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Predictors of Colorectal Cancer Screening Prior to Implementation of a Large Pragmatic Trial in Federally Qualified Health Centers

Amanda F. Petrik[1] · Thuy Le[2] · Erin Keast[1] · Jennifer Rivelli[1] · Keshia Bigler[4] ·
Beverly Green[3] · William M. Vollmer[1] · Gloria Coronado[1]

Abstract Colorectal cancer screening can prevent cancer deaths. Federally qualified health centers serve a unique patient population that often is not screened. Knowing who in this environment is getting screened via fecal testing and via colonoscopy can assist in tailoring intervention to raise rates of colorectal cancer screening. We examined patient-level and neighborhood-level characteristics associated with being up to date with colorectal cancer screening guidelines. We also examined associations between these factors and being screened with a fecal test. We observed an increase in colorectal cancer screening rates from 2010 to 2015. Adjusted analyses revealed that the following factors were significantly associated with colorectal cancer screening: aged 65 or older, having any type of insurance, previous outpatient visits, and current or other preventive screenings. Among adults aged 50–75 who were up to date with colorectal cancer screening, factors associated with *use of fecal testing*, as opposed to colonoscopy, were: being younger, speaking a non-English language, being uninsured, having prior office visits, and having had a flu shot in past year. Our findings may inform clinic-based effort to raise rates of colorectal cancer screening, especially in the

community clinic setting. Trial Registration: ClinicalTrials.gov, NCT01742065.

Introduction

Colorectal cancer (CRC) is the second leading cause of cancer death. An estimated 135,000 individuals will be diagnosed with CRC, and 50,000 will die from CRC in 2017 [1]. Screening can play an important role in reducing burden from this disease [2–4] because early detection and treatment can prevent unnecessary cancer death and prolong the lives of patients when cancers are found at earlier stages. A major effort is underway to increase CRC screening in the United States [5]. The American Cancer Society and the National Colorectal Cancer Roundtable have worked with more than 1000 organizations to make the "80% by 2018" pledge [5]. This is a movement in which organizations commit to working toward the shared goal of screening 80% of Americans for colorectal cancer by 2018. Underserved populations, which historically have had lower screening rates, are a major target of these increased screening efforts.

Currently, the United States Preventive Services Task Force (USPSTF) strongly recommends (Grade A) that adults aged 50–75 complete regular CRC screening. The most commonly used CRC screening tests in the US are colonoscopy (recommended every 10 years) and fecal testing with high sensitivity guaiac or fecal immunochemical (FIT) test (recommended annually). Patient preferences for these tests may be driven by access (availability, insurance coverage), and social factors (costs,

✉ Amanda F. Petrik
Amanda.f.petrik@kpchr.org

1   The Center for Health Research, Kaiser Permanente Northwest, 3800 North Interstate Avenue, Portland, OR 97227, USA

2   OCHIN, 1881 SW Naito Pkwy, Portland, OR 97201, USA

3   Kaiser Permanente Washington, Research Institute, 1730 Minor Ave #1600, Seattle, WA 98101, USA

4   PacificSource Community Solutions, 2965 North East Connors Avenue, Bend, OR 97701, USA

cultural norms) as well as by other pros and cons of each modality (invasiveness, frequency of screening).

Access and social factors may also account for lower uptake of CRC screening tests among patients who receive care at federally qualified health centers (FQHCs) [6–8]. Such individuals are largely uninsured or on Medicaid, predominantly non-white, and often have low education and income. In order to reach the 80% screening target by 2018, interventions that directly target these priority populations are needed.

The Strategies and Opportunities to Stop Colorectal Cancer in Priority Populations (STOP CRC) study is a large pragmatic trial that tests the implementation of health care system-based approaches to improve CRC screening rates in FQHCs through the use of FIT testing [9]. STOP CRC uses electronic health record (EHR) resources to optimize guideline-based screening in clinics whose patient populations have disproportionately low CRC screening rates [9]. Patients at those clinics who were not current for CRC screening were targeted with interventions designed to increase screening rates. Interventions included an introductory letter, a mailed fecal test, a reminder letter, and a Plan-Do-Study-Act (PDSA) cycle to further increase screening rates.

Prior research has indicated that factors including higher education, higher income, consistent health care patterns, male gender, and having insurance of any kind predict the likelihood of obtaining CRC screening [10–14]. However, additional information on individual- and community-level factors that predict screening rates is needed in order to tailor behavioral interventions to specific communities to increase access to CRC screening [11].

Social determinants of health (SDH) are non-medical factors that influence disease risks and outcomes [15, 16]. SDH include community-level factors that reflect living conditions and social context, as well as individual-level factors such as race, ethnicity, and household income. If documented, discussed, and addressed, SDH data can be used to facilitate disease prevention. Patient-level SDH data can help providers make targeted recommendations that are sensitive to a patient's specific circumstances. Community-level SDH data can be used to identify social and environmental barriers to screening, which can then be addressed through targeted interventions [17]. Understanding SDH in the context of analyzing health outcomes is important when designing programs that can improve health outcomes [18].

Using data collected as part of the STOP CRC study, we identified individual- and community-level characteristics that predicted whether or not patients were up-to-date with CRC screening recommendations. We also identified characteristics that predicted mode of screening among screened patients. Identifying these characteristics will allow for better targeting of screening programs and outreach efforts.

Methods

Design of the STOP CRC project has been described elsewhere [9]. Data for these analysis consist of 31,287 eligible patients between the ages of 50–74 who were seen for an office visit at a participating community health center between 1/1/2013 and 12/31/2013. Patients were excluded if they had history of colorectal cancer, inflammatory colitis, end stage renal disease, or a total colectomy. Insurance coverage varied: 30.9% of participants were uninsured, 26.2% were on Medicaid, 27.4% were on Medicare, and 15.4% had commercial health insurance.

Data Sources

Screening information and individual-level variables were obtained from electronic health record (EHR) data from 26 Community Health Center (CHC) sites in Oregon and California that were part of the STOP CRC study. All participating CHCs were part of OCHIN, a nonprofit health care controlled network that provides centrally hosted EHR services to more than 460 CHCs in 18 states. Community-level variables for each CHC were obtained from the ADVANCE Clinical Data Research Network [19]. Community-level variables were collected at the tract level for all variables except for Emergency Department (ED) visits per 1000 enrollees, this was collected at the county level.

Variables

Completion of a FOBT/FIT or colonoscopy was determined through lab results and health maintenance updates in the EHR. CRC screening compliance was defined as not having received fecal testing in the past 12 months, flexible sigmoidoscopy within the past 5 years, or normal colonoscopy within the last 10 years as of 1/1/2014. Among those who were compliant, patients were categorized into those who used FOBT/FIT (including FOBT/FIT followed by a confirmatory colonoscopy) versus colonoscopy alone.

Independent variables included data at the following levels: (1) patient (age, gender, race, ethnicity, language, household income); (2) encounter (patient's insurance status, number of office visits in the past year, types of chronic health conditions, and other screenings); and (3) community (GINI coefficient as a measure of income inequality, percent of unemployment, percent of persons with a bachelor's degree or higher, population density, 1-mile access to a supermarket or large grocery store, urban/rural designation, and number of ED visits per 1000 enrollees).

Analysis

We used a generalized estimating equation (GEE) logistic regression model to assess the relationship between the variables of interest and screening compliance. The logistic regression test was used to calculate p-values for univariate models and the score tests was used to calculate p-values for multivariate models. This method accounts for multiple visits nested within patients. We used the same method to analyze factors associated with FOBT/FIT use among those who were up to date with screening. Variables that were significant at the 0.20 level in univariate analyses were included in an initial multivariate model, then reverse stepwise selection was used to remove variables until all variables in the model were significant at $p < 0.05$. Next, adjusted models were created that accounted for correlation within clinics: assuming an independent correlation structure; we applied a robust sandwich variance estimator to account for possible model misspecification. Analyses were conducted using PROC GENMOD in SAS version 9.4 (SAS Institute Inc., Cary NC).

Results

Across 26 clinics, we identified 31,287 patients with at least one clinic visit in 2013. Of them, 10,381 patients were CRC screening compliant on 1/1/2014. The proportion of patients up-to-date with screening in a year increased from 17.7% in 2010 to 46.8% in 2015, across all eligible patients (Fig. 1). The proportion of all patients who were up-to-date due to FIT/FOBT increased from 11.3% in 2010 to 28.4% in 2015, and the proportion who were up-to-date due to colonoscopy increased from 7.3 to 21.0%. in the same period. Of the 10,381 patients who were up-to-date in their CRC screening, 42.7% were up-to-date because of prior fecal testing (including patients with a colonoscopy

as follow-up to a positive fecal test) as opposed to colonoscopy only.
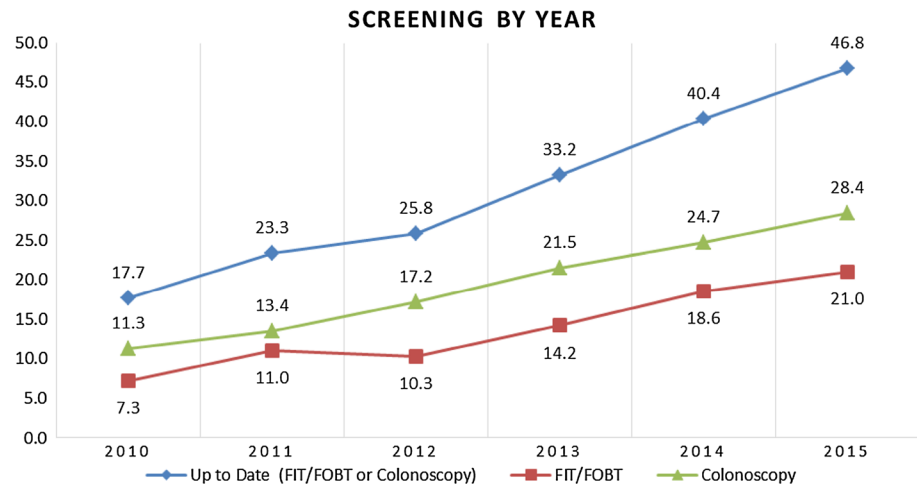
Factors associated with screening compliance are described in Table 1. Age was the only individual-level characteristic that significantly predicted screening compliance in the adjusted model: older adults (ages 65–74) were significantly more likely to be compliant than younger adults (ages 50–64). Encounter-level characteristics that predicted screening compliance included insurance status (rates ranged from 22.5% for uninsured patients to 39.3% for patients with Medicare), number of office visits in the past year (rates ranged from 21.4% for those with one visit to 45.2% for those with six or more visits), and having received prior preventive care, such as Pap testing, mammography, and flu shots. No community-level variables persisted in the adjusted models.

Factors associated with FOBT/FIT use in the screening compliant group are described in Table 2. Individual-level characteristics that predicted screening by FIT/FOBT included age (44.5% for those aged 50–64 vs. 37.6% for those aged 65–75) and language (71.9% for Spanish speakers vs. 37.3% for English speakers). Encounter-level characteristics that predicted screening by FIT/FOBT included insurance status (ranging from 28.5% for those with commercial insurance to 65.5% for the uninsured), number of office visits in the past year (ranging from 37.8% for 1 office visit to 43.1% for 6+ office visits), and not receiving a flu shot in the last year (44.3% vs. 40.6% who did receive a shot). Again, no community-level variables persisted in the adjusted models.

Discussion

While CRC screening rates are increasing, more progress is needed to eliminate disparities and further reduce cancer burden. We sought to understand screening patterns in

Fig. 1 Screening by year overall, by FIT/FOBT, and by colonoscopy

Table 1 Factors associated with being up-to-date for CRC screening at baseline by either FIT/FOBT or colonoscopy

	Total	% up to date	Unadjusted (SE not cluster) Sig	Adjusted[a]
Age				
50–64	24558	31.5	<.0001	0.0001
65–74	6729	39.5		
Gender				
Female	17825	33.5	0.1618	0.0014
Male	13462	32.8		
Ethnicity				
Hispanic	3685	29.8	<.0001	
Non-Hispanic	26849	33.9		
Missing	753	22.4		
Language				
English	25649	33.1	<.0001	
Spanish	2853	29.3		
Other	2448	40.6		
Missing	337	20.8		
Race				
White	26581	32.4	<.0001	
African American	1540	37.0		
Asian American/Pacific Islander	1654	45.0		
Native American	249	32.5		
Mixed race/other	204	25.0		
Unknown/missing	1059	29.6		
Insurance status				
Medicaid	8212	36.6	<.0001	0.0021
Medicare	8584	39.3		
Uninsured	9683	22.5		
Commercial	4808	37.9		
Household income				
<14,999	13865	32.4	<.0001	
15,000-29,000	6039	30.5		
30,000–44,999	1590	35.2		
45,000–59,999	520	47.1		
>60,000	772	53.1		
Unknown	8501	33.3		
Number of office visits in past year				
1	7810	21.4	<.0001	0.0004
2–5	17003	34.0		
6+	6474	45.2		
Chronic health conditions				
Diabetes (type II)	2970	33.0	0.8555	
No	28317	33.2		
Depression	6754	35.4	<.0001	
No	24533	32.6		
Substance Abuse	373	34.3	0.6400	
No	30914	33.2		
Other screenings				
Pap in past 3 years (50–64)	8448	39.4	<.0001	0.0002
No	9377	28.2		

Table 1 (continued)

	Total	% up to date	Unadjusted (SE not cluster) Sig	Adjusted[a]
Mammograms in past 2 years	5348	48.4	<.0001	0.0017
No	12477	27.1		
Flu shots in past year Y/N	10156	44.2	<.0001	<.0001
No	21131	27.9		
Health center				
1	4267	36.9	<.0001	
2	6618	50.0		
3	3070	14.3		
4	2007	11.9		
5	2715	28.5		
6	7543	34.7		
7	4002	31.1		
8	1065	16.8		
Community vital signs				
GINI income inequality ratio				
25th quartile	4867	32.9	<.0001	
50% quartile	8195	35.6		
75% quartile	4371	33.3		
Missing	13854	31.8		
Unemployment				
25th quartile	7852	37.9	<.0001	
50% quartile	15305	31.8		
75% quartile	7735	31.2		
Missing	395	30.9		
College grad				
25th quartile	7886	27.8	<.0001	
50% quartile	15215	35.4		
75% quartile	7795	34.4		
Missing	391	30.7		
Pop density				
25th quartile	7764	31.5	<.0001	
50% quartile	15391	33.3		
75% quartile	7744	34.9		
Missing	388	30.7		
1 mile access				
Yes	23964	33.3	0.5183	
No	7323	32.9		
Urban Rural				
Rural	7233	31.4	<.0001	
Urban	7194	42.7		
Cluster	16860	29.9		
ED visits				
25th quartile	10151	22.3	<.0001	
50% quartile	13009	33.8		
75% quartile	8006	46.1		
Missing	121	26.4		

[a]Final model accounts for correlation within clinic, assuming an independent correlation structure. Model is adjusted for age group, gender, insurance status, office visits in the past year, paps in past 3 years, mammograms in past 2 years, and flu shots in past year

Table 2 Factors associated with FOBT/FIT compared to colonoscopy use among those up-to-date for CRC screening

		Total up to date	% Screened by fit	Unadjusted (SE not cluster) Sig	Adjusted[a]
Age					
50–64		7726	44.5	0.0457	
65–74		2655	37.6		
Gender					
Female		5972	42.6	0.2609	
Male		4409	42.9		
Ethnicity					
Hispanic		1098	63.7	<.0001	
Non-Hispanic		9114	40.3		
Missing		169	36.7		
Language					
English		8480	37.3	<.0001	0.0035
Spanish		837	71.9		
Other		994	65.1		
Missing		70	30.0		
Race					
White		8622	40.5	<.0001	
African American		570	41.1		
Asian American/Pacific Islander		744	60.6		
Native American		81	44.4		
Mixed race/other		51	31.4		
Unknown/missing		313	66.8		
Insurance status					
Medicaid		3009	44.4	<.0001	0.0011
Medicare		3370	34.3		
Uninsured		2178	65.5		
Commercial		1824	28.5		
Household income					
<14,999		4493	46.0	<.0001	
15,000–29,000		1840	47.9		
30,000–44,999		559	39.7		
45,000–59,999		245	30.6		
>60,000		410	22.4		
Unknown		2834	38.8		
Number of office visits in past year					
1		1671	37.8	<.0001	0.0497
2–5		5781	44.0		
6+		2929	43.1		
Chronic health conditions					
Diabetes (type II)	981		51.4	<.0001	
No	9400		41.8		
Depression	2388		40.5	<.0001	
No	7993		43.4		
Substance abuse	128		46.1	0.9825	
No	10253		42.7		
Other screenings					
Pap in past 3 years (50–64)		3330	44.8	0.0042	
No		2642	39.8		

Table 2 (continued)

	Total up to date	% Screened by fit	Unadjusted (SE not cluster) Sig	Adjusted[a]
Mammograms in past 2 years (50–74)	2587	36.1	<.0001	
No	3385	47.6		
Flu Shots in past YearY/N	4485	40.6	<.0001	0.0160
No	5896	44.3		
Health center				
1	1576	27.3	<.0001	
2	3312	30.5		
3	438	48.2		
4	238	79.4		
5	773	51.0		
6	2619	58.9		
7	1246	47.1		
8	179	40.8		
Community vital signs				
GINI income inequality ratio				
25th quartile	1602	45.9	<.0001	
50% quartile	2918	38.0		
75% quartile	1457	40.9		
Missing	4404	45.3		
Unemployment				
25th quartile	2978	36.0	<.0001	
50% quartile	4864	45.9		
75% quartile	2417	44.5		
Missing	122	45.9		
College grad				
25th quartile	2190	48.5	<.0001	
50% quartile	5388	42.3		
75% quartile	2683	38.7		
Missing	120	46.7		
Pop density				
25th quartile	2444	38.1	<.0001	
50% quartile	5118	42.1		
75% quartile	2700	47.9		
Missing	119	47.1		
1 mile access				
Yes	7974	43.8	<.0001	
No	2407	39.2		
Urban Rural				
Rural	2274	36.4	<.0001	
Urban	3071	35.8		
Cluster	5036	49.9		
ED visits				
25th quartile	2265	45.2	<.0001	
50% quartile	4392	49.2		
75% quartile	3692	33.6		
Missing	32	46.9		

[a]Final model accounts for correlation within clinic, assuming an independent correlation structure. Model is adjusted for age group, language, insurance status, number of office visits in the past year, and flu shots in past year

community clinics to better address barriers and challenges to increasing CRC screening. We identified several factors associated with screening compliance, and with use of FIT/FOBT in screening, for CHC patients in Oregon and California.

Several encounter-level factors (insurance status, frequency of office visits, and prior screenings) were associated with being up-to-date with screenings. Knowledge of these associations can lead to clinical practices that target the specific needs of these patients. For example, knowing that uninsured patients are less likely to be screened opens an opportunity for providers to address benefits and barriers to CRC screening during an encounter. Further, understanding that having more office visits increases the likelihood of screening underscores the need to address CRC screening during a single office visit with patients who are not high utilizers, or to find other means, such as mailed FIT test programs, to address screening outside of office visits. Finally, given that patients who have other preventive care/screenings are more likely to have CRC screening, systems can specifically target patients without other preventive care in screening programs [19].

The use of FIT/FOBT has been shown to increase screening among underscreened populations [20]. In this study, we found higher rates of FIT/FOBT use, relative to colonoscopy, among patients who were younger, uninsured, and Spanish-speaking. Screening by FIT can be more accessible for patient's due to the simplicity of the test and the removal of barriers that are common to colonoscopy completion (e.g., missed work, necessary bowel preparation). However, attention needs to be paid to ensure that colonoscopies following an abnormal FIT result are being completed [21].

The predictors of screening in the FQHC population are important for communities that are trying to increase screening among priority populations. Examining community vital signs can help us understand unscreened populations. Although none of our community level variables remained in the adjusted models, social determinants of health and community-level data are an important part of the story, but additional exploration is required to further understand screening deficiencies to increase screening.

Strengths of this study include our ability to describe trends in CRC screening rates over several years in a large FQHC patient population, and our ability to assess community-related factors alongside encounter-level and individual-level factors. One limitation was that we were unable to include or describe patients without a recent visit to the clinic. Based on the patterns seen here, we could expect patients who did not have a recent visit to have even lower screening rates than those seen here. Additionally, we assessed screening from the medical record, and not from self-report. Because colonoscopies are not always adequately reported in the EHR [22], we are likely underestimating screening rates in our sample. However, we would not expect reporting errors to differ by the factors of interest here, so the patterns we report are unlikely to be affected by this underestimation. By focusing our analysis on FQHCs, our findings provide insight into screening patterns amongst at risk populations, and are of particular relevance to heath care providers serving those populations. However, findings may not be generalizable to health care settings serving different patient populations.

We found that the most socially disadvantaged groups, specifically the uninsured, unemployed, and non-English speakers were more likely to complete fecal testing than colonoscopy. This suggests that programs that encourage FIT/FOBT use amongst these populations may be able to gain traction where efforts to encourage colonoscopies may not, and thus have the potential to dramatically reduce disparities in CRC screening. In general, targeting screening efforts to the specific needs and barriers faced by the FQHC population may increase screening rates, decrease disparities, and ultimately improve CRC outcomes.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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