Online supplementary appendix 2: Excerpts from data about study objective, methods, context, mechanisms, and outcomes

Table 1. Outcome: clinical outcomes						
#	Article information	Objective (excerpts)	Design and methods (excerpts)	Context (excerpts)	Mechanisms (excerpts)	Outcomes (excerpts)
1	Wagner et al, 2012. Personal health records and hypertension control: A randomized trial	Examine PHR use and outcomes in a sample of ambulatory patients with hypertension	A prospective two-group cluster-RCT was conducted in which 24 primary care physicians were 'clusters' with patients 'nested' within their practice.	Physicians were recruited from one Family Medicine and one Internal Medicine ambulatory clinic at a southern tertiary academic medical center	The conceptual framework of consumer engagement suggests that access to PHI typically contained in a PHR increases patient activation thus improving health behaviors. Perhaps the PHR serves as a 'cue to action' as suggested by the health belief model.	Little change in outcomes except in limited areas among those using the PHR frequently. Patients who were the most frequent PHR users evidenced a reduction of 5.25 points in DBP and 3.97 points in SBP.
2	Tenforde et al, 2012. The association between personal health record use and diabetes quality measures	Explore the actual use of Cleveland Clinic's electronic medical record (EMR)-linked PHR by a large primary care cohort of patients with DM to determine if use of the PHR was associated with improved diabetes quality measures.	Retrospective audit of PHR use and multivariable regression analyses. Included all primary care patients actively managed DM aged 18–75-years seen in Cleveland Clinic departments of internal medicine and family medicine from July 2008 through June 2009.	Cleveland Clinic made PHR available to the general patient population in 2006. As of July 2010, approximately 20–40% of primary care patients utilized the PHR, depending on practice site and physician.	Access to effective and tailored patient education, electronic patient–provider communication, and tailored patient education, electronic patient–provider communication, and the wealth of clinical information and web-based resources contained within modern PHRs could lead to improvements in chronic disease outcomes through improved patient-centered care and self-management.	Most quality measures were better, on average, among the group who used the personal health record, but the differences were quite small and of marginal clinical significance. More intensive use of the PHR did not result in any clinically important differences compared to minimal use.
3	Shaw, 2011. Patient-provider internet portals - Patient outcomes and use	Examine whether patients with diabetes who are users of the patient-provider Internet portal had a significant difference in clinical indicators compared with diabetes patients who are nonusers.	A cross-sectional secondary data analysis to describe the types of diabetes patients who utilize the portal and explore any preliminary differences in patient outcomes	Study was conducted at Duke University Medical Center	We hypothesize that patients, particularly those with chronic illness, who engage with a patient-provider Internet portal may have improved clinical outcomes due to the ability to be more engaged with their own healthcare.	Results indicated that portal use was not a significant predictor of LDL and total cholesterol levels. Portal use was a statistically significant predictor of HbA1c); however, clinical significance is debatable.

4	Harris et al, 2009. Web-based collaborative care for type 2 diabetes: a pilot randomized trial	To explore whether the association between secure messaging use and diabetes control.	Cross-sectional analysis of electronic messaging activity at Group Health Cooperative between 1 January 2004 and 31 March 2005. The study was restricted to diabetic patients aged >18 years who were continuously enrolled in Group Health Cooperative's Integrated Group Practice during the study period.	Study was conducted at Group Health Cooperative—a mixed-model health care financing and delivery organization in Washington and north Idaho. Over 300,000 members receive care through Group Health Cooperative Integrated Delivery System, which includes 20 Group Health owned facilities and over 500 Group Health physicians. Beginning in August 2003, all patients were able to access patient Web services through the MyGroupHealth Web site.	By increasing the frequency of contact, secure messaging might also strengthen continuity of care, which has also been associated with improved glycemic control Secure messaging may have enabled better glycemic control by filling unmet needs for care. Care providers may have used secure messaging to recommend medication changes between in-person visits, thereby optimizing treatment regimens more quickly.	In this cross-sectional study, patients who used more secure messaging had better glycemic control.
5	Zhou et al, 2010. Improved Quality at Kaiser Permanente through e-mail between physicians and patients	Report experience with secure patient-physician e-mail and the quality of care in a large population of adults with diabetes, hypertension, or both.	Retrospective longitudinal and observational study using administrative data on secure patient-physician e-mail and HEDIS effectiveness-of-care measures for diabetes and hypertension from February 2005 to December 2008	Kaiser Permanente is US' largest not-for-profit integrated health delivery system, serving 8.6 million members in nine states and the District of Columbia. It provides and coordinates the entire scope of care for members. Between 2004 and 2010, Kaiser implemented a nationwide comprehensive electronic health record, called KP HealthConnect.	Possible mechanisms include the increasing continuity of care and patient-physician connectedness. To the extent that the use of e-mail lowers barriers to regular contact, it may promote continuity of care. Continuity of care, defined as regular contact between providers and patients, affects glycemic and lipid control.	In the regression analysis, the use of secure patient-physician e-mail was associated with improved performance on HEDIS measures. It was also associated with improved performance on blood pressure control among members with diabetes and with blood pressure among members with hypertension alone

6	Grant et al, 2008. Practice-linked online personal health records for type 2 diabetes mellitus: a randomized controlled trial	Improve the clinical management of DM in primary care practices through the use of a Web based diabetes PHR.	Multipractice RCT. Practices enrolled Sept 2005, and follow-up was completed in March 2007.	Study was conducted in 11 primary care practices within the Partners HealthCare system. Study practices were staffed by 230 PCPs and located in both hospital- and community based settings in eastern Massachusetts. All participating clinical sites used the same EMR and central laboratory for all clinical care activities.	We hypothesized that use of the DM-specific PHR would result in improved care by increasing patient knowledge and engagement in their own care. A "Diabetes Care Plan" based on patients' responses to share with their PCP at the upcoming clinic visit could facilitate communication and reduce clinical inertia.	Patients in the intervention arm and controls had similar mean HbA1c levels after 1 year of follow-up. Limited analysis of patients with HbA1c level greater than 7.0% at baseline shows that patients in the intervention arm were more likely to reach HbA1c goal at study end.
7	Green et al, 2008. Effectiveness of home blood pressure monitoring, Web communication, and pharmacist care on hypertension control: a randomized controlled trial.	Test whether hypertension control improved with home BP monitoring and training to use patient Web services, or this plus care management by a pharmacist over the We	A three-armed randomized controlled trial designed to compare two interventions to improve hypertension control. At the 12-month follow-up visit at the patient's clinic, trained research assistants blinded to the patients study group measured BP using the same protocol as baseline.	Single-site study conducted at 10 medical centers within Group Health, a large, nonprofit, integrated group practice that provides both medical coverage and care to more than 530,000 residents of Washington State and Idaho. A commercially available EMR integrated with patient website services was available at all Group Health-owned primary care clinics and hospitals at the beginning of the study.	Encouraging patients to participate more actively in their own care, combined with care management, including assisted patient review of paper medical records, leads to improved health outcomes. Conventional office BP measurement is subject to error and bias and physicians often make medication decisions based on one or two office measurements, despite the known variability of BP. Self-monitoring of BP by patients provides similar accuracy, is less expensive, and provides direct feedback as to BP control.	Results indicate that Web-based pharmacy care improved BP control. The intervention was particularly effective for those with higher systolic BP (≥160 mm Hg at baseline), which is typically more difficult to treat and associated with increased cardiovascular risk.

8	Tang et al, 2012. Online disease management of diabetes: engaging and motivating patients online with enhanced resources-diabetes (EMPOWER-D), a randomized controlled trial.	To evaluate an online disease management system supporting patients with uncontrolled type 2 diabetes.	Randomized controlled trial Participants were recruited from March 2008 through December 2009. 12-month follow-up. Clinical measurements, adverse event reports, and online questionnaires were collected from all participants at 6 and 12 months	The study was conducted at the Palo Alto Medical Foundation, a not-for-profit healthcare organization with approximately 1000 multispecialty physicians serving over 800 000 patients. Diabetes has been a focus for PAMF QI projects for over a decade. PAMF has been using an EHR with extensive clinical decision support, shown to improve care of diabetic patients	One of the core objectives is to empower participants with a better understanding of their disease processes and prompt them to take a more active role in self-management. Integrated personal health records (PHRs) can improve patients' access to their data and facilitate communication with their professional healthcare team. Unlike episodic office visits, remote monitoring technologies and automated alerting and communication capabilities can support greater continuity of care".	The intervention group was able to achieve a sustained and rapid reduction in population mean A1C at 6 and 12 months after randomization. However, the difference in A1C reduction compared with usual care was not statistically significant at 12 months
9	Ralston et al, 2009. Web-based collaborative care for type 2 diabetes: a pilot randomized trial	Improve glycemic control via care manager. The program consisted of home access to EHR, secure electronic communication with providers, and interactive disease management tools.	Randomized trial between August 2002 and May 2004. Enrolled participants in a 12-month open, randomized, single-center, controlled trial with a parallel group design.	The trial was conducted at the UW General Internal Medicine Clinic (a teaching clinic that provides care to 7,707 patients. The clinic is staffed by 25 faculty and 48 resident providers and employs a nurse practitioner to provide case-management services to chronic-disease patients. All providers used the same electronic medical record.	Patient interaction with online care plans and electronic medical records may further enhance the effectiveness of chronic care Care systems that use Web-based communications provide an opportunity to shift the focus in health care away from the office and toward patients' daily lives at home.	GHb declined significantly in the intervention group compared with the usual-care group. More participants in the intervention group than in the usual-care group had GHb <7% after 12 months.

10	Simon et al, 2011. Randomized trial of depression follow-up care by online messaging	Examine whether a depression management program led to improvements in severity of depression	Participants were enrolled between April and October of 2009 from nine primary care clinics of Group Health Cooperative. Approximately five months after randomization each participant in the care management and usual cares groups received a message inviting participation in a research follow-up survey.	Group Health Cooperative (GHC), an integrated health system serving approximately 600,000 members in the Pacific Northwest. GHCs performance on measures of antidepressant medication adherence and follow-up visit frequency are between the 50th and 75th percentiles for US health plans. Participating clinics were experienced users of the EpicCare EHR. This study was conducted in an integrated health care system with established collaborative relationships between primary care and mental health providers.	Reliance on live contact between patients and providers, however, makes telephone follow-up less convenient, less timely, and more expensive. "Online patient–provider communication has the potential to increase the availability and reduce the cost of effective depression care. Patients must receive calls when providers are available. Inconvenience and cost are significant barriers to adoption of these (depression management0 programs	Among primary care patients starting antidepressant treatment, care management through online messaging significantly reduced severity of depression compared to usual primary care.
11	Leveille et al, 2009. Health coaching via an internet portal for primary care patients with chronic conditions: a randomized controlled trial	Pair screening for chronic conditions with a coaching intervention conducted entirely through a patient internet portal.	RCT testing the e-coaching intervention conducted by clinical nurses in a population of primary care patients who were registered on PatientSite. Recruited August 2005 through August 2006	The study was conducted at Beth Israel Deaconess Medical Center (BIDMC), an academic medical center in Boston and its affiliates. Shared EHR.	We hypothesized that "e-coaching" via the internet portal, to encourage patients to discuss these common health problems with their primary care physicians (PCP) would improve detection and management during upcoming primary care visits and help alleviate patients' symptoms. A targeted electronic patient empowerment intervention could substantially improve the detection and mitigation of selected chronic conditions that adversely affect patients' quality of life".	No significant differences between the intervention and control groups in health outcomes detected,

Table 2. Outcome: health resource consumption						
#	Article information	Objective (excerpts)	Design and methods (excerpts)	Context (excerpts)	Mechanisms (excerpts)	Outcomes (excerpts)
12	Keplinger et al, 2013. Patient portal implementation: Resident and attending physician attitudes	Evaluate attending physician perceptions in both pre- and post-portal implementation settings	Survey of physicians three times in 2008–2009 about their perceptions of a patient portal. Post-implementation interviews with key attending physician informants	The University of Missouri Health System began to implement its Cerner PowerChart® EMR in 1998. In November 2008, an electronic communications portal, Cerner IQHealth, was added for patients in selected clinics in the Division of General Internal Medicine (GIM) and the Department of Family and Community Medicine (FCM).	Secure electronic messages from patients may in part replace phone calls and have the potential to improve the timeliness and efficiency of the flow of information.	Faculty physicians felt the portal did not increase physician workload despite earlier concerns. With 64% pre-implementation agreeing workload would increase but only 13% agreeing that it had after implementation. Prior to implementation, 82% of pilot faculty physicians thought phone calls would be decreased, but only 27% thought that calls had decreased after implementation .
13	Nielsen et al, 2012. Internet portal use in an academic multiple sclerosis center	Determine if there is an association between portal use and medical resource utilization	Case–control retrospective chart review. Data were collected from online medical record (OMR) during the time period of 1 January 2008 to 31 December 2009. All eligible patients had to carry a diagnosis of clinically isolated syndrome or multiple sclerosis, be at least 18 years or older, and be actively followed in our clinic during this time as evidenced by progress notes in our OMR.	PatientSite is a patient internet portal developed at Beth Israel Deaconess Medical Center (BIDMC) in Boston, Massachusetts. Since its implementation in 2000, 335 clinicians have enrolled in the portal, and over 50 000 patients have used this system within the past 2 years alone. As of December 2010, our MS clinic has enrolled over 1300 patients.	Internet portals may improve patient health and well-being by providing reliable and trusted MS-related information and resources, providing easy and reliable methods for patients to navigate an increasingly complex medical healthcare system, and providing a secure avenue for patients to communicate electronically with their MS provider regarding symptoms and disease management	The number of clinic visits scheduled was greater among portal users compared to non-users . A trend toward a greater proportion of 'no-shows' to clinic was found among portal non-users. Portal utilization also did not discern emergency department visits or hospitalizations for MS-related care. Prescribing habits and medication use were more frequent among our MS staff and portal users.
14	Palen et al, 2012. Association of Online Patient Access to Clinicians and Medical Records With Use of Clinical Services	Investigate the association between patient online access and use of clinical services.	Retrospective cohort study with matched control. The study period was March 2005 through June 2010.	The study was conducted at Kaiser Permanente Colorado (KPCO), a group model, integrated health care delivery system that provides health care for a diverse population of more than 500 000 members in the Denver- Boulder-Longmont metropolitan area. Since 2004, KPCO has	If patients could look up health information such as their test results, request prescription refills, schedule appointments, and send secure email to clinicians, then their use of clinical in-person and telephone calls may decrease". Online access to care may have led to an increase in use of in-	Patients with online access to their medical records, including secure e-mail communication with clinicians, had a subsequent increase in use of most in-person and telephone clinical services. Member use of online access steadily increased from about 25% at the end of 2007 to 53.8% by June 2009 (n = 375 620)

				used a fully integrated EMR for health care documentation. Clinicians are expected to use the system to document all clinical encounters.	person services because of additional health concerns identified through online access	
15	Krist et al, 2012. Interactive preventive health record to enhance delivery of recommended care: a randomized trial	Develop and test a higher-functioning personal health record	A patient-level, randomized, no blinded, controlled comparison of preventive services delivery for patients who were invited to use the IPHR compared with those who received usual care.	The Virginia Ambulatory Care Outcomes Research Network (ACORN) with varying locations, patient populations, information systems, informatics experience, and organizational culture participated in the three trials. ACORN recruited 8 primary care practices in Northern Virginia to participate. Practices were members of a private medical group that shared a common EHR (Allscripts Enterprise), managed by a central informatics staff. Each practice operated independently for clinical activities. Size ranged from 2 to 35 clinicians	Patients need evidence-based information about what is recommended—tailored to their individual risk factors (eg, age, sex, comorbidities, prior testing, family history, health behaviors)—and presented in an understandable format. To act on their choices, patients need written plans and logistical details. They need reminders when services are due, guidance to deal with inconsistent recommendations, and access to decision aids for choices that require shared decision-making.	Among users, the delivery of some services increased by 9% to 23%. The difference between users and nonusers in the increase in up-to-date services at 4 months was 15.3%, 12.3%, and 11.3% for colorectal, breast, and cervical cancer screening, respectively. Similar changes were seen at 16 months, except for breast cancer screening.
16	Ross et al. Providing a Web-based Online Medical Record with Electronic Communication Capabilities to Patients With Congestive Heart Failure: Randomized Trial	Assess the effects of a patient-accessible online medical record in a rigorously controlled fashion	Randomized Trial. When patients completed the initial questionnaire they were blinded to their enrollment status.	Specialty clinic for patients with heart failure at University of Colorado Hospital in Denver, Colorado. The majority of patients in the practice have New York Heart Association Class II or Class III symptoms of heart failure. Patients in this practice are cared for by a team of physicians. They therefore receive clinical notes from a variety of physicians over the course of their treatment.	Patients can review an online medical record repeatedly at their convenience, in the context of other resources that may assist them in comprehending it. Because patients with heart failure often require frequent visits and complicated medical regimens, we anticipated that access to medical records would be particularly helpful for these patients, by clarifying their doctors' assessments and instructions.	The electronic messaging function in SPPARO appeared to supplement, rather than replace, telephone messages. The intervention group sent more messages to the practice (350 total: 287 phone calls and 63 electronic messages) than the control group (267 phone calls) over the course of the study.

					Patients can review an online medical record repeatedly at their convenience, in the context of other resources that may assist them in comprehending it.	
4	Harris et al, 2009. Diabetes Quality of Care and Outpatient Utilization Associated With Electronic Patient-Provider Messaging: A Cross-Sectional Analysis	To test the hypothesis that electronic patient-provider messaging is associated with high care quality for diabetes and lower outpatient utilization	Cross-sectional analysis of electronic messaging activity at Group Health Cooperative between 1 January 2004 and 31 March 2005. The study was restricted to diabetic patients aged >18 years who were continuously enrolled in Group Health Cooperative's Integrated Group Practice during the study period.	Study was conducted at Group Health Cooperative—a mixed-model health care financing and delivery organization in Washington and north Idaho. Over 300,000 members receive care through Group Health Cooperative Integrated Delivery System, which includes 20 Group Health owned facilities and over 500 Group Health physicians. Beginning in August 2003, all patients were able to access patient Web services through the MyGroupHealth Web site	Secure messaging may serve as an important part of care for patients with diabetes and an opportunity to support them in self-management outside of routine visits. Secure messaging use may also raise unmet needs in this population that require further engagement either in person or through secure messaging.	The primary care visit rate was 32% higher among patients with high use of secure messaging compared with that in the non-messaging comparison cohort. This translates to approximately three to four additional outpatient office visits, given a baseline visit rate of nine visits per year. High secure messaging users also had more outpatient specialty visits and emergency care visits
9	Ralston et al, 2009. Web-based collaborative care for type 2 diabetes: a pilot randomized trial	Assess differences between groups in health service utilization after diabetes management program consisting of access from home to the EHR medical record, secure electronic communications between patients and providers, and interactive disease management tools.	Randomized trial between August 2002 and May 2004. Enrolled participants in a 12-month open, randomized, single-center, controlled trial with a parallel group design.	The trial was conducted at the UW General Internal Medicine Clinic (a teaching clinic that provides care to 7,707 patients. The clinic is staffed by 25 faculty and 48 resident providers and employs a nurse practitioner to provide case-management services to chronic-disease patients. All providers used the same electronic medical record.	Health care limited to clinic visits does not meet the needs of many patients with diabetes. Care systems that use Web-based communication provide an opportunity to shift the focus in health care away from the office and toward patients' daily lives at home. Patient interaction with online care plans and electronic medical records may further enhance the effectiveness of chronic care".	No differences between groups in the utilization measures were statistically significant. The care manager self-reported an average of four hours per week spent updating care plans and communicating over the Web with patients in the intervention group. No differences were found in the use of primary care, specialty care, or inpatient services in the intervention group compared with the usual-care group, suggesting that the intervention did not lead to marked changes in health care utilization
17	Zhou et al, 2007. Patient access to an electronic health	To investigate the relationship between patient–physician	A pair of retrospective studies. The 2 designs relied on administrative data about	KP is the nation's largest not-for-profit integrated healthcare delivery system	Electronic communication between patients and physicians can reduce health	Annual adult primary care outpatient visit rates decreased by 6.7% to 9.7% for members using KP HealthConnect™

	record with secure messaging: impact on primary care utilization	electronic messaging and physician workload	subject characteristics, primary care office visit and telephone contact rates, and KP HealthConnect™ Online use.	with more than 8.5 million members in 8 geographic regions. KP's integrated healthcare delivery system addresses all healthcare needs for adult and pediatric members. The Kaiser Permanente Northwest (KPNW) region, with nearly 487 000 adult and pediatric members in April 2006, is located in Oregon and southwest Washington. KP is a largely prepaid, integrated healthcare delivery system. Patients and physicians generally used electronic messaging free of the reimbursement concerns that presently challenge the US healthcare system.	plan spending on physician office and laboratory services. Secure messaging reduces overall physician workload if it requires less time than the replaced visits and telephone contacts. Physicians and staff state that electronic messaging requires less time than telephone calls and that lengthy messages can be completed at intervals throughout the day.	Online, and these members had a smaller increase in documented telephone contacts (16.2%) than the control group (29.9%). Annual adult primary care office visit rates decreased by 9.7%, a statistically significant decline from 2.47 to 2.24 office visits per member per year.

Table 3. Outcome: patient adherence						
#	Article information	Objective (excerpts)	Design and methods (excerpts)	Context (excerpts)	Mechanisms (excerpts)	Outcomes (excerpts)
18	McInnes et al, 2013. Personal health record use and its association with antiretroviral adherence: Survey and medical record data from 1871 us veterans infected with hiv.	Examine whether patient use of a PHR system is positively associated with medication adherence.	We analyzed data from the Veterans Aging Cohort Study (VACS). We used data from 1871 HIV- infected participants who completed the VACS fifth follow-up survey administered in 2010–2011.	The Veterans Affairs (VA) health care system initiated a PHR system, called My HealtheVet, in 2003 and it now has over 1.3 million registered users	TThe ease of navigating the health care system may affect patient adherence to medications of chronic conditions". For example the complex logistics of refilling medication from the patient realizing that a refill is needed, to taking the action to refill, to receipt of the medication from the pharmacy— can contribute to non-adherence.	In this study of 1,871 veterans who were HIV positive, use of an electronic PHR was associated with higher levels of medications adherence, even after controlling for socio- demographic characteristics, self-reported health status, and geographic location of care.
15	Krist et al, 2012. Interactive preventive health record to enhance delivery of recommended care: a randomized trial.	Develop and test a higher-functioning personal health record	A patient-level, randomized, no blinded, controlled comparison of preventive services delivery for patients who were invited to use the IPHR compared with those who received usual care.	The Virginia Ambulatory Care Outcomes Research Network (ACORN) with varying locations, patient populations, information systems, informatics experience, and organizational culture participated in the three trials. ACORN recruited 8 primary care practices in Northern Virginia to participate. Practices were members of a private medical group that shared a common EHR (Allscripts Enterprise), managed by a central informatics staff. Each practice operated independently for clinical activities. Size ranged from 2 to 35 clinicians	Patients need evidence-based information about what is recommended—tailored to their individual risk factors (eg, age, sex, comorbidities, prior testing, family history, health behaviors)—and presented in an understandable format. To act on their choices, patients need written plans and logistical details. They need reminders when services are due, guidance to deal with inconsistent recommendations, and access to decision aids for choices that require shared decision-making.	Patients who were mailed an invitation to use the IPHR were more likely to be up-to-date on all indicated preventive services than were patients who received usual care
19	Muller et al, 2009. The Effectiveness of a Secure Email Reminder System for Colorectal Cancer	Look at the effectiveness of using a secure email system linked to an electronic health	This randomized prospective cohort study had three arms.	This study was conducted in a nonprofit Health Maintenance Organization (HMO) in the northwest United States with	Alerts and reminders, as prompts for inreach, have been shown to be effective in improving vaccination rates, breast cancer screening,	This study shows that reminders are an effective tool in promoting colon cancer screening in the population studied.

	Screening	record to send reminders to patients in an effort to increase CRC screening rates.		approximately 479,000 members. The HMO has an electronic health record (EHR) It contains information about future appointments that are scheduled with both primary care clinicians and specialists.	cardiovascular risk reduction and CRC screening in the outpatient setting. Outreach involves reminding patients of their personal screening recommendations independent of office visit utilization.	
20	Sequist, 2011. Electronic patient messages to promote colorectal cancer screening: a randomized controlled trial	Assess the impact of electronic patient messages coupled with personalized risk assessments delivered via an integrated personal health record on the rate of colorectal cancer screening.	This 4-month trial was conducted from November 2009 to March 2010 at Harvard Vanguard Medical Associates (HVMA),	Harvard Vanguard Medical Associates (HVMA), a multi-specialty group practice composed of 14 ambulatory health centers in eastern Massachusetts. Since 1997, clinical practices within HVMA have used a common EHR. Screening tests for colorectal cancer can be ascertained via an automated electronic algorithm using laboratory results, diagnostic codes, procedure codes, and outpatient and hospital encounters from the EHR.	Personal health records directly integrated into electronic health records allow the efficient and direct delivery of information from doctors to patients. Such information can engage patients and encourage them to promote their own health behaviors. Direct-to-patient mailings can increase rates of colorectal cancer screening by heightening awareness and facilitating performance of recommended tests. Primary care physicians face increasing pressures to provide a wide range of preventive counseling during increasingly shorter office visits. Colorectal cancer screening presents a particular challenge given the multiple screening options. PHRs offer the promise of engaging patients in a more efficient and interactive manner.	Electronic outreach via an integrated personal health record produced an initial increase in colorectal cancer screening rates, but this effect was not sustained. Only half of patients in the intervention group viewed the electronic messages despite having it sent from their personal physician, which limited the overall effectiveness of the intervention.
21	Wright, 2012. Randomized controlled trial of health maintenance reminders provided directly to patients	Determine the effect of HM reminders provided electronically via a secure PHR,	Randomized controlled trial. Practices were randomly allocated to either of two arms (after matching for practice setting, general medicine vs women's health	Participating practices (n=11) were primary care practices at Partners HealthCare, an integrated academic care network in Boston, MA. Participating	The use of a secure, interactive personal health record (PHR) tethered to an EHR can provide an avenue for patients to review and update health information and has the	Patients in the intervention arm who received HM reminders were more likely to receive influenza vaccines (22.0% vs 14.% mammography (48.6% vs 29.5%, and Pap smears . We found that HM reminders, when provided directly to

	through an electronic PHR		and number of enrolled patients), and patients received the intervention associated with their practice's arm.	practices were diverse, and included a mix of hospital and community-based practices, federally qualified health centers and women's health practices. The practices were located in both urban and suburban settings, and served patients across a wide range of the socioeconomic spectrum. Each practice used the Longitudinal Medical Record (LMR), a internally developed, certified electronic health record (EHR)14, and made Patient Gateway (PG) available to patients	potential to improve adherence to guidelines". Increased patient self-efficacy has been associated with better self-care and health management Such tools could potentially enhance patient self-efficacy—a patient's individual perception of how their actions and choices impact their care and health outcomes.By offering patients the opportunity to become more involved in their care, it may be possible to increase self-efficacy and improve adherence to care guidelines. However, it is important to note that patients may too be susceptible to "alert fatigue" and focusing heavily in one area (e.g., health maintenance) may lead them to neglect another area (e.g., diabetes)	patients via a secure EHR-connected PHR, improved the rates of some preventive screenings and vaccinations, but not others.
16	Ross et al. Providing a Web-based Online Medical Record with Electronic Communication Capabilities to Patients With Congestive Heart Failure: Randomized Trial	Assess the effects of a patient-accessible online medical record in a rigorously controlled fashion. SPPARO provides a secure Web interface to three components: the medical record, an educational guide, and a messaging system	Clinical trial. After completing the informed consent, patients who were interested in enrolling in the primary study were provided with an enrollment form and the initial questionnaire. When patients completed the initial questionnaire they were blinded to their enrollment status.	Specialty clinic for patients with heart failure at University of Colorado Hospital in Denver, Colorado. The majority of patients in the practice have New York Heart Association Class II or Class III symptoms of heart failure. Patients in this practice are cared for by a team of physicians. They therefore receive clinical notes from a variety of physicians over the course	Patients can review an online medical record repeatedly at their convenience, in the context of other resources that may assist them in comprehending it. We hypothesized that access to the medical record would improve their adherence, Patients can review an online medical record repeatedly at their convenience, in the context of other resources that may assist them in comprehending it.	General adherence to medical advice showed significant improvement in the intervention group compared with the control group. Adherence to medications showed a similar trend but did not reach statistical significance.

Table 4. Outcome: patient-provider communication						
#	Article information	Objective (excerpts)	Design and methods (excerpts)	Context (excerpts)	Mechanisms (excerpts)	Outcomes (excerpts)
11	Leveille et al, 2009. Health coaching via an internet portal for primary care patients with chronic conditions: a randomized controlled trial	Assess the effects on patient perceived patient-provider communication from use of a health coaching via a portal	RCT testing the e-coaching intervention conducted by clinical nurses in a population of primary care patients who were registered on PatientSite. Recruited August 2005 through August 2006. Chronic disease coaching intervention offered through existing portal. PatientSite	Beth Israel Deaconess Medical Center (BIDMC), an academic medical center in Boston and its affiliates. We recruited primary care doctors from 2 hospital based practices and 2 community-based affiliated practices that use PatientSite.	We hypothesized that "e-coaching" via the internet portal, to encourage patients to discuss these common health problems with their primary care physicians (PCP) would improve detection and management during upcoming primary care visits., The findings suggest that even our modest intervention may have enhanced patient-provider interactions.	Significant differences in patients' reports of their visit experiences in the 1-week post visit survey. More intervention than control group participants reported that their PCP gave them specific advice to improve their health or prevent illness. Intervention patients rated the medical care received in their visit as slightly better than did controls. Otherwise, intervention and control participants reported similar experiences, including comparably high rates of discussing their screened condition with their PCP. The 3-month follow-up survey did not show any significant differences between treatment groups
22	Sun et al, 2013. Understanding patient provider communication entered via a patient portal system	Discover 1) how patients use the patient portal, 2) what themes are discussed, and 3) how the patient portal may improve patient-provider communication	Qualitative study. Researchers drew a random sample of 100 patients in the myHealtheVet 2009 database and examined all the portal messages exchanged in 2009 concerning these patients.	Veteran Health Affairs. As one of the first health organizations that started to offer online patient portal as an option for communication between patients and their providers, myHealtheVet had enrolled 99,434 patients by 2009. .	Our examples illustrate the cases in which patients and providers establish social bonds during the interactions facilitated by the patient portal system. As well, accumulated messages in the portal system about the same patient can provide rich trajectory information that help providers and the patient better understand her illness management from a long-term perspective.	Using patient portals for patient-provider communication can be beneficial for both patients and providers comparing to phone calls. Detailed information from patients can be used to make medical decisions and may also inspire physicians to notice hidden problems.
23	Woods et al, 2013. Patient experiences with full electronic access to health records and clinical notes through the myhealth*e*vet personal health record pilot:	To understand, using qualitative methods, the experience of patients who read their records using a PHR. Determine if veterans who accessed their health data and notes felt	To explore patient perceptions of having full electronic access to their health records, we conducted a qualitative study using focus group interviews.	Between 2000 and 2010, nine VA facilities in Oregon, Florida, New York, and Washington, DC, recruited 7464 patients to enroll in the myHealtheVet Pilot. This study was conducted at the Portland, Oregon VA Medical Center. This facility	Patients described how knowledge of record content allowed for a better understanding of what questions to ask and consequently, to improve the visit by leading to a more efficient encounter.	Patients reported that seeing their records had a positive effect on care communication between visits as well as during encounters. Access to the record was considered to be a valuable supplement to communicating in-person with providers One benefit frequently described by

	Qualitative study.	that such access had an impact on their care or their relationships with their provider(s		achieved the highest enrollment in the My HealtheVet Pilot program, with 72% (5361) of enrollees among nine Pilot sites.	Several patients reported feeling less reliant on providers and staff to relay pertinent information during or between visits which, in turn, allowed them to avoid situations such as remembering in-person discussions or waiting for a phone call to be returned.	patients was that access to health record information served to facilitate communication about their care. Patients felt more prepared for in-person visits, and found a greater ability to communicate with providers inside and outside the VA
24	Hess et al, 2007. Exploring challenges and potentials of personal health records in diabetes self-management: implementation and initial assessment	Learn from potential users what features might be useful to them, and after the release to learn about the experiences of registered users.	90-minute focus groups, both before the release of UPMC HealthTrak. Participants included any patient with diabetes from the three UPMC HealthTrak pilot practices (an academic internal medicine group, an academic family medicine group, and a com-munity internal medicine group) and represented a diverse patient population. Grounded theory methodology to analyze transcripts.	Providers at The University of Pittsburgh Medical Center have access to two EMR systems that allow the exchange of information between clinical settings. We implemented UPMC HealthTrak in three primary care practices in the UPMC health system. To demonstrate the integration of electronic messaging into office workflow, we focus on the workflow of the University of Pittsburgh Physicians General Internal Medicine (UPP– GIM), a large academic internal medicine practice. UPP–GIM has 30 attending physicians and 32 residents.	More substantive matters can be addressed though asynchronous, two-way communication, eliminating the need to "catch the doctor." If questions asked through secure messages are answered by the physician, then electronic messaging can enhance the doctor–patient relationship and avoid the need for a third party (such as a nurse) to relay messages over the phone. Patients can initiate communication with the office at any time, even when the office is closed. They can complete simple administrative tasks, like scheduling appointments or requesting prescription renewals, without waiting to speak with staff	39 pre- and post-implementation focus group participants felt that the system would enhance communication with the office. Patients also felt that it would assist with communication for providers who were not in the office every day.
16	Ross et al. Providing a Web-based Online Medical Record with Electronic Communication Capabilities to Patients With Congestive Heart Failure: Randomized Trial	Assess the effects of a patient-accessible online medical record in a rigorously controlled fashion	Randomized Trial. When patients completed the initial questionnaire they were blinded to their enrollment status	Clinical trial was conducted in a specialty clinic for patients with heart failure at University of Colorado Hospital in Denver, Colorado. The majority of patients in the practice have New York Heart Association Class II or Class III symptoms of heart failure.	Patients can review an online medical record repeatedly at their convenience it. Because patients with heart failure often require frequent visits and complicated medical regimens, we anticipated that access to medical records would be particularly helpful for these patients, by clarifying their doctors' assessments and instructions.	Patient satisfaction with doctor patient-communication demonstrated a trend towards improvement in two areas: how well patients felt their problems were understood, and how well doctors explained information. While significant results were found for these two items individually, the findings did not reach statistical significance when adjusted for multiple comparisons.

Table 5. Outcome: patient empowerment						
#	Article information	Objective (excerpts)	Design and methods (excerpts)	Context (excerpts)	Mechanisms (excerpts)	Outcomes (excerpts)
25	Wiljer et al, 2010. The anxious wait: assessing the impact of patient accessible EHRs for breast cancer patients	To explore how access to a secure patient portal impacts on two clinical outcomes, anxiety levels and self-perceptions of self-efficacy.	A quasi-experimental pre/post test design was used to evaluate usability and measure changes in levels of anxiety and self-efficacy. 320 breast cancer patients were recruited for this study.	The Breast Cancer Survivorship Program (BCSP) at Princess Margaret Hospital and the Shared Information Management Services (SIMS) at University Health Network, in Ontario, Canada, developed a PHR called InfoWell.	By providing patients with accurate information about the status of their current health, PHRs can facilitate effective communication with members of their health care team, and may help patients to become active members in the management of their illness. PHRs provide an ongoing connection between patients and physicians health Enabling patients to access their test results as they become available, without having to wait for a clinic visit. Providing patients with access to this information online has the potential to reduce the time that patients wait for results	This study suggests that providing patients with access to their personal health information through a PHR may have a positive impact on their experience. No change in self-efficacy was detected. This lack of results could pertain to the instrument used.
24	Hess et al, 2007. Exploring challenges and potentials of personal health records in diabetes self-management: implementation and initial assessment	Learn from potential users what features might be useful to them, and after the release to learn about the experiences of registered users.	90-minute focus groups, both before the release of UPMC HealthTrak. Par- ticipants included any patient with diabetes from the three UPMC HealthTrak pilot practices (an academic internal medicine group, an academic family medicine group, and a com- munity internal medicine group) and represented a diverse patient population. Grounded theory methodology to analyze transcripts.	Providers at The University of Pittsburgh Medical Center have access to two commercial EMR systems that allow the exchange of information between clinical settings. We implemented UPMC HealthTrak in three primary care practices in the UPMC health system. We focus on the workflow of the University of Pittsburgh Physicians General Internal Medicine (UPP– GIM), a large academic internal medicine	The ability to view portions of the EMR, such as the problem list and the medication list, help to ensure that patients are aware of important aspects of their own diseases. Links to information about diabetes and other diseases allows patients to explore issues of concern to them.	In the post release focus groups, frequent users of UPMC HealthTrak felt that the portal provided them with a sense of empowerment.

				practice. UPP–GIM has 30 attending physicians and 32 residents.		
26	Tuil et al, 2007. Empowering patients undergoing in vitro fertilization by providing Internet access to medical data	To assess the affect of access to medical data on empowerment	Randomized controlled trial. The research population consisted of patient-couples who were undergoing an IVF or ICSI treatment at our hospital between January 2004 and July 2004.	Fertility clinic at the Radboud University Nijmegen Medical Center the Netherlands. Portal website was installed only in this clinic.	Making electronic health records avail- able across the Internet is viewed as an important step toward consumer empowerment, because without adequate information patients are not able to achieve sufficient levels of desired autonomy and self-efficacy.	The interactive online medical record (personal health re- cord) did not result in significant changes in patient empowerment, measured either as a multidimensional concept or as it individual constituting factors
1	Wagner et al, 2012. Personal health records and hypertension control: A randomized trial	Examine PHR use and outcomes in a sample of ambulatory patients with hypertension. One of the critical questions were, if used, will patient activation increase?	A prospective two-group cluster-RCT was conducted in which 24 primary care physicians were 'clusters' with patients 'nested' within their practice.	Physicians were recruited from one Family Medicine and one Internal Medicine ambulatory clinic at a southern tertiary academic medical center	The conceptual framework of consumer engagement suggests that access to personal health information typically contained in a PHR increases patient activation thus improving health behaviors.	We found infrequent use of a PHR, no increase in patient activation with PHR access or use, and little change in outcomes except in limited areas among those using the PHR frequently.. Contrary to optimism about PHR impact, PHR access alone failed to activate patients,
27	Solomon et al, 2012. Effects of a Web-based intervention for adults with chronic conditions on patient activation: online randomized controlled trial	Evaluate change in self-management capabilities—expressed as patient activation—when a group of chronically ill patients were provided with online access to self-management materials.	Randomized controlled trial. Adult patients who were seen by 300 physicians employed by Carolinas HealthCare System and with a diagnosis of asthma, hypertension, or diabetes constituted the sampling frame. Measured patient activation using the 13-item patient activation measure (PAM-13)	Carolinas HealthCare System, a regional health care-delivery system in the southeastern United States.	We hypothesized that patients given access to a Web-based intervention designed to support self-management in the context of a person's particular chronic disease would demonstrate positive change in patient activation levels compared with control group participants.	The Web-based intervention demonstrated a positive and significant effect on the patient activation levels, on average, of the participants in the intervention group.
23	Woods et al, 2013. Patient experiences with full electronic access to health records and clinical notes through the my healthevet personal health record pilot: Qualitative study.	To understand, using qualitative methods, the experience of patients who read their records using a PHR. Determine if veterans who accessed their health data and notes felt that such access had an impact on their	To explore patient perceptions of having full electronic access to their health records, we conducted a qualitative study using focus group interviews.	Between 2000 and 2010, nine VA facilities in Oregon, Florida, New York, and Washington, DC, recruited 7464 patients to enroll in the My HealtheVet Pilot. This study was conducted at the Portland, Oregon VA Medical Center.	Our findings support prior qualitative research that shows full health record access is empowering for patients and caregivers. In all focus groups, participants put knowledge from their records to use by learning more about their health issues, gaining more knowledge about their providers' views, and	Access was felt to improve patients' knowledge about their own health and prompted greater desire for self-care. Patients reported that health record access improved participation in their care in a variety of ways

		care or their relationships with their provider(s			advocating for themselves in discussions about their care. Reading health information in an unpressured manner allowed patients time to contemplate its content and meaning.	
16	Ross et al. Providing a Web-based Online Medical Record with Electronic Communication Capabilities to Patients With Congestive Heart Failure: Randomized Trial	Assess the effects of a patient-accessible online medical record in a rigorously controlled fashion	Randomized Trial. When patients completed the initial questionnaire they were blinded to their enrollment status.	Specialty clinic for patients with heart failure at University of Colorado Hospital in Denver, Colorado. The majority of patients in the practice have New York Heart Association Class II or Class III symptoms of heart failure. Patients in this practice are cared for by a team of physicians. They therefore receive clinical notes from a variety of physicians over the course of their treatment.	Because patients with heart failure often require frequent visits and complicated medical regimens, we anticipated that access to medical records would be particularly helpful for these patients, by clarifying their doctors' assessments and instructions. We hypothesized that access to the medical record would improve their self-efficacy	For our primary outcome, the self-efficacy domain of the KCCQ, there was a trend towards an improvement in the intervention group, but the improvement of 6 points did not reach the threshold value of 7.7 that we had set as a standard for this outcome.
28	Delbanco et al, 2012. Inviting patients to read their doctors' notes: a quasi-experimental study and a look ahead.	To assess patients' perception of reading their doctors' notes.	A one-year multi-site trial of online patient accessible office visit notes, OpenNote. Survey of participating patients.	Beth Israel Deaconess Medical Center [BIDMC], (Geisinger Health System, and an urban safety-net hospital were invited to offer their patients electronic access to office notes. Two sites had existing patient internet portals; the third used an experimental portal.	Electronic medical records and secure patient portals hold exciting potential for more active patient involvement in care and improved communication between patients and clinicians. Doctors can readily invite patients to read and share their visit notes and even contribute to the notes' formulation.	The vast majority reported an increased sense of control, greater understanding of their medical issues, improved recall of their plans for care, and better preparation for future visits.

Table 6. Outcome: patient satisfaction						
#	Article information	Objective (excerpts)	Design and methods (excerpts)	Context (excerpts)	Mechanisms (excerpts)	Main outcomes (excerpts)
29	Nazi et al, 2010. Veterans' voices: Use of the American Customer Satisfaction Index (ACSI) Survey to identify My HealtheVet personal health record users' characteristics, needs, and preferences	Explore Veteran perceptions about this access to their medical records, including perceived value and effect on satisfaction	Web-based survey. The American Customer Satisfaction Index (ACSI) survey is an industry standard tool for assessing consumer drivers of satisfaction and prioritizing areas of improvement	At the Department of Veteran Affairs (VA), the My HealtheVet Pilot Program was an early PHR prototype	With patients viewing such (PHR) access as beneficial to their health and care, PHRs with access to EHR data are positioned to improve health care quality. Making additional information accessible to patients is crucial to meet their needs and preferences.	Most participants (66%) agreed that the pilot program helped improve their care, with 90% indicating that they would recommend it to another Veteran.
30	Lin, 2005. An internet-based patient-provider communication system: Randomized controlled trial	Assess patient satisfaction after implementing a patient portal in an academic general internal medicine practice.	Randomized controlled trial. Patients were enrolled from August 2002 through February 2003. The study period began at the conclusion of enrollment and lasted 6 months from March 1, 2003 through August 31, 2003.	The study was conducted at an academic ambulatory internal medicine practice affiliated with the University of Colorado Hospital in Denver, CO. Fourteen physicians and staff in the practice were already using an electronic medical record (EMR)	The portal reduced barriers to communication—portal patients were more likely to send FYI and psychosocial messages. Patients may hesitate to "bother the doctor" with FYI messages by phone, but they feel more comfortable sending a portal The portal was convenient: 81% believed that the portal saved them a telephone call, and 33% believed it saved them a visit to the clinic. The portal allowed patients to send messages at all hours; indeed, 73% of incoming messages were sent during non clinic hours.	Portal group patients were more satisfied than controls with overall clinic services, and, for those portal group patients who used the administrative services, they were more satisfied with each of the services (appointments, refills, and referrals) and with clinical messaging.
31	Tom et al, 2012. Integrated personal health record use: Association with parent-reported care experiences	Understand how parents of children with chronic disease use PHRs and to examine whether users, compared with nonusers, report improved access to	This cross-sectional study. Randomly selected 600 households for the survey. We designed a questionnaire based on the recommended survey guidelines of the Consumer Assessment of Healthcare	Group Health Cooperative, an integrated health care system providing care to 660.000 members in Washington. Group Health's PHR (MyGroupHealth) was first made available to members in	PHR use may also improve care coordination for children with chronic disease by facilitating improved communication between parents and all of their child's health care providers Providing parents of children	After adjusting for child characteristics and respondent characteristics, we did not find differences between users and nonusers on the dichotomized CAHPS top box scores.

		and experiences with the health care teams.	Providers and Systems (CAHPS) survey	2000 to improve patient-centered access to care.	with chronic disease access to these features may improve overall care experiences by increasing a parent's understanding of their child's health care needs and providing timely and convenient access to care.	
32	Wald et al, 2010. Implementing practice-linked pre-visit electronic journals in primary care: Patient and physician use and satisfaction	Focuses on the patient and provider implementation experience through analysis of eJournal usage and survey data.	Large, prospective, randomized controlled trial (RCT) in primary care. The eJournal was developed as part of the Prepare for Care study, a RCT offered to all PG users of 11 primary care practices at the BWH and MGH between 2005 and 2007	Partners HealthCare. Patient portal is connected to the Longitudinal Medical Record (LMR)—an ambulatory electronic medical record system used by approximately 5000 physicians as of December 2006, which includes problems, medications, allergies, notes, and advanced clinical decision support.	The electronic journal can share historical patient chart information, ask tailored health history questions, provide relevant educational information, and offer personalized decision support. It can remind patients about appointments, facilitate patient data capture, improve information-sharing, streamline documentation, and identify patient visit priorities. Primary care physicians have much to accomplish in the limited time of a patient visit. Providers reported the eJournal helped patients prepare for the visit	Patients felt more satisfied with the visit (37.7%; 52.1% neutral), and the quality of care at the visit improved (24.5%; 64.1% neutral). Most patients (75.3%) wanted to complete an eJournal again for another visit, and 66.6% would recommend the eJournal to a friend or relative.
10	Simon et al, 2011. Randomized trial of depression follow-up care by online messaging	We examined whether the program led to improvements in patient satisfaction (second outcome) Depression follow-up module offered through existing portal	Participants were enrolled between April and October of 2009 from nine primary care clinics of Group Health Cooperative. Approximately five months after randomization each participant in the care management and usual cares groups received a message inviting participation in a research follow-up survey.	Group Health Cooperative (GHC), an integrated health system serving approximately 600,000 members in the Pacific Northwest. GHCs performance on measures of antidepressant medication adherence and follow-up visit frequency are between the 50th and 75th percentiles for US health plans.	Online patient–provider communication has the potential to increase the availability and reduce the cost of effective depression care. Reliance on live contact between patients and providers, however, makes telephone follow-up less convenient, less timely, and more expensive. Patients must receive calls when providers are available.	Participation in care management contacts was high, and the program significantly improved patients' satisfaction with depression treatment. The proportion of participants "very satisfied" with depression treatment was 53% (56/104) in the care management group compared to 33% (31/93) in usual care,