Association Between Primary Care Visits and Colorectal Cancer Screening Outcomes in the Era of Population Health Outreach

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BACKGROUND: Population outreach strategies are increasingly used to improve colorectal cancer (CRC) screening. The influence of primary care on cancer screening in this context is unknown.

OBJECTIVE: To assess associations between primary care provider (PCP) visits and receipt of CRC screening and colonoscopy after a positive fecal immunochemical (FIT) or fecal occult blood test (FOBT).

DESIGN: Population-based cohort study.

PARTICIPANTS: A total of 968,072 patients ages 50–74 years who were not up to date with CRC screening in 2011 in four integrated healthcare systems (three with screening outreach programs using FIT kits) in the Population-Based Research Optimizing Screening through Personalized Regimens (PROSPR) consortium.

MEASURES: Demographic, clinical, PCP visit, and CRC screening data were obtained from electronic health records and administrative databases. We examined associations between PCP visits in 2011 and receipt of FIT/FOBT, screening colonoscopy, or flexible sigmoidoscopy (CRC screening) in 2012 and follow-up colonoscopy within 3 months of a positive FIT/FOBT in 2012. We used multivariable logistic regression and propensity score models to adjust for confounding.

RESULTS: Fifty-eight percent of eligible patients completed a CRC screening test in 2012, most by FIT. Those with a greater number of PCP visits had higher rates of CRC screening at all sites. Patients with ≥1 PCP visit had nearly twice the adjusted-odds of CRC screening (OR = 1.88, 95 % CI: 1.86–1.89). Overall, 79.6 % of patients with a positive FIT/FOBT completed colonoscopy within 3 months. Patients with ≥1 PCP visit had 30 % higher adjusted odds of completing colonoscopy after positive FIT/FOBT (OR = 1.30; 95 % CI: 1.22–1.40).

CONCLUSIONS: Patients with a greater number of PCP visits had higher rates of both incident CRC screening and colonoscopy after positive FIT/FOBT, even in health systems with active population health outreach programs. In this era of virtual care and population outreach, primary care visits remain an important mechanism for engaging patients in cancer screening.

KEY WORDS: primary care; colorectal cancer screening; population health outreach.

INTRODUCTION

Colorectal cancer (CRC) is the third most common cancer and the second leading cause of cancer deaths in the United States.[1] Screening can prevent CRC and reduce cancer-related mortality.[2] National guidelines recommend CRC screening via colonoscopy, flexible sigmoidoscopy, or fecal immunochemical tests (FIT) or high-sensitivity guaiac occult blood tests (FOBT).[3] Primary care providers (PCP) traditionally initiate cancer screening, and prior work has shown that patients seen by PCPs are more likely to receive CRC screening.[4–8]

However, CRC screening rates remain suboptimal, even after decades of public health campaigns, public reporting of health plan CRC screening rates, and implementation of visit-based preventive service reminders in electronic health records (EHRs).[4,7,9–11] Therefore, a growing number of private and public health systems are taking a population health perspective and using outreach approaches to promote CRC screening that do not require a face-to-face primary care visit.[12] Active outreach strategies, such as mailed invitations for colonoscopy and/or stool blood testing, can substantially increase screening rates.[9–11] The extent to which primary care continues to play an important role in CRC screening in health systems with active population screening outreach programs is unknown.

While all CRC screening modalities are effective, many large integrated delivery systems (like health maintenance organizations, Department of Veterans Affairs, and county health systems), are actively promoting the FIT/FOBT testing strategy. FIT/FOBT tests are inexpensive and easy to mail and distribute, and they may result in higher completion rates than screening colonoscopy due to a combination of patient acceptance, cost, logistics, and system capacity factors.[13] However, the effectiveness of a FIT/FOBT strategy depends on whether positive tests are followed up with diagnostic colonoscopy. Given their relationship with patients and repeated contact with them, PCPs may be instrumental in ensuring that patients with positive FIT/FOBT tests complete follow-up colonoscopy.[14,15] Thus far, however, this relationship has not been explored.

This study used a large, clinically detailed dataset from four integrated delivery systems with varying degrees of CRC screening population outreach in order to examine associations between the number of PCP visits and receipt of CRC screening and follow-up colonoscopy after a positive FIT/FOBT test.

METHODS

This study was conducted as part of the NCI-funded consortium Population-Based Research Optimizing Screening through Personalized Regiments (PROSPR).[16–18] The overall aim of PROSPR is to conduct multi-site, coordinated, transdisciplinary research to evaluate and improve cancer screening processes. The ten PROSPR research centers reflect the diversity of US delivery system organizations. This study used data from four PROSPR CRC sites: Group Health (GH), Kaiser Permanente Northern California (KPNC), Kaiser Permanente Southern California (KPSC), and the Parkland Health & Hospital System - University of Texas Southwestern Medical Center (PHHS-UTSW). The populations and screening practices of the PROSPR sites have been described previously.[17] The four participating systems have different CRC screening strategies. The two Kaiser Permanente health systems have active outreach programs that include annual mailing of FIT kits to patients not up to date with screening, supplemented by distribution of FIT kits in other settings (e.g. vaccination appointments), and system-level follow-up of positive FIT/FOBT results. GH sends patients receiving primary care at GH medical centers an annual preventive services reminder letter that includes CRC screening. The PHHS-UTSW safety-net health system does not have a screening outreach program.

Study Population

The study cohort included men and women 50–89 years of age enrolled from January 1, 2011, to December 31, 2012. For the three health plans (KPNC, KPSC, and GH), individuals entered the cohort if they were enrolled from 2011 through 2012, independent of health care utilization after health plan enrollment. PHHS-UTSW is an integrated delivery system that is the sole safety-net provider for low-income Dallas County residents who are uninsured or under-insured. Because PHHS-UTSW is not a health plan with distinct members, it enrolled patients who were 50–64 years of age who had a primary care visit at any of its 12 community-based clinics during 2010. There was no requirement for any subsequent health care visits. The PHHS-UTSW cohort was restricted to ages 50–64 years, because most patients become eligible for Medicare at age 65 and may receive care outside the safety-net system.

For this study, we focused on individuals continuously enrolled from January 1, 2011, through December 31, 2012, who were not up to date with CRC screening as of January 1, 2012. We examined associations between the number of PCP visits in 2011 and subsequent CRC screening activity in 2012. Screening status of not up to date was assessed using data in the EHRs and administrative databases, and was defined as no colonoscopy in 10 years, flexible sigmoidoscopy in 5 years, or FIT/FOBT in the 2 prior years (to provide a liberal time window around the annual FIT/FOBT testing strategy). We excluded individuals with prior CRC or partial or total colectomy. All activities were approved by the institutional review boards at each PROSPR site and the Statistical Coordinating Center.

Outcome Measures

Our two primary CRC screening outcomes were as follows: 1) incident screening, defined as receipt of CRC screening in 2012 among individuals not up to date as of January 1, 2012; and 2) completion of screening, defined as follow-up colonoscopy within 3 months after a positive FIT/FOBT in 2012. CRC screening was defined as completion of a FIT/FOBT, flexible sigmoidoscopy, or colonoscopy for screening purposes based on data from EHRs and administrative databases.[19,20] The vast majority of stool blood tests were FITs. We excluded in-office FOBTs, which are not recommended for screening. In order to ascertain diagnostic colonoscopy, we restricted analyses of follow-up after positive FIT/FOBT to patients with follow-up time of at least 3 months after the positive result, a time by which the majority of follow-up diagnostic colonoscopies were completed.[18] Similar results were found in sensitivity analyses among individuals with at least 6 months of follow-up time after the positive result.

Independent Variables

The main predictor variable was the number of primary care visits in 2011 based on EHR and administrative data, and categorized as 0, 1, 2, 3, and 4+ visits in 2011, as well as no visits vs. any visit in 2011. Primary care visits were ambulatory encounters with a clinician in general internal medicine, family medicine, primary care, community health, geriatrics, or women's health. We were not able to systematically link screening tests to a specific primary care visit (because of

widespread outreach distribution of FIT tests at the two largest sites), so we examined associations between the number of primary care visits in 2011 and subsequent CRC screening outcomes completed in 2012. Key covariates included age, sex, race/ethnicity, insurance status, and Charlson comorbidity score (0, 1, 2, or 3+) in 2011.[21]

Statistical Analyses

We examined associations between the number of primary care visits in 2011 and CRC screening outcomes in 2012 (incident screening and timely follow-up colonoscopy after positive FIT/FOBT) using chi-square tests and logistic regression. We report associations across all sites combined as well as stratified by health system. We used a propensity-score approach to account for differences between patients with and without any PCP visits. We used logistic regression to estimate the probability of having a PCP visit in 2011 based on their age (in 5-year intervals), sex, race/ethnicity, type of health insurance, comorbidity score, and months in the health system prior to cohort entry.[22–24] Propensity scores were estimated separately for each site, because of substantial differences in patient, provider, and system factors predicting PCP use in each health system. Propensity score weights were obtained as the inverse of the probability of the observed PCP visit status and normalized to sum to *N*. The propensity scores had good discrimination, overlap, and balance of covariates.[22–24] The c-statistics for the site-specific propensity scores ranged from 0.68 to 0.78. Site-specific weights were employed as inverse probability weights for analyses with all sites combined. Logistic regression was used to assess associations between number of PCP visits and CRC screening outcomes using site-specific, propensity score-adjusted results. Alternate models adjusting for the propensity score as a continuous variable or by deciles produced similar findings. The combined-site logistic regression models also adjusted for health system. Sensitivity analyses using multivariable regression to adjust associations for covariates (age, sex, race/ethnicity, insurance, comorbidity, and site) produced findings similar to those of the propensity-adjusted models (*see* Online Tables S1 and S2). Analyses used SAS software version 9.4.[25]

RESULTS

Our study population included 968,072 individuals in four health systems who were not up to date with CRC screening in 2011. Characteristics of study patients are presented in Table 1. The average age was 59.2 years, and slightly more than half were women. The population was racially and ethnically diverse, with 51.7 % non-Hispanic white, 19.0 % Hispanic, 12.3 % Asian, and 8.2 % black individuals. Almost

one-third of patients had at least one comorbid condition. Sociodemographic characteristics of patients differed substantially among sites, based on differences in geography and socioeconomic status of the populations served. Compared to the three insured health plans, patients at Parkland-UTSW were younger, had higher comorbidity scores, and were more likely to be non-white. Across all sites, there was wide variation in the number of annual primary care visits, with 23.6 % having no visits and over half having two or more visits in 2011.

Associations Between Primary Care Visits and Incident CRC Screening

Overall, 58.1 % of those not up to date in 2011 completed a CRC screening test in 2012 (Table 2). The vast majority of screening tests (94 %) were FIT/FOBTs; 5 % were colonoscopies, and <1 % were flexible sigmoidoscopies. Incident screening rates were highest at KPNC (67.2 %) and lowest in the safety-net setting (Parkland-UTSW, 18.3 %). In unadjusted analyses, a greater number of primary care visits in 2011 was associated with higher CRC screening rates in 2012 (Table 2). While absolute rates of incident screening differed by site, the association between primary care visits and screening was similar in settings with and without organized outreach. This was driven predominantly by a higher proportion of persons with ≥1 PCP visit having been screened (vs. those with no visits; OR = 2.34, 95 % CI: 2.32–2.36, Table 2). The higher odds of CRC screening among those with at least one primary care visit was seen across all sites, including those with the most intensive screening outreach (KPNC, KPSC).

A larger number of primary care visits was associated with higher rates of screening in propensity-adjusted analyses (Table 3). Compared to individuals with no PCP visits, those with ≥1 visit had nearly double the risk-adjusted odds of screening (OR = 1.88, 95 % CI: 1.86–1.89). This association was seen in all health systems. We found similar patterns in alternate covariate-adjusted models (Online Table S1).

Associations Between Primary Care Visits and Follow-Up Colonoscopy After a Positive FIT/FOBT

Overall, 79.6 % of patients with a positive FIT/FOBT underwent diagnostic colonoscopy within the following 3 months (Table 4). Both unadjusted (Table 4) and propensity-adjusted analyses (Table 5) showed that patients with a greater number of PCP visits were more likely to complete a colonoscopy following a positive FIT/FOBT, with the exception of those at PHHS-UTSW. Due to small cell sizes, we could not construct reliable estimates for Parkland-UTSW. In all sites combined, patients with ≥1 PCP visit had 30 % higher adjusted odds of following up a positive FIT (OR = 1.30, CI: 1.22–1.40). Alternate covariate-adjusted models demonstrated a similar association.

Table 1 Characteristics of Study Patients Who Were Eligible for Colorectal Cancer Screening in 2012

	Group Health (n = 54,444)	Kaiser Permanente North (n = 465,868)	Kaiser Permanente South (n = 428,059)	Parkland-UT Southwestern (n = 19,701)	Total (n = 968,072)
Age in 2011 in years, n (%)					
50–54	14,395 (26.4)	135,510 (29.1)	129,851 (30.3)	7526 (38.2)	287,282 (29.7)
55–59	14,581 (26.8)	122,638 (26.3)	111,936 (26.1)	7720 (39.2)	256,875 (26.5)
60–64	12,926 (23.7)	101,385 (21.8)	88,904 (20.8)	4455 (22.6)	207,670 (21.5)
65–69	8242 (15.1)	67,274 (14.4)	61,733 (14.4)	0 (0.0)	137,249 (14.2)
70–74	4300 (7.9)	39,061 (8.4)	35,635 (8.3)	0 (0.0)	78,996 (8.2)
Mean (SD)	59.5 (6.2)	59.3 (6.3)	59.1 (6.4)	56.1 (3.6)	59.2 (6.4)
Women, n (%)	30,644 (56.3)	250,132 (53.7)	227,360 (53.1)	12,432 (63.1)	520,568 (53.8)
Race/ethnicity, n (%)					
White NH*	40,048 (73.6)	265,226 (56.9)	191,479 (44.7)	3563 (18.1)	500,316 (51.7)
Black NH*	2000 (3.7)	30,740 (6.6)	38,657 (9.0)	7811 (39.6)	79,208 (8.2)
Hispanic	2051 (3.8)	57,690 (12.4)	116,800 (27.3)	7041 (35.7)	183,582 (19.0)
Asian/PI NH*	4152 (7.6)	71,102 (15.3)	42,611 (10.0)	1127 (5.7)	118,992 (12.3)
Other/multiple races NH*	1654 (3.0)	17,755 (3.8)	1718 (0.4)	63 (0.3)	21,190 (2.2)
Unknown/missing	4539 (8.3)	23,355 (5.0)	36,794 (8.6)	96 (0.5)	64,784 (6.7)
Insurance in 2011, n (%)					
Medicaid	4 (0.0)	3626 (0.8)	10,055 (2.3)	1925 (9.8)	15,610 (1.6)
Medicare	15,561 (28.6)	135,825 (29.2)	112,389 (26.3)	2135 (10.8)	265,910 (27.5)
Commercial/private	38,822 (71.3)	326,412 (70.1)	305,312 (71.3)	1329 (6.7)	671,875 (69.4)
Other	57 (0.1)	0 (0.0)	276 (0.1)	461 (2.3)	794 (0.1)
Uninsured	0 (0.0)	0 (0.0)	0 (0.0)	10,137 (51.5)	10,137 (1.0)
Unknown/missing	0 (0.0)	5 (0.0)	27 (0.0)	3714 (18.9)	3746 (0.4)
Comorbidity score in 2011, n (%)					
0	39,391 (72.4)	346,015 (74.3)	286,541 (66.9)	10,798 (54.8)	682,745 (70.5)
1	7493 (13.8)	72,213 (15.5)	71,718 (16.8)	5690 (28.9)	157,114 (16.2)
2	4099 (7.5)	31,238 (6.7)	35,828 (8.4)	1588 (8.1)	72,753 (7.5)
3+	3285 (6.0)	16,382 (3.5)	33,972 (7.9)	1625 (8.2)	55,264 (5.7)
Unknown/missing	176 (0.3)	20 (0.0)	0 (0.0)	0 (0.0)	196 (0.0)
Number of primary care visits in 2011, n (%)					
0	15,426 (28.3)	105,441 (22.6)	102,050 (23.8)	5615 (28.5)	228,532 (23.6)
1	13,777 (25.3)	112,295 (24.1)	91,684 (21.4)	3651 (18.5)	221,407 (22.9)
2	9533 (17.5)	88,202 (18.9)	77,191 (18.0)	3964 (20.1)	178,890 (18.5)
3	6050 (11.1)	57,818 (12.4)	54,583 (12.8)	2941 (14.9)	121,392 (12.5)
4+	9658 (17.7)	102,112 (21.9)	102,551 (24.0)	3530 (17.9)	217,851 (22.5)

*NH Non-Hispanic

DISCUSSION

In this study of nearly one million patients in four large integrated delivery systems, we found that patients with a greater number of PCP visits had higher subsequent rates of CRC screening, as well as higher rates of follow-up colonoscopy after a positive FIT/FOBT. Those with ≥1 PCP visit had nearly double the adjusted odds of completing an initial CRC screening test, and 30 % increased adjusted odds of having a colonoscopy after a positive FIT/FOBT. We expected to find a strong association between visits and CRC screening in the safety net health system (PHHS-UTSW) without a screening outreach program, because cancer screening is traditionally initiated by PCPs. Interestingly, we found a similar correlation in the health plans (KPNC and KPSC) that did extensive population health outreach with distribution of FIT/FOBT kits in multiple care settings not requiring patients to have a traditional ambulatory visit to initiate screening. This was also the case at the site (GH) that did an intermediate amount of outreach, with annual prevention mailings.

There are several possible explanations for these associations. First, offering CRC screening to patients who are not up to date is a standard component of both the annual wellness exam and health care maintenance discussions during chronic disease management visits. Therefore, a PCP visit can directly result in FIT/FOBT or colonoscopy being ordered. Second, since many patients express initial reluctance to have a colonoscopy or do a stool blood test, multiple discussions over time may be necessary for them to complete a test. Therefore, the greater the number of PCP visits, the greater the chance that a declined/non-completed FIT/FOBT or declined/missed colonoscopy is reordered. Third, even though CRC screening can be triggered via population outreach interventions (independent of an office visit), we hypothesize that prior primary care discussions might have primed patients' knowledge about and willingness to complete a mailed FIT/FOBT kit or schedule a colonoscopy in response to a reminder letter. This may be similar to the multiple discussions needed before someone will take action to quit smoking or lose weight.[26,27] Fourth, patients who are more prevention-oriented may be more likely both to have regular PCP visits and to complete cancer screening.

The similar pattern observed for colonoscopy after a positive FOBT/FIT, even in the setting of the large health plans (KPNC, KPSC) that have strong systems in place to automatically follow up positive stool tests (independent of PCP intervention), could have several explanations. It may reflect "priming" by their PCP that a positive FIT/FOBT would require a follow-up colonoscopy. Conversely, patients who are more prevention-oriented may be both more motivated to follow up abnormal screening tests and more engaged in primary care.

Table 2 Rates of CRC Screening Initiation in 2012 by Number of Primary Care Visits in 2011

	Percentage (%) of patients with CRC screening in 2012 (unadjusted OR, 95% CI)*				
	Group Health (n = 54,444)	Kaiser Permanente North (n = 465,868)	Kaiser Permanente South (n = 428,059)	Parkland-UT Southwestern (n = 19,701)	Total (n = 968,072)
Overall	37.0	67.2	52.8	18.3	58.1
Number of PCP visits					
0	29.9	50.7	37.1	7.5	42.2
	Referent	Referent	Referent	Referent	Referent
1	38.3	69.9	54.7	18.9	60.8
	(1.45, 1.38–1.52)	(2.26, 222–2.30)	(2.05, 2.01–2.09)	(2.85, 2.51–3.25)	(2.13, 2.10–2.15)
2	39.6	72.9	57.7	22.5	63.4
	(1.54, 1.46–1.62)	(2.61, 2.56–2.66)	(2.31, 2.27–2.35)	(3.56, 3.14–4.03)	(2.38, 2.35–2.41)
3	40.5	73.6	58.7	25.0	64.1
	(1.59, 1.50–1.70)	(2.70, 2.64–2.76)	(2.41, 2.36–2.46)	(4.10, 3.60–4.66)	(2.44, 2.41–2.48)
4+	41.6	72.6	60.0	24.7	64.5
	(1.67, 1.58–1.76)	(2.57, 2.53–2.62)	(2.55, 2.50–2.59)	(4.02, 3.55–4.56)	(2.49, 2.46–2.52)
Any PCP visit in 2011					
No	29.9	50.7	37.1	7.5	42.2
	Referent	Referent	Referent	Referent	Referent
Yes	39.8	72.0	57.8	22.6	63.1
	(1.55, 1.48–1.61)	(2.50, 2.46–2.53)	(2.32, 2.28–2.35)	(3.59, 3.22–3.99)	(2.34, 2.32–2.36)

PCP primary care provider
*p < 0.0001 for all site-specific and overall comparisons

Previous research in primary care settings[5,6,28] and the general population[4,8] that have examined predictors of CRC screening have focused primarily on "prevalent" screening (having ever been screened) and in settings where colonoscopy (which offers 10 years of protection) was the predominant screening modality. These studies showed that PCP visits[4–8] and physician recommendation were strong predictors of prevalent CRC screening (mostly with colonoscopy).[2,6,8] Our study extends prior work by demonstrating an independent association between prior primary care visits and subsequent "incident" CRC screening, including outreach screening not linked directly to the primary care visit. This work is particularly important in the modern era, where large private and public health systems have extensive CRC screening outreach programs and are promoting annual FIT/FOBT as a dominant strategy. Since an FIT/FOBT testing strategy is effective only if performed annually, a better understanding of the determinants of "incident" (not just "prevalent") CRC screening is critical. Furthermore, no prior study has shown that PCP visits are associated with colonoscopy after a positive FIT/FOBT. This is relevant because health systems using FIT/FOBT outreach strategies often have organized navigation to follow up positive tests.

The diversity and size of our study population is also a strength. We assessed the association between PCP visits and CRC screening among a cohort of nearly one million patients across a broad range of ages and health systems, in contrast to studies only in the elderly or among Medicare or VA

Table 3 Association Between CRC Screening in 2012 and Primary Care Visits in 2011 Using Propensity Score Models*

Number of PCP visits in 2011[†]	Odds ratio (95% CI) of receipt of CRC screening in 2012				
	Group Health (n = 49,756)	Kaiser Permanente North (n = 442,465)	Kaiser Permanente South (n = 391,252)	Parkland-UT Southwestern (n = 15,927)	All sites (n = 899,400)
0	1.00	1.00	1.00	1.00	1.00
	(ref)	(ref)	(ref)	(ref)	(ref)
1	1.22	1.95	1.54	1.60	1.70
	(1.16, 1.28)	(1.91, 1.98)	(1.51, 1.57)	(1.40, 1.81)	(1.68, 1.72)
2	1.29	2.22	1.72	1.97	1.91
	(1.22, 1.36)	(2.18, 2.27)	(1.69, 1.76)	(1.75, 2.22)	(1.89, 1.94)
3	1.34	2.28	1.79	2.27	1.98
	(1.25, 1.44)	(2.23, 2.34)	(1.75, 1.84)	(1.99, 2.58)	(1.95, 2.01)
4+	1.40	2.18	1.89	2.21	1.99
	(1.32, 1.49)	(2.14, 2.22)	(1.85, 1.92)	(1.96, 2.50)	(1.97, 2.02)
Any PCP visit in 2011[†]					
No	1.00	1.00	1.00	1.00	1.00
	(ref)	(ref)	(ref)	(ref)	(ref)
Yes	1.30	2.13	1.72	1.99	1.88
	(1.25, 1.34)	(2.10, 2.15)	(1.70, 1.75)	(1.83, 2.16)	(1.86, 1.89)

PCP primary care provider
*Propensity score analyses used specific models for each site and for the overall cohort
†p < 0.0001 for all site-specific and overall comparisons in covariate-adjusted and propensity-adjusted models

Table 4 Rates of Follow-Up Colonoscopy Within 3 Months of Abnormal FIT/FOBT According to Primary Care Visit History

	Percentage (%) of patients with colonoscopy within 3 months following + FIT/FOBT (unadjusted OR, 95% CI)				
	Group Health (n = 804)	Kaiser Permanente North (n = 10,558)	Kaiser Permanente South (n = 7395)	Parkland-UT Southwestern (n = 105)	Total (n = 18,862)
Overall colonoscopy follow-up rate	69.0	84.1	74.8	43.8	79.6
Number of PC visits					
0	62.4	81.1	70.6	66.7	75.8
	Referent	Referent	Referent	Referent	Referent
1	66.3	84.4	73.7	38.9	79.5
	(1.18, 0.76–1.84)	(1.26, 1.07–1.48)	(1.17, 0.99–1.38)	(0.32, 0.06–1.70)	(1.24, 1.11–1.39)
2	77.9	86.4	75.4	29.6	81.4
	(2.12, 1.29–3.50)	(1.47, 1.24–1.76)	(1.28, 1.08–1.52)	(0.21, 0.04–1.06)	(1.40, 1.25–1.58)
3	68.2	84.7	77.2	57.1	80.7
	(1.29, 0.78–2.15)	(1.28, 1.06–1.56)	(1.42, 1.17–1.71)	(0.67, 0.14–3.22)	(1.34, 1.18–1.52)
4+	71.0	83.9	76.3	39.1	80.2
	(1.48, 0.96–2.27)	(1.21, 1.04–1.42)	(1.35, 1.15–1.57)	(0.32, 0.06–1.62)	(1.29, 1.16–1.44)
p value	<0.05	<0.001	<0.001	<0.20	<0.0001
Any PC visit in 2011					
No	62.4	81.1	70.6	66.7	75.8
	Referent	Referent	Referent	Referent	Referent
Yes	70.8	84.7	75.6	41.7	80.4
	(1.46, 1.03–2.08)	(1.29, 1.13–1.48)	(1.30, 1.13–1.48)	(0.36, 0.08–1.51)	(1.31, 1.20–1.43)
p value	<0.05	<0.001	<0.001	<0.20	<0.0001

beneficiaries.[29] The study population was also diverse with regard to sex, race, ethnicity, and insurance coverage, and cared for in four geographically and administratively distinct regional delivery systems. The associations we report were robust after controlling for the likelihood of having a PCP visit, as well as in secondary analyses that adjusted for other patient factors known to influence screening and primary care utilization such as age, sex, race, ethnicity, education, and insurance.[4,30,31]

Our study is limited by the observational nature of the data available for analysis. The majority of patients had commer-cial or Medicare insurance. However, we found similar asso-ciations in the UTSW-Parkland cohort of low-income patients in a public safety-net health system. Nevertheless, all four sites represented integrated delivery systems, so patterns of care and rates of CRC screening and follow-up of abnormal tests, while not optimal, are likely to be higher than those in less organized settings. There may be some misclassification of individuals identified as not up to date with CRC screening due to limited data prior to health system enrollment and variation in site-specific algorithms used to identify prior screening colonoscopies.[19,20] In addition, we did not have

Table 5 Association Between Follow-Up Colonoscopy After Positive FIT/FOBT and Primary Care Visits Using Propensity Score Models*

	Adjusted odds ratio (95% CI) of receipt of follow-up colonoscopy after positive FIT/FOBT within 3 months			
	Group Health	Kaiser Permanente North	Kaiser Permanente South	All sites
	(n = 783)	(n = 10,389)	(n = 7106)	(n = 18,377)
Number of PCP visits				
0	1.00	1.00	1.00	1.00
	(ref)	(ref)	(ref)	(ref)
1	1.23	1.35	1.10	1.23
	(0.80, 1.90)	(1.15, 1.58)	(0.93, 1.30)	(1.10, 1.37)
2	2.35	1.56	1.18	1.40
	(1.36, 4.03)	(1.31, 1.87)	(0.99, 1.41)	(1.24, 1.58)
3	1.40	1.36	1.33	1.37
	(0.79, 2.46)	(1.11, 1.67)	(1.08, 1.64)	(1.19, 1.58)
4+	1.61	1.29	1.24	1.28
	(1.02, 2.52)	(1.11, 1.50)	(1.06, 1.44)	(1.16, 1.42)
p value	<0.02	<0.0001	<0.01	<0.0001
Any PC visit in 2011				
No	1.00	1.00	1.00	1.00
	(ref)	(ref)	(ref)	(ref)
Yes	1.56	1.38	1.20	1.30
	(1.16, 2.11)	(1.24, 1.53)	(1.08, 1.33)	(1.22, 1.40)
p value	<0.01	<0.0001	<0.001	<0.0001

PCP primary care provider
*Propensity score analyses used specific models for each site and for the overall cohort. Parkland-UT Southwestern was not included in adjusted analyses because of small cell sizes

information about screening test orders, including what ultimately prompted testing (e.g. provider visit, outreach invitation) or test follow-up, so we were unable to trace the mechanism through which primary care improved outcomes. For the two largest sites, KPNC and KPSC, given their extensive outreach to persons not up to date with screening, it should be assumed that the vast majority of their patients were exposed to FIT screening invitations. While our propensity score analyses adjusted for observable differences between individuals who did and did not seek primary care, such patients could have varied in unmeasured ways. We also do not know the reason for the PCP visit or whether CRC screening was explicitly discussed during the visit.

From a policy perspective, our findings suggest that primary care visits may be an important mechanism for engaging patients in cancer screening, even in settings with structured outreach programs. This may reflect the diminishing impact of outreach as patients are exposed to an increasing number of mailings and phone calls from provider organizations seeking to close preventive care gaps. In order to ensure success, it will be important for outreach programs to seek opportunities to reference and leverage existing primary care relationships, rather than replacing them. This may be especially useful for processes such as CRC screening, for which there are numerous patient and system barriers to completion, such that multiple reminders, encouragement, and facilitating steps are often needed. PCPs working in health systems that have outreach programs should continue to discuss evidence-based cancer screening with their patients, and should not rely solely on population health programs to close preventive care gaps. For health systems where baseline CRC screening and follow-up rates are low, FIT outreach programs followed by intensive navigation for positive tests may also be needed to improve screening rates, and represent an important area for future study.

In conclusion, even among organized, integrated delivery systems with insured patients and widespread population-based CRC screening outreach and follow-up programs that do not require a face-to-face visit, engagement in primary care was associated with higher rates of incident CRC screening and follow-up colonoscopy after a positive FIT/FOBT. Thus, in this brave new world of virtual care, an old-fashioned primary care visit still appears to be important in ensuring successful cancer screening.

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Compliance with ethical standards:

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