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Association between the use of secure patient-clinician email and clinical services utilization: a retrospective cohort study

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ABSTRACT

Objective

To assess associations between secure patient-clinician email use and clinical services utilization over time

Design

Retrospective cohort study between July 2010 and December 2013 using propensity score methods and controlling for a utilization surge around first secure email use. We analyzed difference of differences between matched groups of secure patient-clinician email users and non-users for utilization one to 12 months before and seven to 18 months after first email (users) or a randomly assigned index date (non-users).

Setting

A U.S. integrated healthcare delivery system

Participants

9,345 adults with first secure email use between July 2011 and July 2012 and continuous enrollment for ≥30 months and 9,345 adults without secure email use between July 2010 and July 2012 matched to users on demographics, health status, and baseline utilization characteristics.

Primary Outcome Measures

Rates of office visits, patient-initiated phone calls, scheduled telephone visits, after-hours clinic visits, emergency department visits, and hospitalizations

Results

Utilization transiently increased by 88-237% around the time of first email use. Annual rates of patient-initiated phone calls significantly decreased among secure email users, 0.2 fewer calls per person [95% CI -0.3 to -0.1], from a mean of 4.1 per person one to 12 months before first use to

a mean of 3.8 calls per person seven to 18 months after first use. Annual rates of patient-initiated phone calls also significantly decreased among non-users, 0.1 fewer calls per person [95% CI -0.2 to 0.0], from a mean of 4.2 calls per person one to 12 months before the index date to mean of 4.1 calls per person seven to 18 months after the index date. No other statistically significant differences in utilization occurred.

Conclusions

Patient use of secure email with clinicians was not associated with statistically significant differences in clinical services utilization seven to 18 months after first use.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- This study reports on the association between patient use of secure email with clinicians and medium-term use of office visits, patient-initiated phone calls, scheduled telephone visits, after-hours clinic visits, emergency department visits, and hospitalizations.
- No association was found between secure patient-email use and the use of other health care services.
- This study improved on previous methods by excluding data for six months after first secure email use, comprehensively adjusting for baseline utilization, deriving propensity scores from a robust set of independent variables, and examining clinical services utilization seven to 18 months after the index date.
- The population consisted of individuals who were late adopters of secure email use with clinicians and likely differed in systematic ways from those who opted for earlier use, which may limit the generalizability of the results.

INTRODUCTION

Under meaningful use requirements of the U.S. Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009, patient portals are emerging as a key technology for engaging patients. In 2013, 40% of U.S. physicians in ambulatory care settings had some type of patient portal.[1] Patient portals tethered to electronic health records (EHRs) generally enable patients to communicate electronically and securely with health care clinicians, access their medical records, schedule appointments, pay bills, and refill prescriptions.[2] Other functions typically include a problem list, list of medications, allergy list, test results, and links to personalized health information.[3]

A recent systematic review concluded that insufficient evidence existed that patient portals improve health outcomes, cost, or utilization.[4] However, it did not assess the impact of individual portal functions. Secure email communication between patients and clinicians via an online portal is a new care modality in which patients communicate clinical concerns and receive a reply.[5] It is highly desirable to patients and holds the potential to improve health care quality and efficiency.[6-10]

To date, evidence about the association of secure patient-clinician email with utilization of other clinical services is inconsistent. Patients and clinicians report time savings from avoided in-person visits and more efficient management of patient care and, conversely, some increased time demands on clinicians from using secure email with patients.[11-14] A 2012 Cochrane review concluded that the effect of patient-clinician email on utilization could not be assessed due to differing methodologies and measures, variable results, and missing data.[5] Similarly, a 2014 systematic interpretive review concluded that heterogeneous reporting precluded assessing overall workload changes.[15] Investigations of the association of secure patient-clinician email

with utilization of specific clinical services have most frequently examined telephone calls and office visits. In three reports, patients using secure email had phone call volumes similar to those of patients in control or comparison groups; in a fourth study, increases over time in phone calls were smaller for patients using secure email than for non-users.[16-19] Evidence regarding office visit utilization is also mixed. In separate trials among patients with diabetes, a 10% increase in secure message threads was associated with a 1.25% increase in office visits, and the primary care visit rate was 32% higher among patients with at least 12 message threads per year.[20,21] Secure email was also associated with decreased or unchanged rates of primary care office visits in three reports.[19,22-24] Studies assessing other types of utilization are rare. In a small trial among patients with congestive heart failure, secure patient-clinician email was associated with increased emergency department (ED) visits but unchanged hospitalization rates.[25]

The aim of this study was to assess the association of secure patient-clinician email with utilization of various clinical services over time. We hypothesized that: 1) patients who initiated secure e-mail with clinicians would use fewer clinical services in the longer term than they did before using secure email; and 2) that patients who initiated secure e-mail with clinicians would use fewer clinical services than would matched patients who did not use secure e-mail with clinicians.

METHODS

The study was conducted at Kaiser Permanente Colorado (KPCO), one of seven regions of Kaiser Permanente, among the largest not-for-profit integrated health care delivery systems in the U.S., serving 10 million members. At KPCO, 1,000 physicians and 6,000 staff members

provide care for 615,000 members at 28 medical offices. Inpatient care is provided through contracts with non-Kaiser Permanente hospitals.

KP HealthConnect™, KPCO's integrated electronic health record, was implemented in 2004. The patient portal, MyHealthManager (MHM), was implemented in 2006 and allows members to securely access parts of their medical record, such as test results, active medications, and care plans, and to schedule appointments, request prescription refills, and exchange secure email with health care clinicians. Members receive information about the patient portal and instructions for registering in multiple ways, including mailed materials, notices posted in KPCO clinics, and while checking in for clinic visits. All KPCO members aged 13 and over can register for an account. In 2012, 66% of KPCO members with Internet access meeting the age requirement were registered for an account. Registered members can access all MHM functionalities. Although members may use any portal function after registering, we focused on patients initiating secure email communication with clinicians, in contrast to earlier evaluations at Kaiser Permanente that assessed the use of any portal function and yielded conflicting findings about the impact of use on clinical services utilization.[19,26]

Although we did not assess the types of clinicians that patients emailed, secure messages are primarily delivered to the inboxes of physicians, physician assistants, and nurse practitioners providing primary and specialty care. Clinicians may choose to respond directly to all patient email messages or to have a medical assistant or registered nurse on the care team review all incoming secure email from patients, respond to any requests or concerns within their scopes of practice, and forward the remainder of patient secure email messages to the clinician's attention.

Study design

We conducted a retrospective cohort study of secure patient-clinician email use and clinical services utilization between July 2010 and December 2013. For study inclusion, members were required to be at least 18 years of age and continuously enrolled for at least 30 months with either first use of secure patient-clinician email between July 2011 and July 2012 or no use between July 2010 and July 2012. We did not assess the portal registration status of members with no secure email use. After excluding members in the top 1% of baseline utilization, we separated the population into secure email users and non-users. To eliminate bias arising from seasonal variations in utilization, we assigned each non-user a randomly selected index date between July 2011 and July 2012.

A spike in utilization of clinical services occurs around the time of the first use of secure patient-clinician messaging or patient portal registration, which may be prompted by a new illness or medical concern.[19,23,26] Previous studies excluded one to two months before and one month after the index date, and a recent study at Kaiser Permanente adjusted for baseline office visit utilization in the year before the index date.[19,23,26] We adjusted for the utilization spike in two ways that substantially strengthened the study design. First, to eliminate its effect and focus on longer term effects, we excluded a period of six months after the index date. Thus, we assessed clinical utilization from one to 12 months before the index date (the pre period) and from seven to 18 months after the index date (the post period). Second, because variable baseline utilization may reflect unmeasured differences between patients who do and do not use secure email with clinicians, we matched users and non-users on all baseline utilization up to and including the index date. We collected data from the EHR and administrative databases on age, gender, benefit type, number of chronic illnesses, distance from the nearest medical office

building, utilization of office, after-hours clinic, and ED visits, patient-initiated and scheduled telephone calls, and inpatient admissions. We used DxCG risk scores (Verisk Health, Inc.; Waltham, MA) to characterize illness severity. A commercial product, DxCG relative risk scores predict health care costs relative to the population mean, based on age, gender, diagnoses, and drug codes.[27]

Statistical analyses

We assessed differences between secure email users and non-users with *t* tests for DxCG risk scores and χ^2 tests for categorical variables. To adjust for differences between users and non-users, we calculated propensity scores using a logistic regression model and a robust selection of independent variables to estimate the probability of secure email use. Independent variables included index month and year, age, gender, benefit type, DxCG risk score, number of chronic illnesses, distance from the nearest medical office building, and baseline utilization of office, urgent care, and emergency department visits, patient-initiated and scheduled telephone calls, and inpatient admissions. Matching on baseline utilization occurred in two steps. We first matched users and non-users on utilization for the first eleven months of the pre period and then on utilization for the month immediately before the index date. Finally, we created matched pairs of users and non-users whose individual propensity scores differed by .001 or less and assessed differences between the groups of matched users and non-users with *t* tests for DxCG risk scores and χ^2 tests for categorical variables.

We calculated utilization rates for clinical services and analyzed difference of differences for utilization before and after the index date using bootstrapping methods, comparing the matched groups of secure email users and non-users. Office visits and patient-initiated phone calls were reported as per member per year rates. Clinicians may schedule telephone visits to

follow up with members; these were reported as per 1000 members per year rates. After-hours clinic visits, ED visits, and hospitalizations occurred less frequently and were also reported as per 1000 members per year rates. All statistical analyses were conducted with SAS version 9.2 (SAS Institute), with two-sided statistical tests and a .05 level of statistical significance. The KPCO Institutional Review Board approved this study.

RESULTS

We identified 11,937 KPCO members aged 18 and over who were continuously enrolled for at least 30 months and first used secure patient-clinician email between July 2011 and July 2012 and 212,155 members with the same age and enrollment characteristics but no secure patient-clinician email use between July 2010 and December 2013 (Figure 1). Applying propensity score matching, we refined the cohorts to include 9,345 matched pairs of users and non-users, which we used to examine differences in clinical services utilization associated with secure patient-clinician email use. After matching, some statistically significant but minimal differences persisted between secure email users and non-users (Table 1).

Table 1. Pre- and post-matching population characteristics

	Unmatched, No. (%)			Matched, No. (%)		
	MHM Users (n = 11,737)	Non-users (n = 212,155)	*P* value	MHM Users (n = 9,345)	Non-users (n = 9,345)	*P* value
Age categories, y			<.001			<.01
18-19	283 (2.4)	7,494 (3.5)		238 (2.5)	244 (2.6)	
20-44	4,750 (40.5)	80,419 (37.9)		3,734 (40.0)	3,662 (39.2)	
45-64	4,713 (40.2)	81,156 (38.3)		3,741 (40.0)	3,710 (39.7)	
≥ 65	1,991 (17.0)	43, 086 (20.3)		1,632 (17.5)	1,729 (18.5)	

Sex			<.001			.63
Female	6,758 (57.6)	108,360 (51.0)		3,896 (41.7)	3,861 (41.3)	
Male	4,979 (42.4)	103,795 (48.9)		5,449 (58.3)	5,484 (58.7)	
Benefit type			<.001			<.01
DHMO	3,751 (32.0)	71,577 (33.7)		3,072 (32.9)	2,845 (30.4)	
HMO	5,134 (43.8)	80,928 (38.1)		3,974 (42.5)	4,086 (43.7)	
Medicare	1,862 (15.9)	37,790 (17.8)		1,532 (16.4)	1,618 (17.3)	
Medicaid	60 (0.5)	3,397 (1.6)		48 (0.5)	54 (0.6)	
Other	930 (7.9)	18,463 (8.7)		719 (7.7)	742 (7.9)	
DxCG score, mean	1.75	1.85	.002	1.79	1.82	.39
Number of chronic illnesses			<.001			.39
0	10,288 (88.0)	188,254 (88.7)		7,877 (86.8)	8,285 (86.2)	
1	1,322 (11.3)	21,367 (10.1)		1,096 (12.1)	1,207 (12.6)	
2	112 (10.0)	2,228 (1.1)		90 (1.0)	109 (1.1)	
3	15 (0.1)	271 (0.1)		13 (0.1)	11 (0.1)	
4	0 (0.0)	35 (0.0)		0 (0.0)	2 (0.0)	
Distance to nearest medical office building, miles			<.001			0.17
0 – 4.9	8,144 (69.4)	143,368 (67.6)		6,154 (67.8)	6,639 (69.1)	
5 – 19.9	2,954 (25.2)	54,127 (25.5)		2,406 (26.5)	2,461 (25.6)	
≥ 20	639 (5.4)	14,660 (6.9)		516 (5.7)	514 (5.3)	
Annual utilization, per member						
Inpatient stays	0.07	0.05	<.001	0.07	0.07	.94
ED visits	0.13	0.11	<.001	0.13	0.13	.23
After-hours office visits	0.08	0.05	<.001	0.08	0.07	.09

Low acuity office visits	0.24	0.16	<.001	0.24	0.24	.88
Low acuity patient calls	0.08	0.05	<.001	0.07	0.08	.17
Office visits	3.27	2.18	<.001	3.30	3.28	.69
Patient calls	3.83	3.03	<.001	3.83	4.07	<.01
Scheduled telephone visits	0.29	0.22	<.001	0.28	0.31	.03

Abbreviations: DHMO, deductible health maintenance organization plan; ED, emergency department; HMO, health maintenance organization

A pronounced surge in utilization occurred around the time of first use of secure email. Peak utilization occurred in the index month for all clinical services except patient-initiated and scheduled telephone calls, which peaked in the month following the index date. Across all services, the unweighted average relative increase in utilization was 143%. Relative increases in monthly utilization rates for specific clinical services ranged from 88% for after-hours clinic visits, an increase of .006 visits per member, from .006 in months one to 12 before the index date to .012 in the index month, to 238% for scheduled telephone visits, an increase of 0.55 visits per member, from 0.23 in months one to 12 before the index date to 0.78 per member in the month following the index date. The surge in utilization largely dissipated by six months after the index date.

Only two statistically significant changes in utilization occurred between the pre and post periods. Among secure email users, patient-initiated phone calls decreased by 0.2 calls per member per year [95% CI -0.3 – -0.1], from an annual mean of 4.1 patient-initiated calls per member one to 12 months before the index date to a mean of 3.8 calls per member seven to 18

months after the index date. Patient-initiated phone calls also decreased among non-users by 0.1 calls per member [95% CI -0.2 – -0.0], from a mean of 4.2 patient-initiated phone calls per member one to 12 months before the index date to mean of 4.1 calls per member seven to 18 months after the index date. No other differences in utilization before and after the index date within user and nonuser groups were statistically significant (Table 2).

Table 2. Annual health care utilization before and after the index date among secure patient-clinician email users and non-users

	Mean per Member per Year (95% CI)		Mean per 1000 Members per Year (95% CI)			
Matched data	Office visits	Patient-initiated calls	Scheduled telephone visits	After hours office visits	ED visits	Inpatient stays
User pre	3.2	4.1	279.2	77.0	130.2	64.6
User post	3.3	3.8	280.9	81.6	127.6	65.8
P value [a]	.06	<.0001	.89	.37	.69	.81
Nonuser pre	3.3	4.2	287.8	72.8	131.4	64.1
Nonuser post	3.3	4.1	310.1	74.1	134.5	65.0
P value [b]	.57	.05	.07	.76	.63	.85
Difference of differences [c]	0.1 (0.0 – 0.2)	-0.1 (-0.3 – 0.0)	20.7 (-57.2 – 12.9)	3.3 (-11.2 – 15.1)	5.6 (-21.6 – 12.0)	.35 (-13.9 – 15.7)
P value	.33	.14	.23	.62	.53	.96

[a]User post – user pre

[b]Nonuser post – nonuser pre

[c] (User post – user pre) minus (nonuser post – nonuser pre)

When comparing changes between secure patient-clinician email users and non-users in clinical services utilization before and after the index date, we found no statistically significant

differences (Table 2). Figure 2 depicts monthly mean rates for office visit and patient-initiated telephone calls. Similar figures for all types of utilization are available online (see Supplementary Figure 1, Supplementary Figure 2).

DISCUSSION

No differences were detected between patients who did and did not use secure patient-clinician email in utilization of office visits, scheduled telephone visits, patient-initiated phone calls, emergency department visits, after-hours clinic visits, and hospitalizations seven to 18 months after the index date. Very small decreases in patient-initiated phone calls between the pre and post periods for both secure email users and non-users were likely clinically meaningless despite statistical significance.

Strengths of the study include adjustment for a utilization spike around the index date by matching on all baseline utilization data and excluding data for six months after the index date. The inclusion of a robust array of independent variables in the propensity score matching model is also a strength. Several limitations deserve mention. Although secure clinician-patient email had been available since 2006, we studied individuals who had not used secure email with clinicians after one (users) to two (non-users) years of membership. They comprised a minority population; in 2012, 66% of all eligible KPCO members were registered for the patient portal, and secure email is second only to viewing lab results in frequency of use by members. The members we included in our study likely differed in systematic ways from those who opted for earlier use, but the potential impact of these differences on our findings is unknown. We also lacked data on the volume of secure patient-clinician email messages among study participants. A study of proxy PHR use by caregivers of pediatric patients found that increased use of clinical services occurred only among those with the highest use.[28] Finally, our study took place in an

integrated care delivery system. The degree to which the findings are generalizable to other settings is unknown.

The present findings contrast with those of previous studies at Kaiser Permanente exploring the association of portal registration with the use of clinical services.[19,26] Potential explanations for differing results include the likelihood that the association with utilization of clinical services is different for secure patient-clinician email than for other portal functions. This explanation is supported by a recent report examining the association between secure patient-clinician email use and office visit rates, which found that the latter were unchanged.[23] A previous study that found increased utilization after portal registration excluded a month before and after the index date, in comparison to the six-month exclusion period used here.[26] The utilization spike around portal registration or first secure email use may signal a sudden and serious health event, such as acute illness or identification of a new medical condition. In the present study, approximately six months after the index date, utilization returned to a stable level similar to that of the pre-index date period. A second previous study at Kaiser Permanente examined associations between portal registration and clinical services utilization among members who registered when overall portal registration rates were only 6%.[19] As noted earlier, early and late adopters of portal use may differ from each other in ways that affect their patterns of clinical services use over time. Differences in this series of studies are summarized in Supplementary Table 1.

Health care organizations implementing secure clinician-patient email can anticipate a neutral effect on utilization of other health care services over the longer term among patients who use it for the first time due to a new health concern. An initial surge in utilization of clinical services is followed by a return to utilization levels similar to those of patients who do not

securely email clinicians. In the absence of health concerns prompting higher utilization of all clinical services, secure email does not substitute for office and telephone contacts or avert emergency department and after hours clinic visits and inpatient stays. These findings also suggest that patients who use secure email with clinicians are not inherently more likely to use all types of clinical services.

Further study is required to more fully understand the relationship between secure patient-clinician email use and clinical services utilization. Applying the strengths of this study—the extended data exclusion period and the robust matching on baseline characteristics—to a population of earlier adopters would validate the findings. In a previous study, clinical services utilization patterns varied by diagnosis; future research should examine associations between secure email use and utilization patterns within and across diagnostic groups.[26] Although our study expands the time period within which secure patient-clinician email has been studied, longitudinal studies on the order of three to five years are needed that track the relationship between secure email use and clinical service utilization as organizational experience with patient portals accumulates. A better understanding is also needed regarding the use of health care services and the health outcomes for patients who send multiple emails and are frequent portal users, compared to patients who send occasional emails and are low or moderate users of the portal. Doing so requires rigorous study designs other than randomized trials, which are unlikely to be conducted because of the organization-wide implementation of portals and the widespread desire among patients to have access to their health information.[3] Stepped wedge designs, which can be conducted as implementation proceeds, hold some promise for adding to our understanding of the relationship between the use secure patient-clinician email and other types of clinical services.[29-31]

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All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organization for the submitted work; no financial relationships with any organizations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work**.**

CONTRIBUTORS

DM, TP, TG, and HQ were involved in the conception and design of the study. MM and JT acquired the data that were analyzed. DM, TP, TG, JT, and HQ analyzed and interpreted the data. DM, TG, MM, and JT drafted the manuscript. DM, TP, TG, HQ, and JT revised the manuscript for important intellectual content. All authors approved the final version of the manuscript. All authors had access to all of the data in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis. DM is the guarantor.

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FIGURE LEGENDS

Figure 1. Flow Diagram of Participants (Figure 1.pdf)

Creation of propensity score-matched cohorts

Figure 2. Matched Cohort Mean Office Visits and Patient-Initiated Calls per Month (Figure 2. pdf)

Each data point represents mean office visits from the preceding month. The tinted area indicates the period from which data were excluded for the rates reported in Table 2.

Figure 1. Flow Diagram of Participants

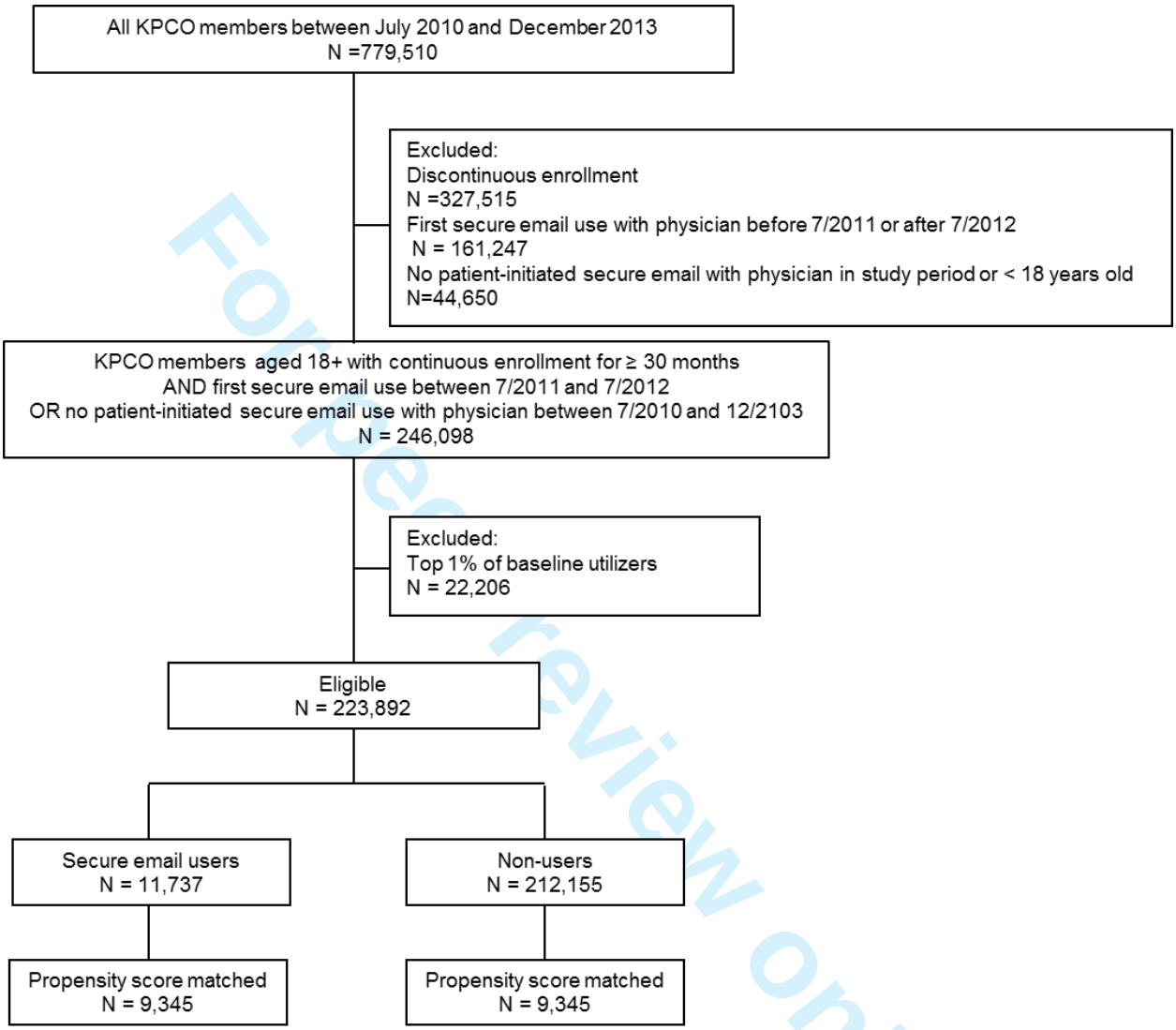
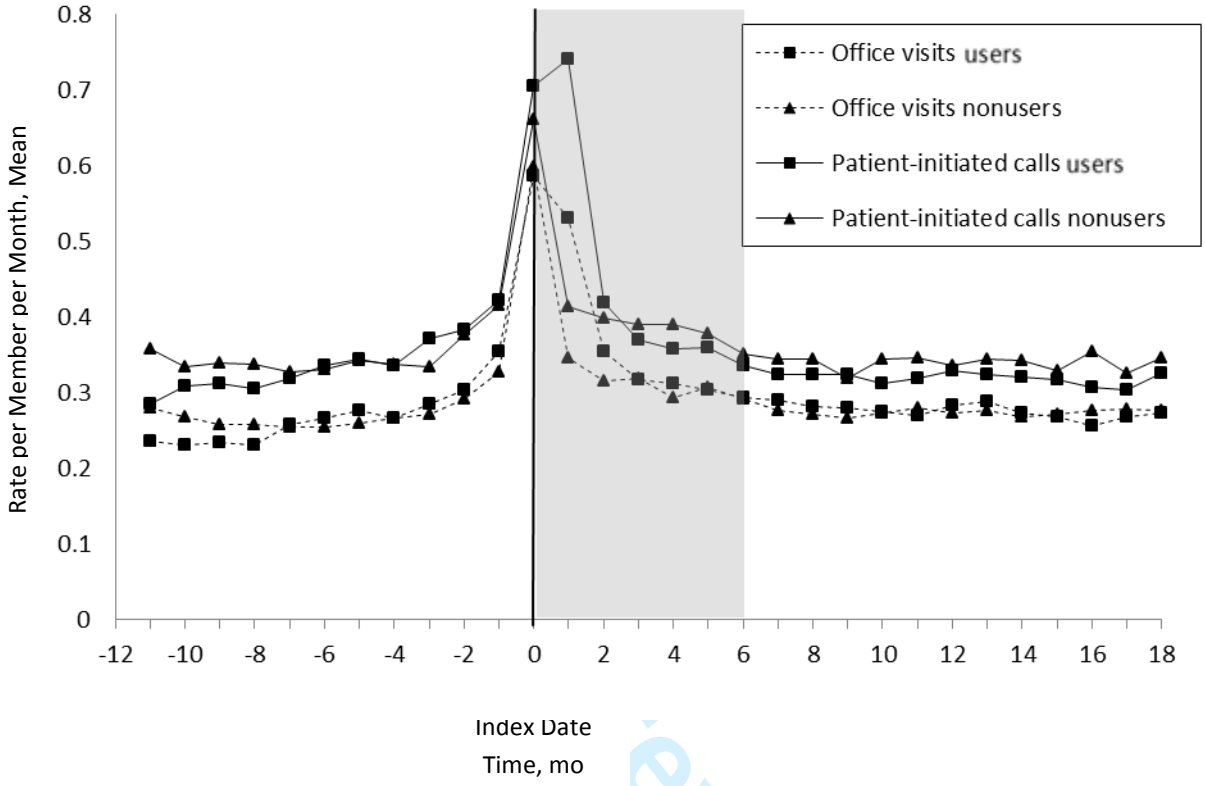


Figure 2. Matched Cohort Mean Office Visits and Patient-Initiated Calls per Month



Note: Each data point represents mean office visits from the preceding month. The tinted area indicates the period from which data were excluded for the rates reported in Table 2.

Supplementary figures 1

Supplementary Table 1. Comparison of Kaiser Permanente studies examining associations between portal or secure email use and clinical services utilization

Supplementary Figure 1. Matched cohort mean after hours clinic visits and hospitalizations per month

Supplementary Figure 2. Matched cohort mean scheduled telephone and emergency department visits per month

Supplementary Figure 3. Effect of matching method on differences in utilization over time

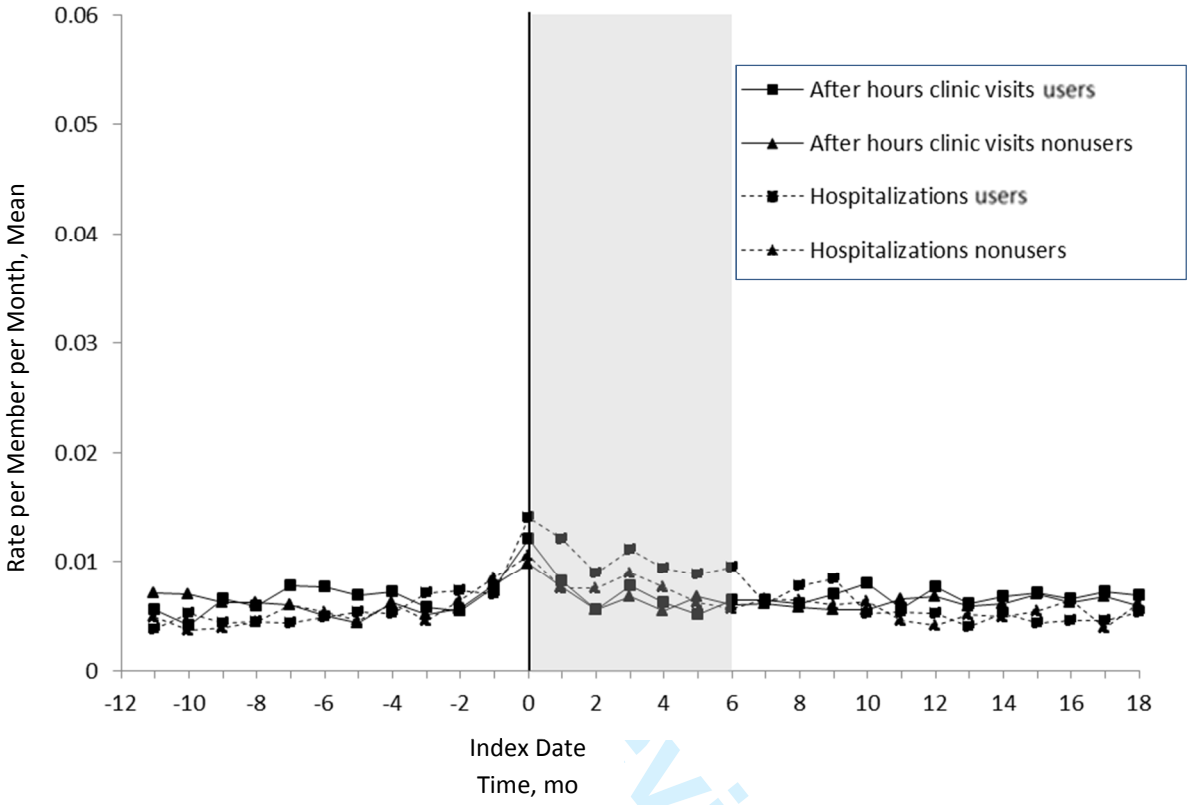
Supplementary figures 2

Supplementary Table 1. Comparison of Kaiser Permanente studies examining associations between portal or secure email use and clinical services utilization

	Zhou et al., 20071[9]	Palen et al., 2012[26]	Meng, 2014
Years since portal initiation	3	1- 4	4 - 6
Eligible members registered, %	6	25 (year 1) 54 (year 4)	54 (year 4) 66 (year 6)
Portal function assessed	≥ 1 use of any function	≥ 1 use of any function	First use of secure email
Study design	Matched retrospective cohort	Propensity-matched retrospective cohort	Propensity-matched retrospective cohort
Matching variables	Age, sex, selected chronic conditions, primary care provider	Age, sex, number of chronic illnesses, baseline office visits	Index month and year, age, sex, benefit type, DxCG risk score, number of chronic illnesses, distance from the nearest medical office, baseline utilization of office, urgent care, and emergency department visits, patient-initiated and scheduled telephone calls, and inpatient admissions
Study population			
Total users, n	4686	87,206	360,138 (≥ 13 years)
Matched cohort, n	3201	44,321	9,345
Time periods studied before and after index use/ portal registration	3-14 months before 2-13 months after	1-11 months before 1-12 months after	1-12 months before 7-18 months after
Study outcomes	Primary care office visit and telephone contact rates	Rates of office visits, telephone encounters, after-hours clinic visits, ED visits, and hospitalizations	Rates of office visits, patient-initiated phone calls, scheduled telephone visits, after hours clinic visits, ED visits, and hospitalizations
Findings	Office visits decreased and telephone contacts increased among cases and controls with statistically significant difference in differences favoring portal use for both.	Among portal users, increases in office visits, telephone encounters, after-hours clinic visits, ED visits, and hospitalizations.	Decreased patient-initiated telephone calls after the index date among secure patient-clinician email users and non-users. No other differences within or between user and nonuser groups.

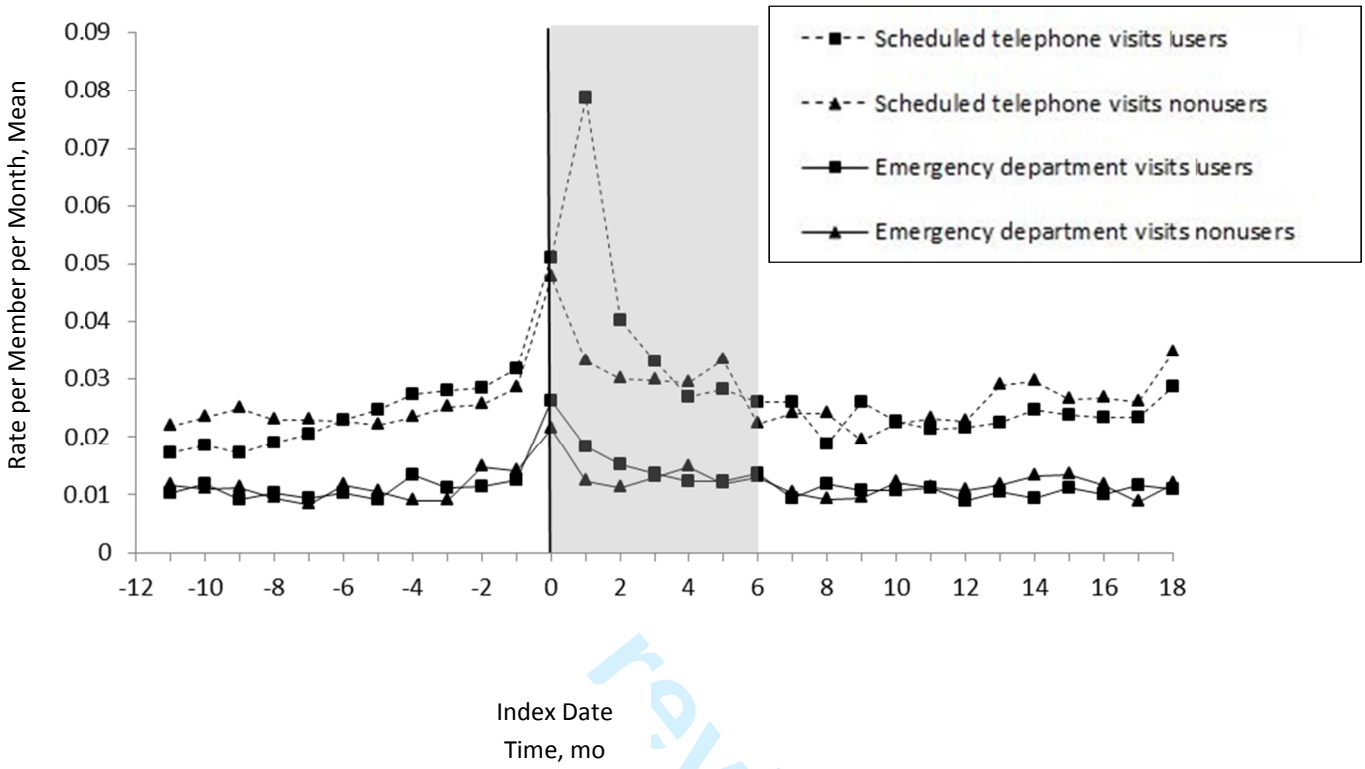
Abbreviations: ED, emergency department; PKMPY, per 1000 members per year; PMPY, per member per year

Supplementary Figure 1. Matched cohort mean after hours clinic visits and hospitalizations per month



Note: Each data point represents mean office visits from the preceding month. The tinted area indicates the period from which data were excluded for the rates reported in Table 2.

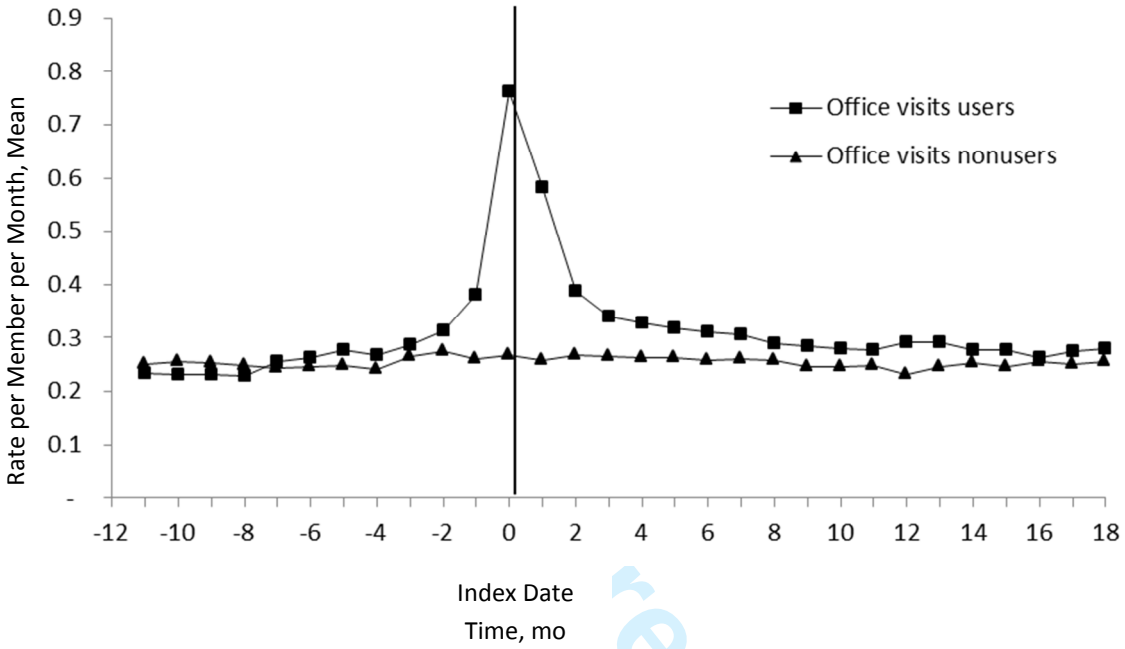
Supplementary Figure 2. Matched cohort mean scheduled telephone and emergency department visits per month



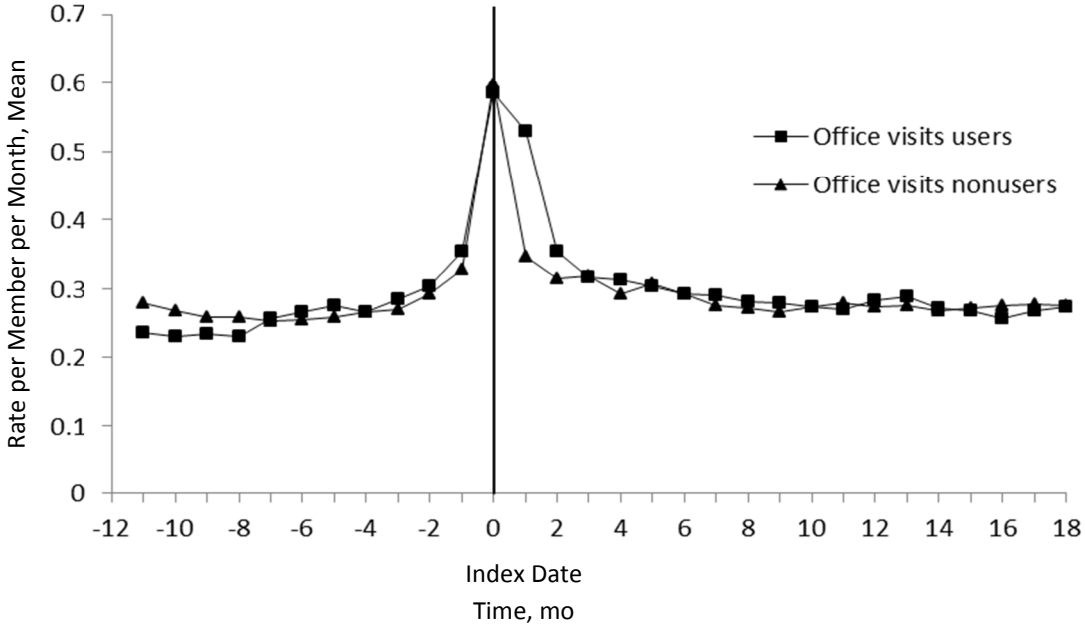
Note: Each data point represents mean office visits from the preceding month. The tinted area indicates the period from which data were excluded for the rates reported in Table 2.

Supplementary Figure 3. Effect of matching method on differences in utilization over time

3a. Matching on baseline office visits in 12 months before the index date



3b. Two-step matching on all baseline utilization in first 11 months of pre period and month before the index date



STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract [within the title page 1 and design section of the abstract page 2]
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found [please see design and results sections of abstract page 2]
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported [pages 5-6]
Objectives	3	State specific objectives, including any prespecified hypotheses [page 6]
Methods		
Study design	4	Present key elements of study design early in the paper [pages 8-10]
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection [pages 6-8]
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up [pages 8-9]
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed [pages 10–12]
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable [pages 7-9]
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group [pages 8-9]
Bias	9	Describe any efforts to address potential sources of bias [page 8]
Study size	10	Explain how the study size was arrived at [page 10]
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why [page 9-12, Table 1]
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding [page 9]
		(*b*) Describe any methods used to examine subgroups and interactions [n/a]
		(*c*) Explain how missing data were addressed [n/a]
		(*d*) If applicable, explain how loss to follow-up was addressed [n/a]
		(*e*) Describe any sensitivity analyses [n/a]
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed [page 10]
		(b) Give reasons for non-participation at each stage [n/a]
		(c) Consider use of a flow diagram [Figure 1]
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders [Table 1]
		(b) Indicate number of participants with missing data for each variable of interest [n/a]
		(c) Summarise follow-up time (eg, average and total amount) [page 8]
Outcome data	15*	Report numbers of outcome events or summary measures over time [pages 11-13, Table 2]
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and

		their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included [pages 13, Table 2]
		(*b*) Report category boundaries when continuous variables were categorized [Table 1]
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period [n/a]
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses [n/a]
Discussion		
Key results	18	Summarise key results with reference to study objectives [page 14]
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias [page 14-15]
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence [pages 15-16]
Generalisability	21	Discuss the generalisability (external validity) of the study results [page 15]
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based [page 17]

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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Association between secure patient-clinician email and clinical services utilization in a U.S. integrated health system: a retrospective cohort study

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Association between secure patient-clinician email and clinical services utilization in a U. S. integrated health system: a retrospective cohort study

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3855 words, 2 tables, 2 figures, 1 online-only supplement, 31 references

ABSTRACT

Objective

To assess associations between secure patient-clinician email use and clinical services utilization over time

Design

Retrospective cohort study between July 2010 and December 2013. Controlling for a utilization surge around first secure email use, we analyzed difference of differences between propensity score-matched groups of secure patient-clinician email users and non-users for utilization one to 12 months before and seven to 18 months after first email (users) or a randomly assigned index date (non-users).

Setting

U.S. integrated healthcare delivery system

Participants

9,345 adults with first secure email use between July 2011 and July 2012 and continuous enrollment for ≥30 months and 9,345 adults without secure email use between July 2010 and July 2012 matched to users on demographics, health status, and baseline utilization.

Primary Outcome Measures

Rates of office visits, patient-initiated phone calls, scheduled telephone visits, after-hours clinic visits, emergency department visits, and hospitalizations

Results

After controlling for multiple factors, no statistically significant differences in utilization between secure email users and non-users occurred. Utilization transiently increased by 88-237% around first email use. Annual rates of patient-initiated phone calls decreased among secure email users, 0.2 fewer calls per person [95% CI -0.3 to -0.1], from a mean of 4.1 one to 12

months before first use to a mean of 3.8 calls per person seven to 18 months after first use. Rates of patient-initiated phone calls also decreased among non-users, 0.1 fewer calls per person [95% CI -0.2 to 0.0], from a mean of 4.2 calls per person one to 12 months before the index date to mean of 4.1 calls per person seven to 18 months after the index date.

Conclusions

Compared to non-users, patient use of secure email with clinicians was not associated with statistically significant differences in clinical services utilization seven to 18 months after first use.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- This study reports on the association between patient use of secure email with clinicians and medium-term use of office visits, patient-initiated phone calls, scheduled telephone visits, after-hours clinic visits, emergency department visits, and hospitalizations.
- No association was found between secure patient-email use and the use of other health care services.
- This study improved on previous methods by excluding data for six months after first secure email use, comprehensively adjusting for baseline utilization, deriving propensity scores from a robust set of independent variables, and examining clinical services utilization seven to 18 months after the index date.
- The population consisted of individuals who were late adopters of secure email use with clinicians and likely differed in systematic ways from those who opted for earlier use, which may limit the generalizability of the results.

INTRODUCTION

Under meaningful use requirements of the U.S. Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009, patient portals are emerging as a key technology for engaging patients. In 2013, 40% of U.S. physicians in ambulatory care settings had some type of patient portal.[1] Patient portals tethered to electronic health records (EHRs) generally enable patients to communicate electronically and securely with health care clinicians, access their medical records, schedule appointments, pay bills, and refill prescriptions.[2] Other functions typically include a problem list, list of medications, allergy list, test results, and links to personalized health information.[3]

A recent systematic review concluded that insufficient evidence existed that patient portals improve health outcomes, cost, or utilization.[4] However, it did not assess the impact of individual portal functions. Secure email communication between patients and clinicians via an online portal is a new care modality in which patients communicate clinical concerns and receive a reply.[5] It is highly desirable to patients and holds the potential to improve health care quality and efficiency.[6-10]

To date, evidence about the association of secure patient-clinician email with utilization of other clinical services is inconsistent. Patients and clinicians report time savings from avoided in-person visits and more efficient management of patient care and, conversely, some increased time demands on clinicians from using secure email with patients.[11-14] A 2012 Cochrane review concluded that the effect of patient-clinician email on utilization could not be assessed due to differing methodologies and measures, variable results, and missing data.[5] Similarly, a 2014 systematic interpretive review concluded that heterogeneous reporting precluded assessing overall workload changes.[15] Investigations of the association of secure patient-clinician email

with utilization of specific clinical services have most frequently examined telephone calls and office visits. In three reports, patients using secure email had phone call volumes similar to those of patients in control or comparison groups; in a fourth study, increases over time in phone calls were smaller for patients using secure email than for non-users.[16-19] Evidence regarding office visit utilization is also mixed. In separate trials among patients with diabetes, a 10% increase in secure message threads was associated with a 1.25% increase in office visits, and the primary care visit rate was 32% higher among patients with at least 12 message threads per year.[20,21] Secure email was also associated with decreased or unchanged rates of primary care office visits in three reports.[19,22-24] Studies assessing other types of utilization are rare. In a small trial among patients with congestive heart failure, secure patient-clinician email was associated with increased emergency department (ED) visits but unchanged hospitalization rates.[25]

The aim of this study was to assess the association of secure patient-clinician email with utilization of various clinical services over time. We hypothesized that: 1) patients who initiated secure e-mail with clinicians would use the same level of clinical services over the longer term that they did before using secure email; and 2) patients who initiated secure e-mail with clinicians would use the same level of clinical services as matched patients who did not use secure e-mail with clinicians.

METHODS

The study was conducted at Kaiser Permanente Colorado (KPCO), one of seven regions of Kaiser Permanente, among the largest not-for-profit integrated health care delivery systems in the U.S., serving 10 million members. At KPCO, 1,000 physicians and 6,000 staff members provide care for 615,000 members at 28 medical offices. Inpatient care is provided through

contracts with non-Kaiser Permanente hospitals. KPCO members represent a diverse racial/ethnic mix similar to that of the general population in the Denver metropolitan area, where Kaiser Permanente facilities are predominantly located. Members select KPCO as their healthcare provider in a number of ways. The Colorado Affordable Care Act Health Exchange, which is primarily for people without other health insurance options, includes KPCO membership as an option. Employers may offer KPCO membership as one of several options from which employees can select healthcare coverage. Government-subsidized programs are available for individuals 65 years of age and those qualifying on the basis of low income. Patients may also privately purchase coverage, choosing from a variety of KPCO health plans that include a traditional health maintenance organization plan and high-deductible cost sharing plans.

KP HealthConnect™, KPCO's integrated electronic health record, was implemented in 2004. The patient portal, MyHealthManager (MHM), was implemented in 2006 and allows members to securely access parts of their medical record, such as test results, active medications, and care plans, and to schedule appointments, request prescription refills, and exchange secure email with health care clinicians. Members receive information about the patient portal and instructions for registering in multiple ways, including mailed materials, notices posted in KPCO clinics, and while checking in for clinic visits. All KPCO members aged 13 and over can register for an account. In 2012, 66% of KPCO members with Internet access meeting the age requirement were registered for an account. Registered members can access all MHM functionalities. Although members may use any portal function after registering, we focused on patients initiating secure email communication with clinicians, in contrast to earlier evaluations

at Kaiser Permanente that assessed the use of any portal function and yielded conflicting findings about the impact of use on clinical services utilization.[19,26]

Although we did not assess the types of clinicians that patients emailed, secure messages are primarily delivered to the inboxes of physicians, physician assistants, and nurse practitioners providing primary and specialty care. Clinicians may choose to respond directly to all patient email messages or to have a medical assistant or registered nurse on the care team review all incoming secure email from patients, respond to any requests or concerns within their scopes of practice, and forward the remainder of patient secure email messages to the clinician's attention.

Study design

We conducted a retrospective cohort study of secure patient-clinician email use and clinical services utilization between July 2010 and December 2013. For study inclusion, members were required to be at least 18 years of age and continuously enrolled for at least 30 months with either first use of secure patient-clinician email between July 2011 and July 2012 or no use between July 2010 and July 2012. We did not assess the portal registration status of members with no secure email use. After excluding members in the top 1% of baseline utilization, we separated the population into secure email users and non-users. To eliminate bias arising from seasonal variations in utilization, we assigned each non-user a randomly selected index date between July 2011 and July 2012.

A spike in utilization of clinical services occurs around the time of the first use of secure patient-clinician messaging or patient portal registration, which may be prompted by a new illness or medical concern.[19,23,26] Previous studies excluded one to two months before and one month after the index date, and a recent study at Kaiser Permanente adjusted for baseline office visit utilization in the year before the index date.[19,23,26] We adjusted for the utilization

spike in two ways that substantially strengthened the study design. First, to eliminate its effect and focus on longer term effects, we excluded a period of six months after the index date. Thus, we assessed clinical utilization from one to 12 months before the index date (the pre period) and from seven to 18 months after the index date (the post period). Second, because variable baseline utilization may reflect unmeasured differences between patients who do and do not use secure email with clinicians, we matched users and non-users on all baseline utilization up to and including the index date. We collected data from the EHR and administrative databases on age, gender, benefit type, number of chronic illnesses, distance from the nearest medical office building, utilization of office, after-hours clinic, and ED visits, patient-initiated and scheduled telephone calls, and inpatient admissions. We used DxCG risk scores (Verisk Health, Inc.; Waltham, MA) to characterize illness severity. A commercial product, DxCG relative risk scores predict health care costs relative to the population mean, based on age, gender, diagnoses, and drug codes.[27]

Statistical analyses

We assessed differences between secure email users and non-users with *t* tests for DxCG risk scores and χ^2 tests for categorical variables. To adjust for differences between users and non-users, we calculated propensity scores using a logistic regression model and a robust selection of independent variables to estimate the probability of secure email use. Independent variables included index month and year, age, gender, benefit type, DxCG risk score, number of chronic illnesses, distance from the nearest medical office building, and baseline utilization of office, urgent care, and emergency department visits, patient-initiated and scheduled telephone calls, and inpatient admissions. Matching on baseline utilization occurred in two steps. We first matched users and non-users on utilization for the first eleven months of the pre period and then

on utilization for the month immediately before the index date. Finally, we created matched pairs of users and non-users whose individual propensity scores differed by .001 or less and assessed differences between the groups of matched users and non-users with *t* tests for DxCG risk scores and χ^2 tests for categorical variables.

We calculated utilization rates for clinical services and analyzed difference of differences for utilization before and after the index date using bootstrapping methods, comparing the matched groups of secure email users and non-users. Office visits and patient-initiated phone calls were reported as per member per year rates. Clinicians may schedule telephone visits to follow up with members; these were reported as per 1000 members per year rates. After-hours clinic visits, ED visits, and hospitalizations occurred less frequently and were also reported as per 1000 members per year rates. All statistical analyses were conducted with SAS version 9.2 (SAS Institute), with two-sided statistical tests and a .05 level of statistical significance. This data-only retrospective study required only approval by the KPCO Institutional Review Board for the use of data from the EHR database (reference number CO-14-2073); an ethics review was not required.

RESULTS

We identified 11,937 KPCO members aged 18 and over who were continuously enrolled for at least 30 months and first used secure patient-clinician email between July 2011 and July 2012 and 212,155 members with the same age and enrollment characteristics but no secure patient-clinician email use between July 2010 and December 2013 (Figure 1). Applying propensity score matching, we refined the cohorts to include 9,345 matched pairs of users and non-users, which we used to examine differences in clinical services utilization associated with secure patient-clinician email use. After applying propensity score matching between secure

email users and non-users, some statistically significant differences persisted related to age, type of insurance benefits, and baseline utilization of telephone calls and scheduled telephone visits (Table 1).

Table 1. Pre- and post-matching population characteristics

	Unmatched, No. (%)			Matched, No. (%)		
	MHM Users (n = 11,737)	Non-users (n = 212,155)	*P* value	MHM Users (n = 9,345)	Non-users (n = 9,345)	*P* value
Age categories, y			<.001			<.01
18-19	283 (2.4)	7,494 (3.5)		238 (2.5)	244 (2.6)	
20-44	4,750 (40.5)	80,419 (37.9)		3,734 (40.0)	3,662 (39.2)	
45-64	4,713 (40.2)	81,156 (38.3)		3,741 (40.0)	3,710 (39.7)	
≥ 65	1,991 (17.0)	43, 086 (20.3)		1,632 (17.5)	1,729 (18.5)	
Sex			<.001			.63
Female	6,758 (57.6)	108,360 (51.0)		3,896 (41.7)	3,861 (41.3)	
Male	4,979 (42.4)	103,795 (48.9)		5,449 (58.3)	5,484 (58.7)	
Benefit type			<.001			<.01
DHMO	3,751 (32.0)	71,577 (33.7)		3,072 (32.9)	2,845 (30.4)	
HMO	5,134 (43.8)	80,928 (38.1)		3,974 (42.5)	4,086 (43.7)	
Medicare	1,862 (15.9)	37,790 (17.8)		1,532 (16.4)	1,618 (17.3)	
Medicaid	60 (0.5)	3,397 (1.6)		48 (0.5)	54 (0.6)	
Other	930 (7.9)	18,463 (8.7)		719 (7.7)	742 (7.9)	
DxCG score, mean	1.75	1.85	.002	1.79	1.82	.39
Number of chronic illnesses			<.001			.39
0	10,288 (88.0)	188,254 (88.7)		7,877 (86.8)	8,285 (86.2)	

1	1,322 (11.3)	21,367 (10.1)		1,096 (12.1)	1,207 (12.6)	
2	112 (10.0)	2,228 (1.1)		90 (1.0)	109 (1.1)	
3	15 (0.1)	271 (0.1)		13 (0.1)	11 (0.1)	
4	0 (0.0)	35 (0.0)		0 (0.0)	2 (0.0)	
Distance to nearest medical office building, miles			<.001			0.17
0 – 4.9	8,144 (69.4)	143,368 (67.6)		6,154 (67.8)	6,639 (69.1)	
5 – 19.9	2,954 (25.2)	54,127 (25.5)		2,406 (26.5)	2,461 (25.6)	
≥ 20	639 (5.4)	14,660 (6.9)		516 (5.7)	514 (5.3)	
Annual utilization, per member						
Inpatient stays	0.07	0.05	<.001	0.07	0.07	.94
ED visits	0.13	0.11	<.001	0.13	0.13	.23
After-hours office visits	0.08	0.05	<.001	0.08	0.07	.09
Low acuity office visits	0.24	0.16	<.001	0.24	0.24	.88
Low acuity patient calls	0.08	0.05	<.001	0.07	0.08	.17
Office visits	3.27	2.18	<.001	3.30	3.28	.69
Patient calls	3.83	3.03	<.001	3.83	4.07	<.01
Scheduled telephone visits	0.29	0.22	<.001	0.28	0.31	.03

Abbreviations: DHMO, deductible health maintenance organization plan; ED, emergency department; HMO, health maintenance organization

A pronounced surge in utilization occurred around the time of first use of secure email. Peak utilization occurred in the index month for all clinical services except patient-initiated and

scheduled telephone calls, which peaked in the month following the index date. Across all services, the unweighted average relative increase in utilization was 143%. Relative increases in monthly utilization rates for specific clinical services ranged from 88% for after-hours clinic visits, an increase of .006 visits per member, from .006 in months one to 12 before the index date to .012 in the index month, to 238% for scheduled telephone visits, an increase of 0.55 visits per member, from 0.23 in months one to 12 before the index date to 0.78 per member in the month following the index date. The surge in utilization largely dissipated by six months after the index date.

Only two statistically significant changes in utilization occurred between the pre and post periods. Among secure email users, patient-initiated phone calls decreased by 0.2 calls per member per year [95% CI -0.3 – -0.1], from an annual mean of 4.1 patient-initiated calls per member one to 12 months before the index date to a mean of 3.8 calls per member seven to 18 months after the index date. Patient-initiated phone calls also decreased among non-users by 0.1 calls per member [95% CI -0.2 – -0.0], from a mean of 4.2 patient-initiated phone calls per member one to 12 months before the index date to mean of 4.1 calls per member seven to 18 months after the index date. No other differences in utilization before and after the index date within user and nonuser groups were statistically significant (Table 2).

Table 2. Annual health care utilization before and after the index date among secure patient-clinician email users and non-users

	MHM users			MHM non-users			Difference in differences (95% CI)	P value
	Before	After	P value	Before	After	P value		
Office visits[a]	3.2	3.3	.06	3.3	3.3	.57	0.1	.33

							(0.0 – 0.2)	
Patient-initiated calls[a]	4.1	3.8	<.0001	4.2	4.1	.05	-0.1 (-0.3 - 0.0)	.14
Scheduled telephone visits[b]	279.2	280.9	.89	287.8	310.1	.07	20.7 (-57.2 – 12.9)	.23
After-hours office visits[b]	77.0	81.6	.37	72.8	74.1	.76	3.3 (-11.2 – 15.1)	.62
ED visits[b]	130.2	127.6	.69	131.4	134.5	.63	5.6 (-21.6 – 12.0)	.53
Inpatient stays[b]	64.6	65.8	.81	64.1	65.0	.85	.35 (-13.9 – 15.7)	.96

[a] Mean per member per year

[b] Mean per 1000 members per year

When comparing changes between secure patient-clinician email users and non-users in clinical services utilization before and after the index date, we found no statistically significant differences (Table 2). Figure 2 depicts monthly mean rates for office visit and patient-initiated telephone calls. Similar figures for all types of utilization are available online (see Supplementary Figure 1, Supplementary Figure 2).

DISCUSSION

We had hypothesized that: 1) patients who initiated secure e-mail with clinicians would use the same level of clinical services over the longer term that they did before using secure email; and 2) patients who initiated secure e-mail with clinicians would use the same level of clinical services as matched patients who did not use secure e-mail with clinicians. Our hypothesis was confirmed. We observed no differences between patients who did and did not use

secure patient clinician email in utilization of office visits, scheduled telephone visits, patient-initiated phone calls, emergency department visits, after-hours clinic visits, and hospitalizations seven to 18 months after the index date. Very small decreases in patient-initiated phone calls between the pre and post periods for both secure email users and non-users were likely clinically meaningless, despite statistical significance.

Strengths of the study include adjustment for a utilization spike around the index date by matching on all baseline utilization data and excluding data for six months after the index date. The inclusion of a robust array of independent variables in the propensity score matching model is also a strength. Several limitations deserve mention. Although secure clinician-patient email had been available since 2006, we studied individuals who had not used secure email with clinicians after one (users) to two (non-users) years of membership. They comprised a minority population; in 2012, 66% of all eligible KPCO members were registered for the patient portal, and secure email is second only to viewing lab results in frequency of use by members. The members we included in our study likely differed in systematic ways from those who opted for earlier use, but the potential impact of these differences on our findings is unknown. We also lacked data on the volume of secure patient-clinician email messages among study participants. A study of proxy PHR use by caregivers of pediatric patients found that increased use of clinical services occurred only among those with the highest use.[28] Finally, our study took place in an integrated care delivery system. The degree to which the findings are generalizable to other settings is unknown.

The present findings contrast with those of previous studies at Kaiser Permanente exploring the association of portal registration with the use of clinical services.[19,26] Potential explanations for differing results include the likelihood that the association with utilization of

clinical services is different for secure patient-clinician email than for other portal functions. This explanation is supported by a recent report examining the association between secure patient-clinician email use and office visit rates, which found that the latter were unchanged.[23] A previous study that found increased utilization of clinical services after portal registration excluded a month before and after the index date, in comparison to the six-month exclusion period used here.[26] A shorter exclusion period likely captured some of the utilization surge that, in the present study, abated by approximately six months after the index date. A second previous study at Kaiser Permanente examined associations between portal registration and clinical services utilization among members who registered when overall portal registration rates were only 6%, finding that registration was associated with decreased rates of office visits and telephone contacts.[19] As noted earlier, early and late adopters of portal use may differ from each other in ways that affect their patterns of clinical services use over time. Differences in this series of studies are summarized in Supplementary Table 1.

The potential short- and longer term impacts on workloads of the utilization surge around the time of registration for clinician-patient email should be considered. The initial surge in utilization of clinical services was followed by a return to utilization levels similar to those of patients who did not securely email clinicians. Although we did not directly investigate the causes of the surge, we believe two types of utilization surges may occur at the same time. First, when new individuals have a clinic visit, they are actively encouraged to also register for the patient portal and to communicate by secure email with clinicians. In this case, initial utilization around first secure email use is due to how Kaiser Permanente promotes portal registration. Second, we also speculate that increased use of clinical services for this cohort of late-registrant patients signals a sudden and serious health event, such as acute illness or identification of a new

medical condition. Such an event may prompt patients to increase many types of clinical utilization and, for some, to also initiate secure email as a result of the need to interact more frequently with clinicians and staff members. Users and non-users were matched on baseline utilization immediately before the index date, as well as for the preceding eleven months (Figure 2, Supplementary Figure 3). This suggests that the surge in utilization of clinical services we observed may be an artifact of a natural association between a new health concern, increased utilization, and, for some patients, portal registration and first secure email use.

In practical terms, the workload impact of surges in individual utilization concomitant with new health events and first use of secure email is unlikely to be perceived by clinicians and organizations as distinct from expected demand for clinical services. However, in our experience, widespread use over time among patients of a portal offering secure email with clinicians is associated with an increase in secure email workload that must be taken into account. Unpublished KPCO data indicate that, on average, physicians with more than 500 patients send six to seven emails to patients per day, spending three to four minutes on each email response; some of these emails may avoid clinical services use, but many will not.

Further study is required to more fully understand the relationship between secure patient-clinician email use and clinical services utilization. Applying the strengths of this study—the extended data exclusion period and the robust matching on baseline characteristics—to a population of earlier adopters would validate the findings. In a previous study, clinical services utilization patterns varied by diagnosis; future research should examine associations between secure email use and utilization patterns within and across diagnostic groups.[26] Although our study expands the time period within which secure patient-clinician email has been studied, longitudinal studies on the order of three to five years are needed that track the

relationship between secure email use and clinical service utilization as organizational experience with patient portals accumulates. Our findings confirmed our original hypothesis. After controlling for the initial surge in utilization after the index date, clinical services utilization for late-stage enrollees returned to baseline, indicating that secure patient-clinician email may be a distinct form of patient contact that does not substitute for office and telephone contacts or avert emergency department and after-hours clinic visits and inpatient stays when there is a sudden and serious health event. Similar utilization of clinical services by users and non-users over the longer term also suggests that patients who use secure email with clinicians are not inherently more likely to use all types of clinical services. However, more research is needed to understand the specific benefits to patients of secure email with clinicians and to investigate the use of health care services and health outcomes for patients who send multiple emails and are frequent portal users, compared to patients who send occasional emails and are low or moderate users of the portal. Doing so requires rigorous study designs. Conducting a randomized trial of secure patient-provider email communication within the USA would be difficult because this capability is a requirement of stage 2 Meaningful Use implementation of EHRs. Stepped wedge designs that can be conducted as implementation proceeds and RCTs conducted in other countries hold promise for adding to our understanding of the relationship between the use secure patient-clinician email and other types of clinical services..[29-31]

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COMPETING INTERESTS

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organization for the submitted work; no financial relationships with any organizations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work**.**

CONTRIBUTORS

DM, TP, TG, and HQ were involved in the conception and design of the study. MM and JT acquired the data that were analyzed. DM, TP, TG, JT, and HQ analyzed and interpreted the data. DM, TG, MM, and JT drafted the manuscript. DM, TP, TG, HQ, and JT revised the manuscript for important intellectual content. All authors approved the final version of the manuscript. All authors had access to all of the data in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis. DM is the guarantor.

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DATA SHARING: No additional data are available

TRANSPARENCY: The lead author (DM) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; no important aspects of the study have been omitted.

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FIGURE LEGENDS

Figure 1. Flow Diagram of Participants (Figure 1.tiff)

Creation of propensity score-matched cohorts

Figure 2. Matched Cohort Mean Office Visits and Patient-Initiated Calls per Month (Figure 2. tiff)

Each data point represents mean office visits from the preceding month. The tinted area indicates the period from which data were excluded for the rates reported in Table 2.

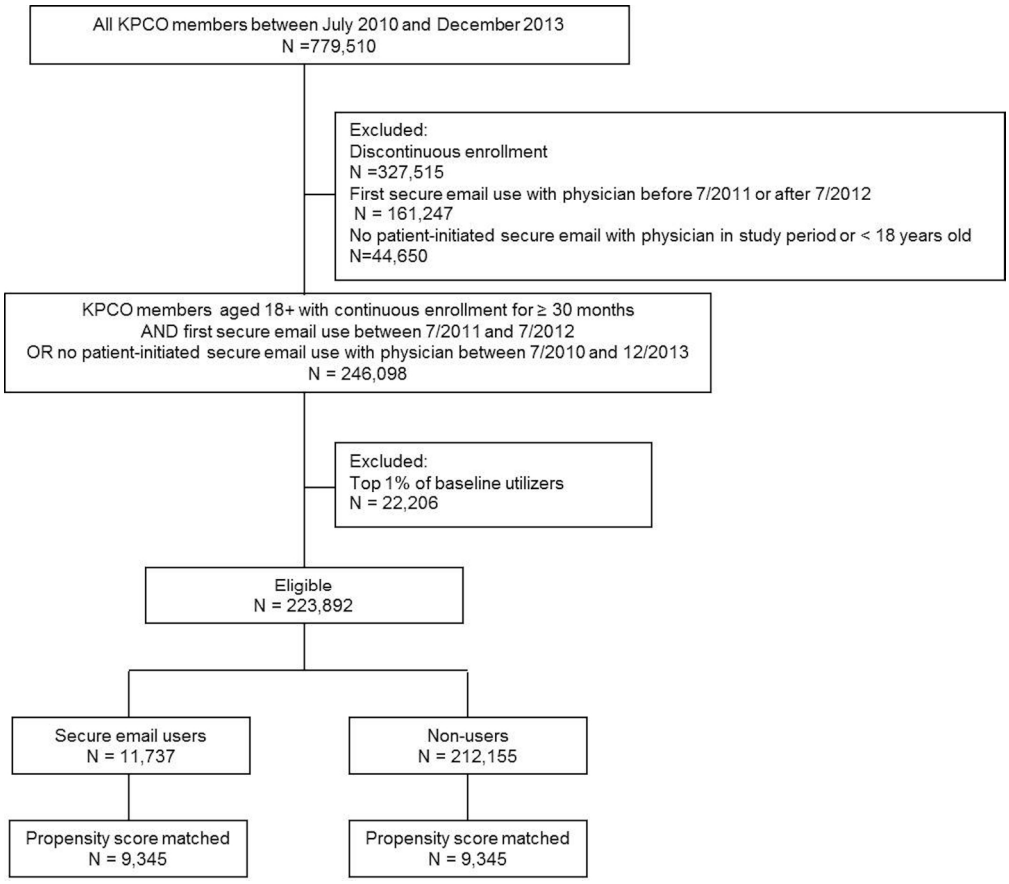


Figure 1. Flow Diagram of Participants
177x155mm (300 x 300 DPI)

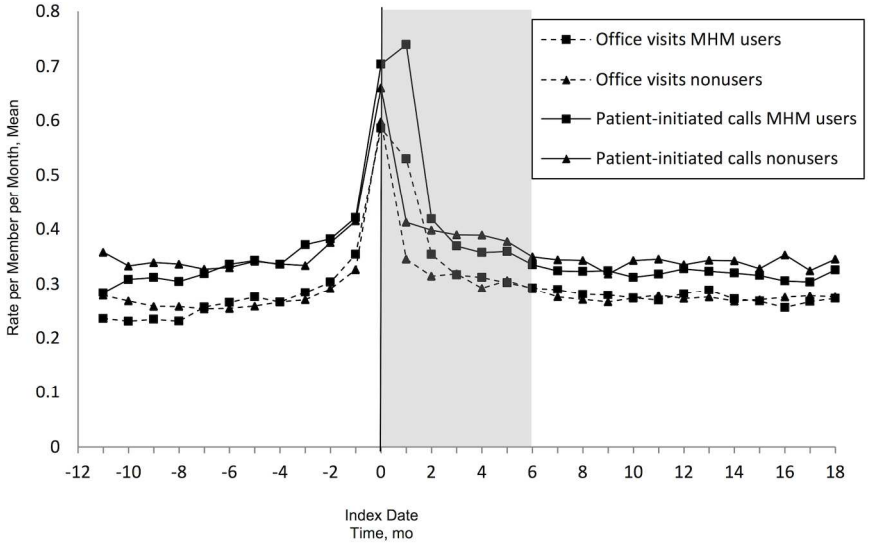


Figure 2. Matched Cohort Mean Office Visits and Patient-Initiated Calls per Month
203x157mm (300 x 300 DPI)

Supplementary figures 1

Supplementary Table 1. Comparison of Kaiser Permanente studies examining associations between portal or secure email use and clinical services utilization

Supplementary Figure 1. Matched cohort mean after hours clinic visits and hospitalizations per month

Supplementary Figure 2. Matched cohort mean scheduled telephone and emergency department visits per month

Supplementary Figure 3. Effect of matching method on differences in utilization over time

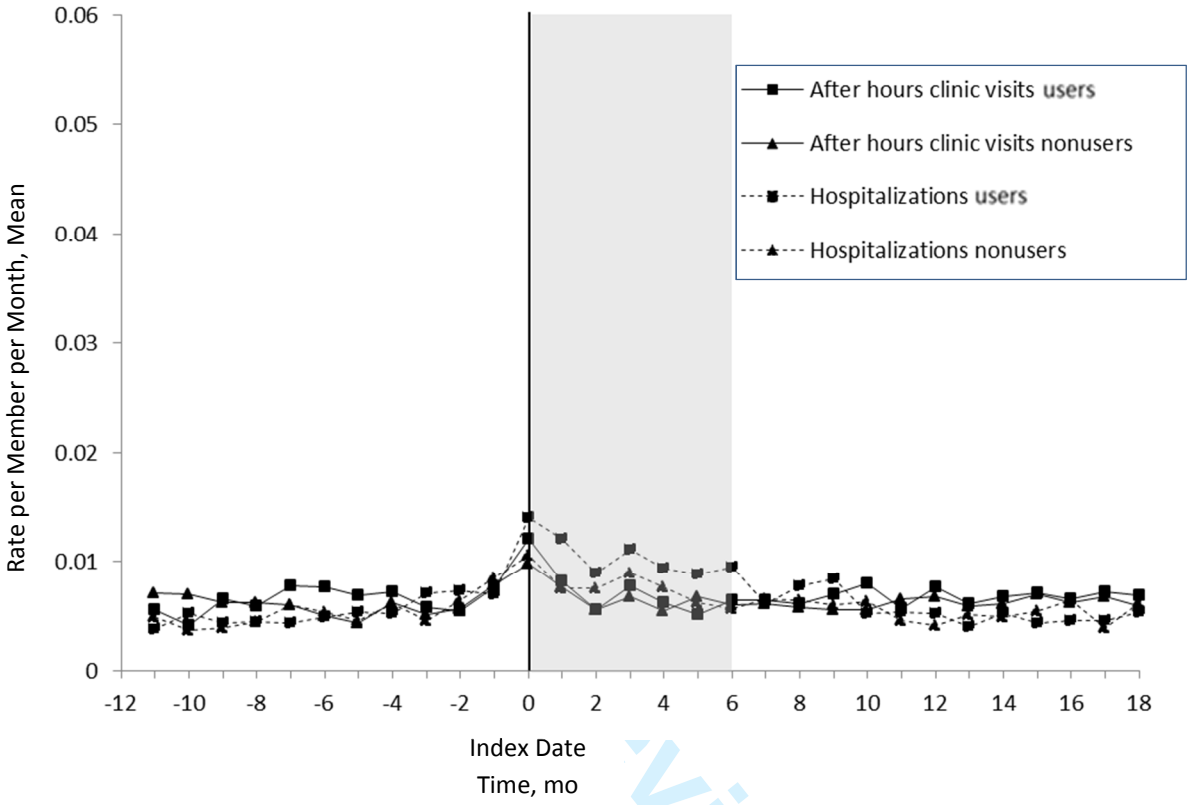
Supplementary figures 2

Supplementary Table 1. Comparison of Kaiser Permanente studies examining associations between portal or secure email use and clinical services utilization

	Zhou et al., 20071[9]	Palen et al., 2012[26]	Meng, 2014
Years since portal initiation	3	1- 4	4 - 6
Eligible members registered, %	6	25 (year 1) 54 (year 4)	54 (year 4) 66 (year 6)
Portal function assessed	≥ 1 use of any function	≥ 1 use of any function	First use of secure email
Study design	Matched retrospective cohort	Propensity-matched retrospective cohort	Propensity-matched retrospective cohort
Matching variables	Age, sex, selected chronic conditions, primary care provider	Age, sex, number of chronic illnesses, baseline office visits	Index month and year, age, sex, benefit type, DxCG risk score, number of chronic illnesses, distance from the nearest medical office, baseline utilization of office, urgent care, and emergency department visits, patient-initiated and scheduled telephone calls, and inpatient admissions
Study population			
Total users, n	4686	87,206	360,138 (≥ 13 years)
Matched cohort, n	3201	44,321	9,345
Time periods studied before and after index use/ portal registration	3-14 months before 2-13 months after	1-11 months before 1-12 months after	1-12 months before 7-18 months after
Study outcomes	Primary care office visit and telephone contact rates	Rates of office visits, telephone encounters, after-hours clinic visits, ED visits, and hospitalizations	Rates of office visits, patient-initiated phone calls, scheduled telephone visits, after hours clinic visits, ED visits, and hospitalizations
Findings	Office visits decreased and telephone contacts increased among cases and controls with statistically significant difference in differences favoring portal use for both.	Among portal users, increases in office visits, telephone encounters, after-hours clinic visits, ED visits, and hospitalizations.	Decreased patient-initiated telephone calls after the index date among secure patient-clinician email users and non-users. No other differences within or between user and nonuser groups.

Abbreviations: ED, emergency department; PKMPY, per 1000 members per year; PMPY, per member per year

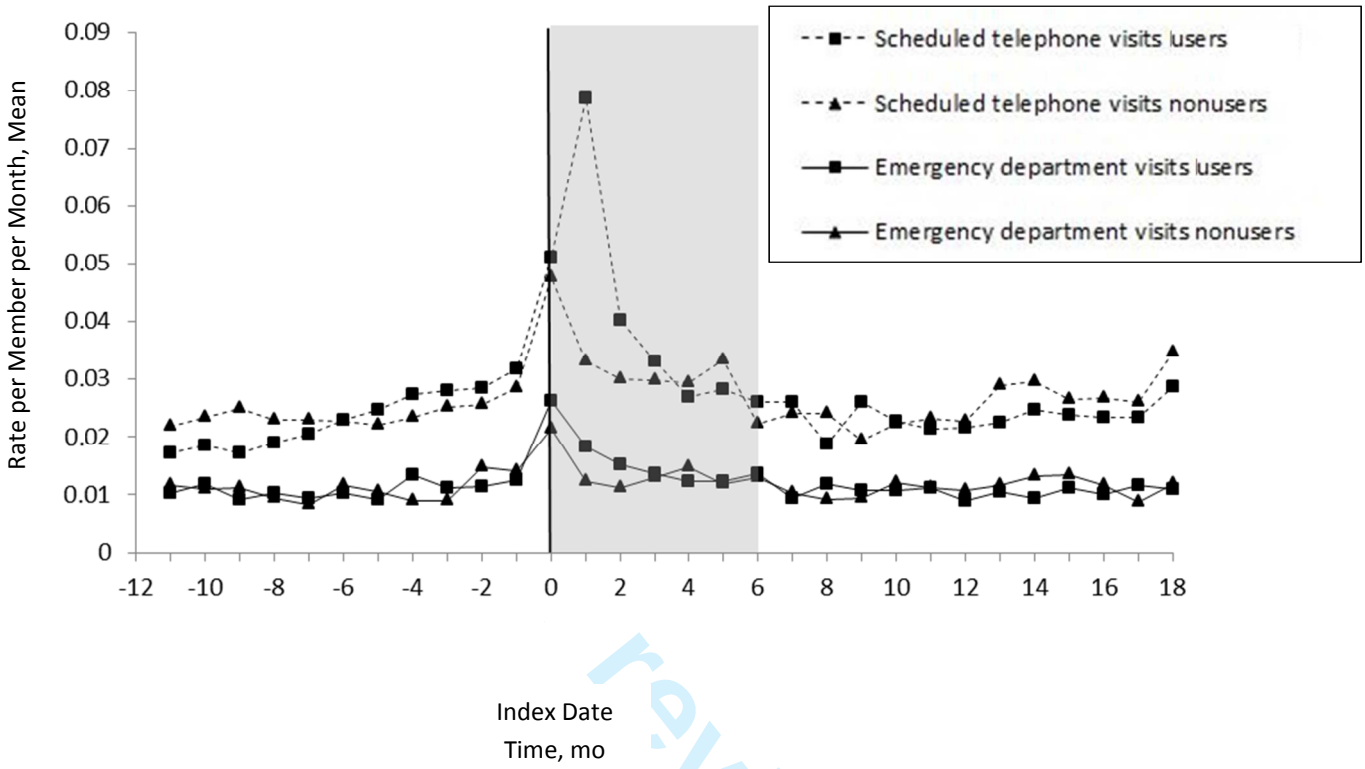
Supplementary Figure 1. Matched cohort mean after hours clinic visits and hospitalizations per month



Note: Each data point represents mean office visits from the preceding month. The tinted area indicates the period from which data were excluded for the rates reported in Table 2.

Supplementary figures 4

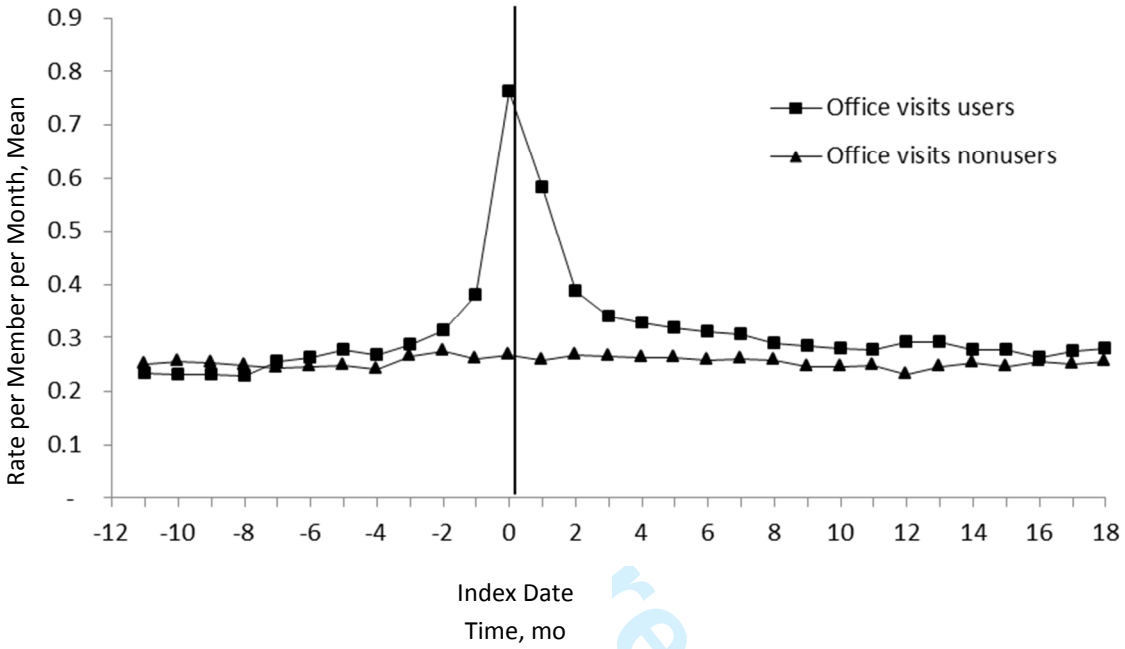
Supplementary Figure 2. Matched cohort mean scheduled telephone and emergency department visits per month



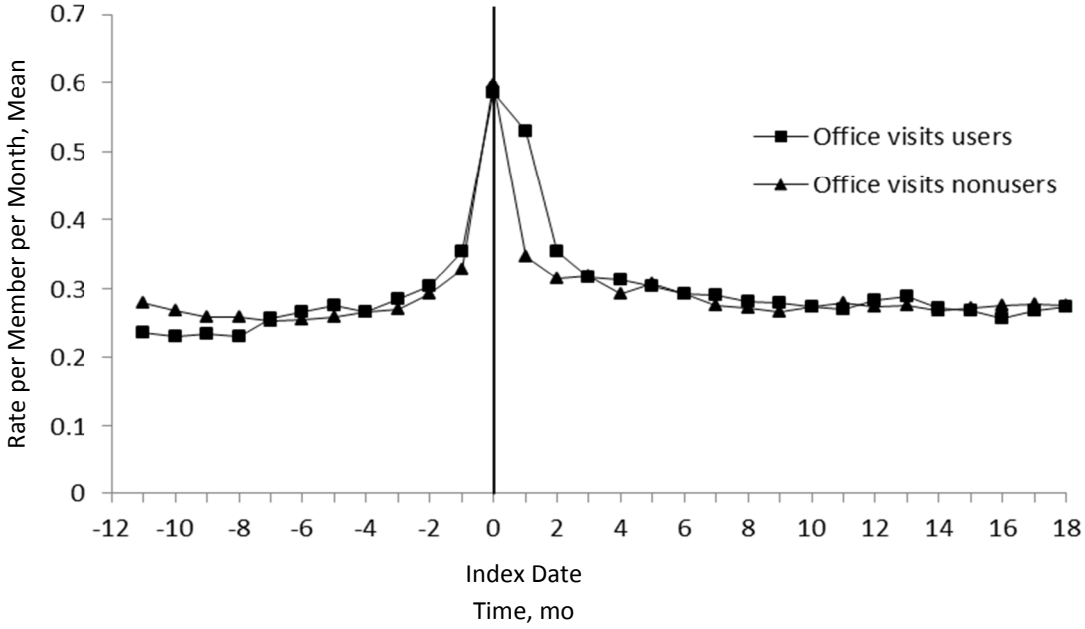
Note: Each data point represents mean office visits from the preceding month. The tinted area indicates the period from which data were excluded for the rates reported in Table 2.

Supplementary Figure 3. Effect of matching method on differences in utilization over time

3a. Matching on baseline office visits in 12 months before the index date



3b. Two-step matching on all baseline utilization in first 11 months of pre period and month before the index date



STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract [within the title page 1 and design section of the abstract page 2]
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found [please see design and results sections of abstract page 2]
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported [pages 5-6]
Objectives	3	State specific objectives, including any prespecified hypotheses [page 6]
Methods		
Study design	4	Present key elements of study design early in the paper [pages 8-10]
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection [pages 6-8]
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up [pages 8-9]
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed [pages 10–12]
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable [pages 7-9]
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group [pages 8-9]
Bias	9	Describe any efforts to address potential sources of bias [page 8]
Study size	10	Explain how the study size was arrived at [page 10]
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why [page 9-12, Table 1]
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding [page 9]
		(*b*) Describe any methods used to examine subgroups and interactions [n/a]
		(*c*) Explain how missing data were addressed [n/a]
		(*d*) If applicable, explain how loss to follow-up was addressed [n/a]
		(*e*) Describe any sensitivity analyses [n/a]
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed [page 10]
		(b) Give reasons for non-participation at each stage [n/a]
		(c) Consider use of a flow diagram [Figure 1]
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders [Table 1]
		(b) Indicate number of participants with missing data for each variable of interest [n/a]
		(c) Summarise follow-up time (eg, average and total amount) [page 8]
Outcome data	15*	Report numbers of outcome events or summary measures over time [pages 11-13, Table 2]
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and

		their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included [pages 13, Table 2]
		(*b*) Report category boundaries when continuous variables were categorized [Table 1]
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period [n/a]
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses [n/a]
Discussion		
Key results	18	Summarise key results with reference to study objectives [page 14]
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias [page 14-15]
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence [pages 15-16]
Generalisability	21	Discuss the generalisability (external validity) of the study results [page 15]
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based [page 17]

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.