 1 y of follow-up, there were no differences in hemoglobin A _{1c} levels, BP, or LDL cholesterol levels between groups; 50% of intervention patients completed a Diabetes Care Plan and were more likely to have a medication adjustment for diabetes, hypertension, or hyperlipidemia than patients in the control group (53% vs. 15%, <i>P</i> <0.001).
Ross et al, 2004 (11)	RCT; 107 patients with CHF (54 intervention and 53 control participants); dates not specified, but recruitment was 2001–2002	Intervention patients received access to a patient portal with access to clinical notes, laboratory and test results, educational guides, and secure messaging.	Heart failure subspecialty clinic at the University of Colorado Hospital	Primary: Change in the self-efficacy domain of the Kansas City Cardiomyopathy Questionnaire Secondary: Patient satisfaction and adherence	There were no statistically significant differences between the groups in self-efficacy or patient satisfaction. General adherence to medical advice was improved in the intervention group, but there was no significant improvement in medication adherence.
Green et al, 2008 (12)	RCT; 778 patients with uncontrolled hypertension (258 usual care; 259 home BP monitoring and Web training; and 261 home BP monitoring, Web training, and pharmacy case management); June 2005–December 2007	All groups had access to GHC's patient portal and educational materials. Active intervention patients received a home BP monitor and training. An additional subset of the intervention patients also received pharmacy case management by secure messaging and telephone calls, with development of an "action plan."	GHC (10 medical centers in Washington and Idaho)	Primary: Percentage of patients with controlled BP (<140/90 mm Hg) Secondary: Number of antihypertensive medications, aspirin use, secure message threads, and other healthcare utilization	Web-based pharmacist care in conjunction with home BP monitoring and portal access resulted in significantly increased percentages of patients with controlled BP (25% more than usual care and 20% more than usual care with home BP monitoring). Patients receiving the full intervention had greater numbers of medications but not greater aspirin use. They had greater mean numbers of message threads and more phone encounters, but there were no differences in primary care, inpatient, or urgent care/emergency visits.

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Study, Year (Reference)	Study Design; Sample; Study Date	Health IT Intervention	Setting	Outcome Measures	Findings
Simon et al, 2011 (14)	RCT; 208 patients starting antidepressant treatment for depression; April–October 2009	Online depression care management using secure messaging through a patient Web site linked to the medical record.	GHC (9 primary care clinics in Washington)	Primary: Depression severity (Hopkins Symptom Checklist) Secondary: Satisfaction with care, antidepressant adherence, and use of health services	Intervention patients had lower depression severity at the end of the evaluation period and higher proportions had 50% or greater decreases in depression scores (55% vs. 41%; OR, 1.8 [95% CI, 1.0–3.1]); 53% of patients in the intervention group were "very satisfied" compared with 33% in usual care ($P = 0.004$). Intervention patients were more likely to continue medication beyond 90 d (86% vs. 62%; $P = 0.001$). There were no differences in outpatient visits, telephone encounters, or on-study messaging.
Tang et al, 2013 (18)	RCT; 415 patients with type 2 DM (202 intervention and 213 usual care); March 2008–December 2010	Diabetes disease management involving use of patient portal, including ability to upload glucometer readings; view diabetes clinical data, maintain a diabetes diary, and receive personalized educational information augmented by intensive nurse and pharmacist case management.	Palo Alto Medical Foundation	Primary: Hemoglobin A _{1c} levels Secondary: BP, lipid control, satisfaction, psychosocial well-being, diabetes knowledge, and diabetes treatment satisfaction	Intervention patients had lower hemoglobin A _{1c} levels at 6 mo (-1.32% vs. -0.66% ; $P < 0.001$), but the differences did not persist at 12 mo. Intervention patients had lower LDL cholesterol levels at 12 mo (-0.2 mmol/L [-6.1 mg/dL] vs. 0.0 mmol/L [0.0 mg/dL]; $P = 0.001$), lower treatment distress scores, higher treatment satisfaction, and more intensive medication management. There were no differences in BP or other measures of diabetes distress.
Wagner et al, 2012 (19)	Cluster-randomized trial; 443 patients (193 intervention and 250 control patients); dates not specified	Intervention patients had access to a patient portal that allowed them to view problem lists, information on medications, allergies and immunizations, secure messaging, and educational materials; record BP and other measures; and keep a health diary.	1 family medicine and 1 internal medicine clinic affiliated with a southern tertiary academic medical center	DBP, SBP, BMI, metabolic laboratory measures, patient empowerment measures, and patient satisfaction measures	Only 26% of intervention patients frequently used the portal. Access to the portal was not associated with any clinically significant differences in any of the measures.
Krist et al, 2012 (16)	RCT; 2250 intervention and 2250 control patients; 2007–2009	IPHR tied to a shared EHR providing tailored prevention recommendations and reminders based on EHR data and patient.	8 primary care practice in northern Virginia	IPHR utilization, percentage eligible patients who were up-to-date on all indicated services, and composite measure of average up-to-date	16.8% of intervention patients established an account and received recommendations. Users were older and more likely to be male, be non-Hispanic, be college educated, and have more illnesses. The percentage of intervention patients who were up-to-date on all indicated services increased by 3.8% compared with 1.5% in control participants ($P < 0.001$). Changes in the composite measure were not statistically different between groups. Subgroup analyses of users to nonusers demonstrated significant increases in colorectal, breast, and cervical cancer screening.
Wright et al, 2012 (17)	RCT; 2218 intervention and 1761 control participants	Access to PG with access to appointment and referral management, secure messaging, and prescription refills and the ability to complete eJournals. Intervention patients received patient-specific health maintenance reminders if they submitted a family history eJournal.	11 primary care practices at Partners HealthCare	Performance rates of health maintenance items	In multivariate analyses, intervention patients were 1.9 times as likely to receive influenza vaccines ($P = 0.023$) and 2.8 times as likely to receive mammography ($P = 0.01$). When women's clinics were included, they were 5 times more likely to receive Papanicolaou smears ($P = 0.001$).

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Study, Year (Reference)	Study Design; Sample; Study Date	Health IT Intervention	Setting	Outcome Measures	Findings
Tuili et al, 2007 (9)	RCT; 51 male and female intervention participants and 40 female and 38 male control participants; January–July 2004	Access to a Web portal providing information about infertility and IVF treatment, access to all digital medical information related to fertility treatments, and secure messaging	Radboud University Nijmegen Medical Center (The Netherlands)	Patient empowerment, patient satisfaction, meaning of infertility programs, social support, anxiety, and depression	No significant differences were seen in patient empowerment, patient satisfaction, meaning of infertility programs, social support, anxiety, or depression. No adverse effects were noted in the use of Internet-based health record.
Lin et al, 2005 (7)	RCT; 305 intervention and 301 control participants; March–August 2003	Access to My Doctor's Office, a patient portal with appointment management, prescription refills, and secure messaging	Academic internal medicine clinic affiliated with the University of Colorado Hospital	Primary: Patient satisfaction Secondary: Qualitative content analysis of requests and messages	Intervention patients were more likely to report better communication with the clinic (44% vs. 11%; $P < 0.001$) and more likely to rate services received and ability to refill prescriptions, request referrals, and schedule appointments higher than control patients.
Tenforde et al, 2012 (29)	Retrospective cohort study; 10 746 patients with DM; 2008–2009	Access to MyChart, a patient portal with access to test results, problem lists, secure messaging, glucometer readings, and diabetes-specific health reminders.	Primary care patients in Cleveland Clinic departments of internal medicine and family medicine	Diabetes quality measure performance	After adjustment for patient and provider characteristics, MyChart users had slightly better diabetes quality measures than nonusers for 8 of 11 measures. They were more likely to have a dilated examination (OR, 1.1), have a pneumococcal vaccination (OR, 1.4), use ACE inhibitors/ARBs (OR, 1.3), have hemoglobin A _{1c} level measurements (OR, 2.1), and be nonsmokers (OR, 1.5). Increased use of the portal was associated with better quality for 3 measures. Users were more likely to be young, have commercial insurance, be white, have higher income, and live in an area with higher education levels.
Wade-Vuturo et al, 2013 (30)	Cross-sectional survey/focus group study; 39 participants in survey/focus group and 15 in survey-only group, all with DM and on medications; no dates provided	Access to MHAV with access to EHR data, secure messaging, and appointment and bill management.	Vanderbilt University Medical Center primary care clinic	Barriers and facilitators to portal use and association between use and glycemic control	Users reported satisfactions with multiple communication options, including secure messaging, which they viewed as expanding access. Preconceived beliefs about technology and rules and previous negative experience were barriers to secure messaging use. Use of secure messaging was marginally associated with improved glycemic control.
Wiljer et al, 2010 (40)	Pre–post study; 250 patients with breast cancer; no dates provided	Access to InfoWell with access to laboratory, imaging, and pathology results; appointments; medication and treatment history; and educational materials and ability to record information.	Breast Cancer Survivorship Program, Princess Margaret Hospital (Toronto, Ontario, Canada)	Anxiety and self-efficacy (State-Trait Anxiety Inventory and Stanford Self-Efficacy for Managing Chronic Disease)	Postintervention anxiety scores were lower (mean change, -2.2 ; $P = 0.03$), but not for the subgroup of chemotherapy patients. Self-efficacy scores were not statistically significantly different after intervention.
Ralston et al, 2007 (22)	Cross-sectional cohort study and survey; 325 634 integrated delivery system members and 201 969 contracted network members; 2002 patients for satisfaction survey; September 2002–December 2005	MyGroupHealth portal requiring ID verification for higher-level access, including sharing of test results, after-visit summaries, problem and allergy lists, immunization history, secure messaging, and appointment management.	GHC integrated delivery system sites and contracted physician network with Washington and northern Idaho	Use and satisfaction	Over 3 y, the percentage of patients receiving ID verification to use MyGroupHealth increased from 3% to 25%. In the integrated delivery system, members who were ID-verified were more likely to be female, have commercial insurance, and have higher-than-expected clinical need. There were greater increases in rates of use of secure messaging and viewing test results or health summaries than viewing immunization, allergy, or problem lists. There were high satisfaction rates, with satisfaction greater for secure messaging and medication refills than with the overall application.

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Appendix Table 2—Continued

Study, Year (Reference)	Study Design, Sample; Study Date	Health IT Intervention	Setting	Outcome Measures	Findings
McInnes et al, 2013 (38)	Cohort study (Veterans Aging Cohort Study): 1871 patients with HIV	Access to MHV with ability to view and refill medications, manage appointments, receive prevention reminders, download portions of the record, and send secure messages to providers.	U.S. Department of Veterans Affairs	Antiretroviral therapy adherence	In bivariate analysis, adherence was better in older, white, and wealthier patients and in those using the patient portal. Drinkers and substance users were less adherent. After adjustment for sociodemographic factors and health behaviors, portal users were 1.8 times more likely to be adherent with HIV medications (CI, 1.35–2.38).
Schnipper et al, 2012 (37)	Matched cohort study: 541 intervention (267 participants) and 274 control participants; September 2005–March 2007	Intervention patients had access to a medications module eJournal as part of the patient portal, whereas control patients had access to eJournal modules for family history and health maintenance.	11 primary care practices affiliated with Partners HealthCare	Proportion of medications with unexplained discrepancies	72% of intervention patients completed a medication eJournal. The proportion of medications per patient with unexplained discrepancies was 42% in the intervention group compared with 51% in the control group ($P = 0.01$). The number of unexplained discrepancies with potential for severe harm was 0.03 and 0.08 in the intervention and control groups, respectively ($P = 0.04$).
Efficiency/utilization					
Ross et al, 2004 (11)	RCT; 107 patients with CHF (54 intervention and 53 control participants); dates not specified but recruitment 2001–2002	Intervention patients received access to a patient portal with access to clinical notes, laboratory and test results, educational guides, and secure messaging.	Heart failure subspecialty clinic at the University of Colorado Hospital	Primary: Change in the self-efficacy domain of the Kansas City Cardiomyopathy Questionnaire Secondary: Patient satisfaction and adherence	There were no statistically significant differences between the groups in self-efficacy or patient satisfaction. General adherence to medical advice was improved in the intervention group, but there was no significant improvement in medication adherence.
Ralston et al, 2009 (8)	RCT; 83 patients with DM; August 2002–May 2005	Web-based diabetes care management using a case manager for training, review of blood source readings, communication with patients, adjustment of diabetes medications, and discussion with the patient's PCP. Patients could review electronic clinical data, upload data to the portal, and send secure messages.	University of Washington General Internal Medicine Clinic	Primary: Change in hemoglobin A _{1c} levels Secondary: Total plasma cholesterol levels, BP, and health care utilization	After adjustment for age, sex, and baseline hemoglobin A _{1c} levels, intervention patients had significantly greater decreases in hemoglobin A _{1c} levels after 1 y (change, -0.7% ; $P = 0.01$). There were no differences between groups in BP control or lipid levels or the numbers of outpatient visits, primary care visits, specialty physician visits, or inpatient days. Care manager self-reported an average of 4 h/wk of working with the intervention group.
Green et al, 2008 (12)	RCT; 778 with uncontrolled hypertension (258 in usual care; 259 in home BP monitoring and Web training; and 261 in home BP monitoring, Web training, and pharmacy case management); June 2005–December 2007	All groups had access to GHC's patient portal and educational materials. Active intervention patients received a home BP monitor and training. An additional subset of the intervention patients also received pharmacy case management by secure messaging and telephone calls, with development of an "action plan."	GHC (10 medical centers in Washington and Idaho)	Primary: Percentage of patients with controlled BP (<140/90 mm Hg). Secondary: Number of antihypertensive medications, aspirin use, secure message threads, and other healthcare utilization	Web-based pharmacist care in conjunction with home BP monitoring and portal access resulted in significantly increased percentages of patient with controlled BP (25% more than usual care and 20% more than usual care with home BP monitoring). Patients receiving the full intervention had greater numbers of medications but not greater aspirin use. They had greater mean numbers of message threads and more phone encounters, but there were no differences in primary care, inpatient, or urgent care/emergency visits.

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Study, Year (Reference)	Study Design, Sample, Study Date	Health IT Intervention	Setting	Outcome Measures	Findings
Simon et al, 2011 (14)	RCT; 208 patients starting antidepressant treatment for depression; April–October 2009	Online depression care management using secure messaging through a patient Web site linked to the medical record.	GHC (9 primary care clinics in Washington)	Primary: Depression severity (Hopkins Symptom Checklist) Secondary: Satisfaction with care, antidepressant adherence, and use of health services	Intervention patients had lower depression severity at the end of the evaluation period, and higher proportions had 50% or greater decreases in depression scores (55% vs. 41%; OR, 1.8 [95% CI, 1.0–3.1]); 53% of patients in the intervention group were “very satisfied” compared with 33% in usual care ($P = 0.004$). Intervention patients were more likely to continue medication beyond 90 d (86% vs. 62%; $P = 0.001$). There were no differences in outpatient visits, telephone encounters, or on-study messaging.
Wald et al, 2010 (6)	RCT; 3979 participants with 1760 in group 1 and 2219 in group 2; 84 physicians; 2005–2007	Access to a previsit eJournal as a component of PC, a portal that provides access to secure messaging, chart extracts, appointment management, health information. Group 1 had access to a medication/allergies/diabetes eJournal, and group 2 had access to a health maintenance/family history/personal history eJournal.	11 primary care practices with Partners HealthCare	Use and patient and provider satisfaction	More group 1 participants reported submitting an eJournal (46% vs. 25%; $P < 0.001$), discussing it with their providers (59% vs. 46%; $P < 0.01$), and feeling more prepared for their visit (59% vs. 51%; $P < 0.01$) than group 2 participants. Providers in group 1 reported no change in visit length, whereas 47% of providers in group 2 believed that visits were longer ($P < 0.013$). Only 37% of all participants felt more satisfied with the visit or believed that communication improved, and only 24.5% believed that the quality of care at the visit improved.
Palen et al, 2012 (31)	Retrospective case-control study; 44 321 users and 44 321 matched nonusers; March 2005–June 2010	Access to MHM with access to appointment management, progress notes, test results, secure messaging, prescription refills, and care plans.	KP Colorado, Denver/Boulder/Longmont metropolitan area	Rates of office visits, telephone encounters, after-hours clinic visits, ED visits, and hospitalizations	After adjustment for age, sex, baseline rates of office visits, and specific chronic illnesses, MHM users had higher rates of office visits (RR, 1.16), telephone encounters (RR, 1.1), after-hours clinic visits (RR, 1.1), ED visits (RR, 1.1), and hospitalizations (RR, 1.4) compared with their pre-MHM access rates. Nonusers had fewer office visits (RR, 0.9), a small increase in telephone encounters (RR, 1.02), fewer after-hours clinic visits (RR, 0.91), and no change in ED visits. Differences between users and nonusers were significant ($P < 0.01$).
Zhou et al, 2007 (24)	Retrospective case-control study; 3201 case and control participants; 2002–2005	Access to KP HealthConnect, including access to parts of the health record and secure messaging.	KP Northwest, Oregon and southwest Washington	Primary care visits rates and telephone contact rates before and after registration for KP HealthConnect	Visit rates decreased by 10.3% in case participants but only 3.7% in control participants, with a statistically significant difference of 6.7% ($P < 0.003$). Telephone contact rates increased by 16.2% for case participants and 29.9% for control participants, with a statistically significant difference of 13.7% ($P < 0.01$).

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Study, Year (Reference)	Study Design; Sample; Study Date	Health IT Intervention	Setting	Outcome Measures	Findings
Patient characteristics Ralston et al., 2007 (22)	Cross-sectional cohort study and survey; 325 634 members and 201 969 contracted network members; 2002 patients for satisfaction survey; September 2002–December 2005	MyGroupHealth portal requiring ID verification for higher-level access, including sharing of test results, allergy lists, immunization history, secure messaging, and appointment management.	GHC integrated delivery system sites and contracted physician network with Washington and northern Idaho	Use and satisfaction	Over 3 y, the number of patients receiving ID verification to use MyGroupHealth increased from 3% to 25%. In the integrated delivery system, members who were ID-verified were more likely to be female, have commercial insurance, and have higher-than-expected clinical need. There were greater increases in rates of use of secure messaging and viewing test results/health summaries than viewing immunization, allergy, or problem lists. There were high satisfaction rates with satisfaction greater for secure messaging and medication refills than with the overall application.
Weppner et al., 2010 (20)	Retrospective cohort study; 6185 patients aged ≥ 65 y with DM; August 2003–December 2007	MyGroupHealth portal with access to secure messaging, medication refills, appointment management, after-visit summaries, test results, and medication/allergy/immunization lists.	GHC primary care clinics	Initial and subsequent use	Over an average of 2.8 y, approximately one third of enrollees used the portal with younger age, male sex, higher socioeconomic status, and higher PCP use of secure messaging significantly associated with use. Greater illness rates were associated with earlier sign-up and ongoing use (RR, 1.3; $P < 0.001$).
Lyles et al., 2012 (25)	Cross-sectional survey and medical record review; 718 patients with diabetes for survey, 625 patients with diabetes for record review; September 2009	Access to the patient portal, which provides access to after-visit summaries, medical history/diagnoses, appointment management, prescription refills, physician notes, test results, and secure messaging.	5 GHC medical clinics in western Washington	Association of portal use with race/ethnicity and provider characteristics	In a model adjusted for age, sex, health need, education, income, and provider factors, blacks were 82% less likely and Asians were 60% less likely than whites to use the portal. When restricted to those who used the Internet, blacks were still 75% less likely to use the portal.
Roblin et al., 2009 (26)	Cohort study; 1777 patients; October 2005–November 2007	Registration for KP.org, providing access to appointment management, prescription refills, secure messaging, laboratory results, self-entered health data, and educational information.	KP Georgia	Time to registration and association with race/ethnicity	35% of participants registered during the study and were more likely to be white than black (42% vs. 30%; $P < 0.01$), have diabetes or elevated lipid levels (36% and 38% vs. 30%; $P = 0.01$), and have higher levels of education compared with low-risk adults.
Sarkar et al., 2010 (28)	Cross-sectional survey and KP.org data; 14 102 English-speaking patients with diabetes; January–December 2006	KP.org portal, providing access to laboratory results, secure messaging, appointment management, prescription refills, and health information.	KP Northern California	Registration and use of portal and association with health literacy	Only 40% registered for KP.org and 27% signed on ≥ 1 time. Blacks, Latinos, and Filipinos were more than twice as likely not to sign on to KP.org when compared with whites. Those with lower self-reported health literacy were 1.7 times less likely to sign on to KP.org. Literacy findings persisted even when restricting to those with computer access.
Yamin et al., 2011 (27)	Cross-sectional secondary data analysis; 75 056 patients; January 2002–September 2009	PG providing access to medication lists, appointment management, laboratory results, and secure messaging.	Partners HealthCare	Adoption/registration and association with demographic characteristics	43% were "adopters," with lower rates among racial/ethnic minorities compared with whites (OR for adoption in blacks, 0.5; OR in Hispanics, 0.64) and with lower annual income. Adopters were more likely to have ≥ 2 illnesses (asthma, CHF, diabetes, and hypertension). Use of an aggressive marketing strategy increased adoption 3-fold.

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Study, Year (Reference)	Study Design; Sample; Study Date	Health IT Intervention	Setting	Outcome Measures	Findings
Hassol et al, 2004 (44)	Cross-sectional survey (1421 patients) and qualitative study with focus groups (25 patients; 10 clinicians); study dates not provided	MyChart patient portal with access to laboratory tests, allergy/medication/problem lists, appointment management, prescription renewal, referral requests, and secure messaging with providers.	Geisinger Health System	User characteristics: ease of use, and completeness/accuracy/understandability	Most users were aged 46–64 y, and 60% were female; 23% used portal on behalf of a spouse. Respondents reported high ratings for ease of use (78–85 out of 100) and for understandability and accuracy, and 28% of men and 30% of women had data confidentiality concerns.
Jung et al, 2011 (39)	Retrospective cohort study; 10 532 participants; April 2009–May 2010	Access to MyChart patient portal, including ability to view test results, send secure messages, obtain prescription refills, receive health maintenance reminders, schedule appointments, and use eVisits for nonurgent conditions.	UPMC patients for the portal and 4 primary care practices for the eVisit option	Patient characteristics and use of eVisit	3.2% of portal users had eVisit service. Female patients were more likely to use eVisit, whereas older and retired patients were less likely. Patients with greater numbers of diagnoses and medications were more likely to use eVisit services.
Tsai and Rosenheck, 2012 (32)	Cross-sectional survey; 7215 veterans; 2010	2010 National Survey of Veterans	U.S. Department of Veterans Affairs	Characteristics associated with Internet use and use of the VA's patient portal in mental health service users	22% of VA users used the VA's patient portal, MHV, and utilization was no different between those using mental health services at the VA and other groups of veterans. There were no statistically significant predictors of MHV use among survey respondents, although there were trends toward more use among those who entered active duty later, had more education and higher income, and had served in Iraq and Afghanistan.
Burke et al, 2010 (23)	Cohort study; 252 patients; September 2006–February 2009	Access to history and physical and discharge summary, patient care instructions, intraoperative cardiac images, and daily patient images from "I-Rounds," a Web-based EHR used by the pediatric cardiac surgical team.	Miami Children's Hospital, Congenital Cardiac Disease Unit	Use and user characteristics	95% of the patients or families used the system. Access was more common when the patients were in the hospital than out of the hospital (median, 6 vs. 4; $P < 0.001$). Imaging data were viewed more than textual data (median, 8 vs. 5 views; $P < 0.001$).
Attitudes, including barriers and facilitators					
Wald et al, 2010 (6)	RCT; 3979 participants with 1760 in group 1 and 2219 in group 2; 84 physicians; 2005–2007	Access to a previsit eJournal as a component of PC, a portal that provides access to secure messaging, chart extracts, appointment management, and health information. Group 1 had access to a medication/allergies/diabetes eJournal, and group 2 had access to a health maintenance/family history/personal history eJournal.	11 primary care practices with Partners HealthCare	Use and patient and provider satisfaction	More group 1 than group 2 participants reported submitting an eJournal (46% vs. 25%; $P < 0.001$), discussing it with their provider (59% vs. 46%; $P < 0.01$), and feeling more prepared for their visit (59% vs. 51%; $P < 0.01$). Providers in group 1 reported no change in visit length, whereas 47% of providers in group 2 believed that visits were longer ($P < 0.013$). Only 37% of all participants were more satisfied with the visit or believed that communication improved, and only 24.5% believed that the quality of care at the visit improved.

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Appendix Table 2—Continued

Study, Year (Reference)	Study Design; Sample; Study Date	Health IT Intervention	Setting	Outcome Measures	Findings
Earnest et al, 2004 (10)	RCT; 107 patients, 8 physicians; January–December 2002	Access to SPARO, which provides access to clinical notes, test results, and secure messaging.	Academic cardiology CHF clinic at University of Colorado	Patient and physician attitudes and efficiency	Patients were significantly less likely than physicians to anticipate problems before the intervention; 71% of physicians anticipated more questions or worry among patients whereas only 37% of patients anticipated more questions and only 5% more worry. Over time, physician concerns decreased, but decreases were not statistically significant. All of the physicians ultimately supported the concept of giving patients online access to their clinical notes and test results.
Cho et al, 2010 (21)	Cross-sectional; 201 veterans with diabetes and hemoglobin A _{1c} levels >8%; dates not provided	MHV patient portal with access to health logs, prescription refill, provider notes, preventive reminders, and secure messaging.	Durham VA Medical Center	Use, access, and interest	Of 201 patient surveys completed (63% response rate), 59% reported having Internet access at home and being “moderately” comfortable with Internet tasks, 18% had heard of MHV, and 9% had used it; 41% of patients were “very interested” in using it. In multivariate analyses, age and trust in the Internet were independent predictors of interest in using MHV for diabetes management with odds of being “very interested” increasing by 1.4 for each decade younger a respondent was, and by 2.3 if the respondent had “a lot/some” trust in the Internet.
Delbanco et al, 2012 (33)	Quasi-experimental trial with surveys; 113 physicians and 19 371 patients; 2010–2011	Patient electronic access to primary care provider notes after visits.	Beth Israel Deaconess Medical Center, Geisinger Health System, and Harborview Medical Center	Patient and physician attitudes	Before the intervention, fewer physicians than patients anticipated potential benefits of OpenNotes (e.g., patients would be more prepared for visits, more adherent) and most were worried about workload effects. After the intervention, participating physician concerns about workload effects diminished (generally by more than half), but attitudes about the need to change documentation about sensitive topics persisted. The main concerns of patients were about privacy.
Goel et al, 2011 (34)	Cross-sectional survey; 159 patients; February–June 2010	Failure to enroll in a patient portal after receiving an electronic invitation.	Faculty general medicine practice affiliated with Northwestern University	Reasons for not enrolling or attempting to enroll; perceived benefits	60% reported lack of information/motivation as reason for not enrolling; 30% had negative attitudes about the portal. Preference and security concerns were commonly cited barriers. Blacks were significantly less likely than whites to view portals as important to self-management, getting test results, managing medical problems, or seeing when screening was due.
Emani et al, 2012 (35)	Cross-sectional survey; 760 patients; study dates not provided	Access to PG	Partner HealthCare	Patient perceptions of value of patient portal and predictors of adoption	After adjustment for age, sex, education, income, access and use of technology, ease of use, and relative advantage (the degree to which the portal is perceived as being better than the alternative, such as calling the physician’s office) were the top predictors of adoption. More positive perceptions of privacy and security were also associated with adoption and greater perceived value.

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Study, Year (Reference)	Study Design; Sample; Study Date	Health IT Intervention	Setting	Outcome Measures	Findings
Tom et al, 2012 (36)	Cross-sectional survey; 256 parents of children with chronic conditions; study dates not provided	Access to MyGroupHealth, which provides access to secure messaging, medical records, medication management, and appointment management.	GHC	Parental use patterns and attitudes/experience about access	Portal users were more likely to have commercial insurance (97% vs. 73%; $P < 0.001$) and a 4-y college degree (74% vs. 50%; $P < 0.001$). After adjustment to child characteristics, including health status, insurance, race/ethnicity, and parent characteristics (age and education), there were no differences between users and nonusers in their assessments of their health care providers and health systems, including access to care.
Hassol et al, 2004 (44)	Cross-sectional survey (1421 patients) and qualitative study with focus groups (25 patients; 10 clinicians); study dates not provided	MyChart patient portal with access to laboratory tests, allergy/medication/problem lists, appointment management, prescription renewal, referral requests, and secure messaging with providers.	Geisinger Health System	User characteristics, ease of use, and completeness/accuracy/understandability	Most users were aged 46–64 y, and 60% were female; 23% used portal on behalf of a spouse. Respondents reported high ratings for ease of use (78–86 out of 100) and understandability and accuracy, and 28% of men and 30% of women had data confidentiality concerns.
Volk et al, 2005 (41)	Cross-sectional survey; 460 patients; 2003	PG with access to medication/allergy lists, secure messaging, prescription refills, and appointment management.	Partners HealthCare	Patient perceptions about value and effect of portal	Response rate was 23%; 70% of portal users reported overall satisfaction as "good" or better; 38% believed that PG improved communication, but equal numbers were unsure or disagreed. The most frequently rated valuable functions were the ability to renew prescriptions, ask an administrative question, and obtain referral approvals.
Schnipper et al, 2008 (42)	Cross-sectional survey; 466 patients; 2005–2007	Medications Module eJournal	Partners HealthCare	Attitudes	70% found the journal easy to use, 53% strongly agreed or agreed that the journal gave providers more accurate information, and 56% felt more prepared for their visit.
Eklund and Joustra-Enquist, 2004 (43)	Cross-sectional survey; 100 patients; 1999–2001	SUSTAINS with access to medical record and secure messaging.	Uppsala University Hospital (Sweden)	Ease of use and attitudes	82% of "users" had no worries about security whereas 15% expressed some concern; and only 2% were very concerned about the security risks of "full scale service."
Ralston et al, 2004 (48)	Qualitative; 9 patients with diabetes; 2001–2002	Diabetes care module with access to the electronic record, secure messaging, ability to upload glucose readings, education site, and online diary.	General medicine clinic affiliated with the University of Washington	Experiences with using the module	6 themes emerged, including believing that nonacute concerns are valued, an enhanced sense of security about health, frustration with unmet expectations, feeling more able to manage, valuing feedback, and difficulty fitting the program into daily life.
Hess et al, 2007 (46); Zickmund et al, 2008 (47)	Qualitative; 39 patients; 2004–2007	UPMC HealthTrak with access to secure messaging, preventive reminders, disease-specific tools, and information.	3 primary care practices affiliated with the UPMC	Challenges to implementation and patient reactions	Patients believed that the system would enhance communication and reminders would be helpful. They identified potential barriers as forgotten passcodes, lack of knowledge about all aspects of the system, and inability to view all records of interest. Interest was linked to dissatisfaction with the provider–patient relationship, including inability to obtain information and logistical issues. Disinterest was related to satisfaction with the relationship but also to difficulty in using the portal.

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Appendix Table 2—Continued

Study, Year (Reference)	Study Design; Sample; Study Date	Health IT Intervention	Setting	Outcome Measures	Findings
Wald, 2010 (49)	Cross-sectional; 4 primary care practices; 2002–2009	Access to PG, a portal that provides access to secure messaging, medication management, chart extracts, appointment management, and health information. Later in the study, laboratory and imaging results were available.	4 primary care practices in the Partners HealthCare system	Implementation experiences	Patient enrollment varied substantially among practices with marketing limitations, leadership concerns, and limited staff engagement related to low enrollment. The addition of an incentive for patient enrollment was associated with 3- to 6-fold increases in portal adoption.
Haggstrom et al, 2011 (50)	Cross-sectional usability testing; 24 patients; study dates not provided	Usability testing of MHV patient portal	Human-computer interaction laboratory	Assessment of registration, prescription refill, tracking health, and searching health information	Most participants had trouble with the registration process and using tools designed to allow them to track their health and self-report health information, indicating that complex portal interfaces may present a barrier to use. Only efficiency in prescription refills was significantly better than target values.
Wade-Vuturo et al, 2013 (30)	Cross-sectional survey/focus group study; 39 patients in survey/focus group and 15 patients in survey-only group, all with DM and on medications; no dates provided	Access to MHAV with access to EHR data, secure messaging, and appointment and bill management.	Vanderbilt University Medical Center primary care clinic	Barriers and facilitators to portal use and association between use and glycemic control	Users reported satisfactions with multiple communication options, including secure messaging, which they viewed as expanding access. Preconceived beliefs about technology and rules and previous negative experience were barriers to secure messaging use. Use of secure messaging was marginally associated with improved glycemic control.
Day and Gu, 2012 (51)	Qualitative; 10 patients; no dates provided	Access to PHR linked to their physician's Practice Management System with access to laboratory results, diagnoses, immunizations, and medication lists.	General practitioner group practice in Wellington, New Zealand	Factors influencing PHR use	Factors influencing use were the perception that the personal health record helped make care more efficient and effective, whether the patient had adequate computer and health literacy to realize the potential benefits, and what the costs would be to the patient for using the personal health record.
Wald et al, 2009 (45)	Cross-sectional survey; 31 patients; 2005–2007	Access to a diabetes eJournal as part of PG that provided diabetes-related medical information and laboratory and other relevant test results and allowed patients to request referrals, update information, and generate a care plan.	11 primary care practices associated with Partners HealthCare	Use and experience with eJournal	61% talked with their providers about journal information, and 60% believed that the eJournal made them more prepared for the visit; 39% were more satisfied with the visit; 81% did not believe that the eJournal improved the quality of care during the visit.

ACE = angiotensin-converting enzyme; ARB = angiotensin-receptor blocker; BMI = body mass index; BP = blood pressure; CHF = congestive heart failure; DBP = diastolic blood pressure; DM = diabetes mellitus; ED = emergency department; EHR = electronic health record; GHC = Group Health Cooperative; ID = identification; IPHR = interactive preventive health record; IT = information technology; IVF = in vitro fertilization; KP = Kaiser Permanente; LDL = low-density lipoprotein; MHAV = MyHealthAtVanderbilt; MHM = My Health Manager; MHV = My HealthVer; OR = odds ratio; PCP = primary care physician; PG = Patient Gateway; PHR = personal health record; RCT = randomized, controlled trial; RR = rate ratio; SBP = systolic blood pressure; SPPARO = System Providing Patients Access to Records Online; SUSTAINS = Support Users to Access Information and Services; UPMC = University of Pittsburgh Medical Center; VA = Veterans Affairs.