

NARRATIVE REVIEW

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What Multilevel Interventions Do We Need to Increase the Colorectal Cancer Screening Rate to 80%?

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Screening reduces colorectal cancer mortality; however, this remains the second leading cause of cancer deaths in the United States and adherence to colorectal cancer screening falls far short of the National Colorectal Cancer Roundtable goal of 80%. Numerous studies have examined the effectiveness of interventions to increase colorectal cancer screening uptake. *Outreach* is the active dissemination of screening outside of the primary care setting, such as mailing fecal blood tests to individuals' homes. *Navigation* uses trained personnel to assist individuals through the screening process. *Patient education* may take the form of brochures, videos, or websites. *Provider education* can include feedback about screening rates of patient panels. *Reminders* to healthcare providers can be provided by dashboards of patients due for screening. *Financial incentives* provide monetary compensation to individuals when they complete screening tests, either as fixed payments or via a lottery. *Individual preference for specific screening strategies* has also been examined in several trials, with a choice of screening strategies yielding higher adherence than recommendation of a single strategy.

Keywords: Mass Screening; Colorectal Cancer; Healthcare Disparities; Implementation Science.

The most effective interventions to increase screening include *outreach* with mailed or in-person distributed fecal blood tests; and *patient navigation*. Moreover, multicomponent interventions may increase uptake more than single component interventions, especially interventions that target several levels of the cancer screening continuum including the *patient*; *providers and healthcare delivery teams*; *family and social supports*; and the *healthcare environment*. The financial, political and cultural barriers to screening must be overcome and a national colorectal cancer screening program should be adopted to improve the health of our population.

Despite solid evidence that multiple screening strategies can reduce colorectal cancer (CRC) mortality, CRC remains the second leading cause of cancer-related deaths in the United States.¹ Randomized trials demonstrate the efficacy of screening fecal blood testing (FBT)

and flexible sigmoidoscopy to reduce cancer deaths and retrospective studies illustrate reductions in cancer incidence and mortality using colonoscopy screening. The National Colorectal Cancer Roundtable, an organization cofounded by the American Cancer Society and the Centers for Disease Control and Prevention launched 80% by 2018 with a goal to regularly screen at least 80% of recommended adults for CRC.² However, U.S. population adherence to CRC screening tests remains far below this goal, with 67% of eligible adults participating in CRC screening and 40% of medically underserved populations served by federally qualified health care centers.^{3–5}

Conceptual Models for Cancer Screening

To fully realize the mortality benefit that screening confers, there has been a surge of studies over the past decade testing interventions intended to increase CRC screening completion. CRC screening is a multistep process that requires communication and coordination across multiple levels (individual, clinical team, health care institution, community setting, etc.) of the health care system. Yet, the majority of clinical studies address one barrier at one level of the care process or multiple barriers at the same level of care (ie, multicomponent interventions).^{6–9} These studies, while expanding our understanding of screening behavior, have not led to sustainable increases in CRC screening participation. Therefore, to move the needle closer to the 80% CRC screening goal, multilevel evidence-based interventions are needed. Taplin and Rogers described the multiple levels of influence on the cancer care continuum (Figure 1).¹⁰ This model highlights the potential targets for which interventions could be developed to improve

Abbreviations used in this paper: CI, confidence interval; CRC, colorectal cancer; FBT, fecal blood test; RR, relative risk.

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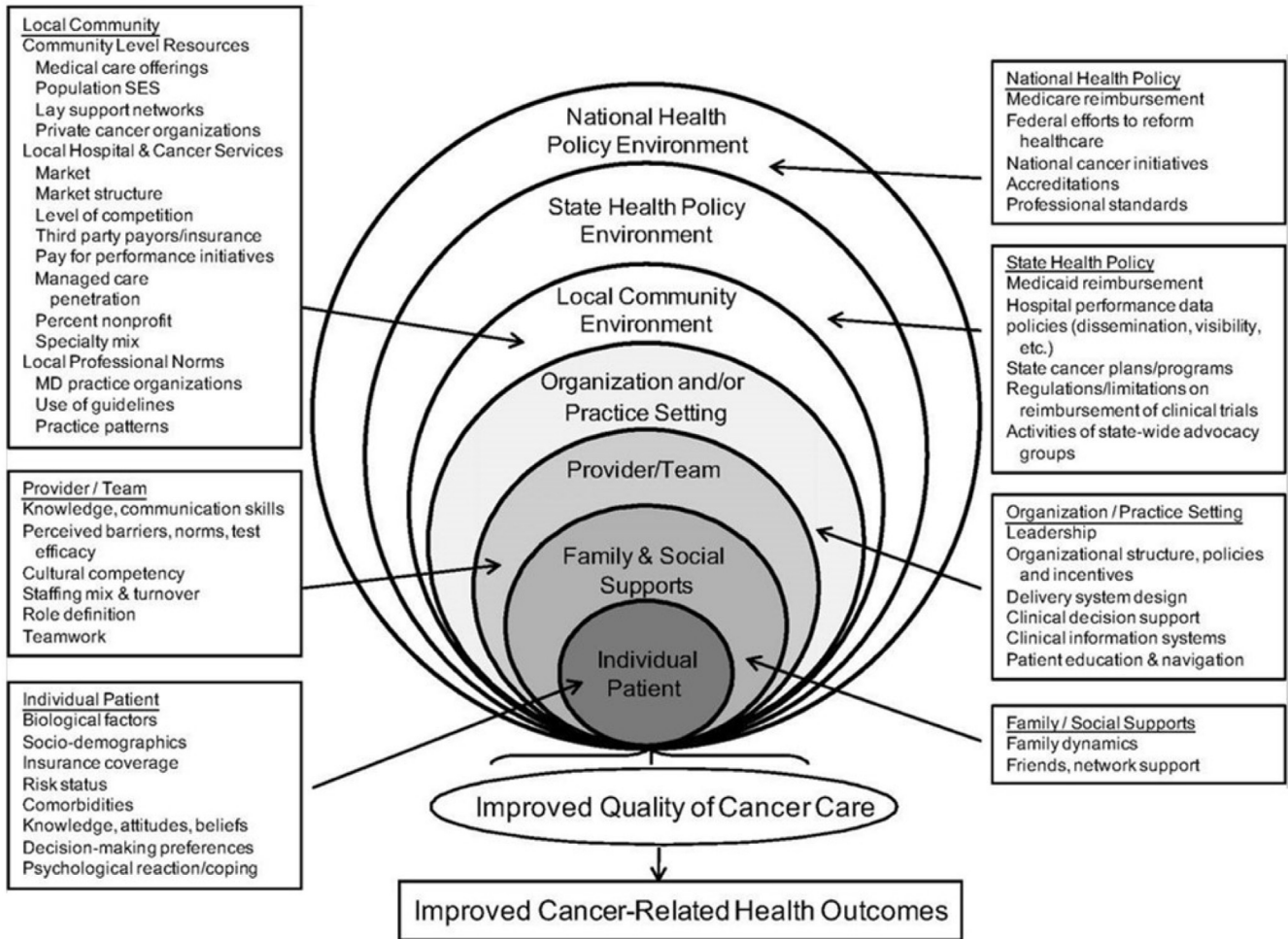


Figure 1. Conceptual model of multilevel cancer screening. SES, socioeconomic status.

clinical outcomes, starting with the patient and expanding to the provider, family and social supports, local community environment, state environment, and national environment. Individual patient factors that influence uptake of cancer screening include attitudes and beliefs, sociodemographic characteristics, and individual risk factors (biological and behavioral). Providers and health care delivery teams rely on skills and attitudes, and the overall functioning of the provider team to optimize cancer screening. Family and social supports are necessary to conduct screening, such as providing escort of patients undergoing sedated colonoscopy, and offer human and capital resources to complete screening. The health care environments at the local community, state, and national levels dictate social and professional norms as well as health care service reimbursement policies (eg, elimination of cost-sharing for CRC screening), and could offer national screening programs. This model illustrates the different levels at which interventions could act to increase screening participation but does not specify the mechanisms through which interventions could synergistically lead to the outcome of interest.

In addition to general models of cancer care, there are cancer-specific conceptual models that may explain the main

causes of nonadherence CRC screening and identify potential targets for interventions to increase screening. One conceptual model has been proposed by Tiro et al (Figure 2).¹¹ This CRC screening process model is based on the general continuum of cancer care and identifies the 4 types of care needed to complete the screening process: risk assessment, detection, diagnostic evaluation, and treatment. The 3 transitions necessary to move between types of care include (1) the initial screening test, (2) follow-up of abnormal screening tests with colonoscopy (if colonoscopy was not the initial screening test), and (3) referral for treatment if the follow-up colonoscopy identifies an early cancer. This model identifies potential targets for interventions to increase adherence to screening such as risk assessment (average risk vs elevated risk), screening performance, follow-up colonoscopy for abnormal screening tests, return to interval-appropriate screening for negative screening tests, and referral for treatment for detection of CRC.

Interventions to Increase CRC Screening

There have been a number of recent systematic reviews and meta-analyses examining the effectiveness of interventions to increase CRC screening. It should be

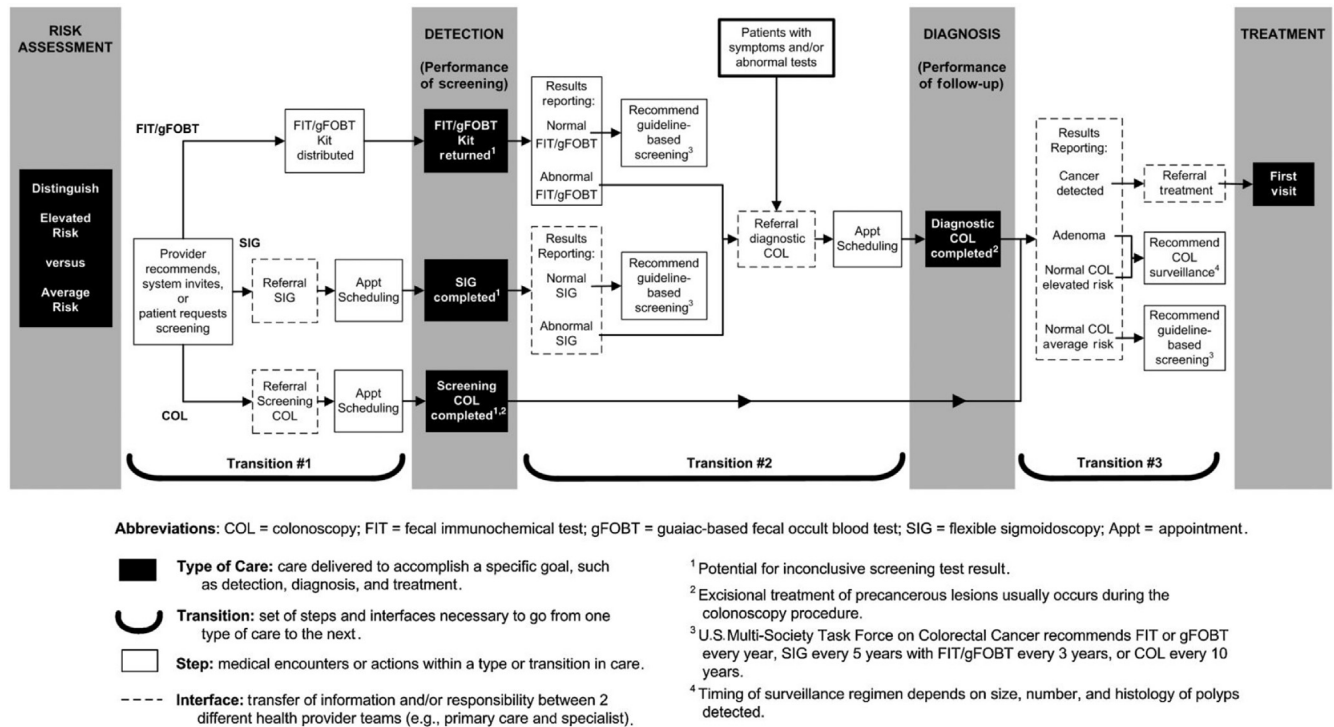


Figure 2. PROSPR (Population-based Research to Optimize the Screening Process) CRC screening process model. COL, colonoscopy; FIT, fecal immunochemical test; gFOBT, guaiac-based fecal occult blood test; SIG, flexible sigmoidoscopy.

noted that these studies focus on individuals 50 years of age and older, which is an important caveat in light of the American Cancer Society recommendations to begin screening at 45 years of age in individuals at average risk for development of CRC.¹² One included randomized clinical trials of interventions designed to improve screening test completion in individuals at average risk for development of CRC using either FBT or colonoscopy.⁷ Others focused on interventions to increase uptake of FBT only.^{6,8,9} Interventions to increase initial screening test uptake included outreach, navigation, education of patients or providers, reminders, and financial incentives. Outreach is the active dissemination of screening outside of the primary care setting, such as distribution of FBTs by either mailing kits or distributing during a nonclinic health care encounter such as influenza vaccination. Outreach could also include mailing, texting, or calling patients at home to schedule screening procedures such as colonoscopy or sigmoidoscopy. Navigation is the process by which trained personnel (either nurses, laypeople, or peers) assist the individual through the process of screening including obtaining the test, performing the test, obtaining test results, and obtaining follow up colonoscopy if the screening test is positive. Navigators may not only be language but also culturally concordant with the patient, which can address the various cultural and social barriers to screening completion in addition to the access and logistical barriers to screening. Patient education may take the form of brochures, videos, and websites and may include features such as motivational interviewing

(directed, patient-centered counseling designed to enable behavior change through resolving ambivalence), cancer risk stratification, or decision aids to identify a patient’s preferred screening strategy. Physician–provider education is sometimes called academic detailing and can include feedback about screening rates of their patient panel including comparison with their peers. Reminders to health care providers (also termed *inreach*) can be provided by pop-up warnings or dashboards of patients due for screening that are embedded in the electronic health record. Financial incentives have been examined in multiple randomized studies in which patients are given monetary incentives to complete screening tests, either as fixed payments or via a lottery such as a 1 in 10 chance to win \$50 after undergoing screening. Individual preference for specific screening strategies has also been examined in several trials, with a choice of screening strategies (annual FBT or colonoscopy) being more effective than recommending a single strategy.¹³

The most effective interventions to increase initiation of screening include *outreach* with mailed or in-person distributed fecal blood tests that more than doubles the rate of screening uptake (relative risk [RR], 2.26; 95% confidence interval [CI], 1.81–2.81) and patient navigation (RR, 2.01; 95% CI, 1.64–2.46) compared with usual care.⁷ The absolute increase in screening (median efficacy) of mailed FBT outreach compared with control subjects is 21.5% (interquartile range, 13.6%–29.0%).⁸ The results for outreach revealed consistent benefit among the different trials; however, incomplete

implementation such as failure to mail FIT kits or not providing introductory letters or reminders is associated with lower net benefit.¹⁴ Moreover, outreach appears to provide benefit across different patient populations irrespective of insurance status, sex, or race and ethnicity, type of FBT (fecal immunochemical test or guaiac-based FBT) or use of other interventions. Navigation likewise provides consistent benefit in increasing screening uptake irrespective of whether navigation is delivered by health care professionals or lay or peer navigators. Finally, navigation combined with other cointerventions further increases screening uptake.⁷

Other interventions significantly increased screening rates but more modestly. Patient education or patient reminders yielded a 20% increase in screening rates in one meta-analysis⁷ with a median 4.1% (interquartile range, 3.6%–6.7%) increase in screening compared with usual care in another meta-analysis.⁸ Patient reminders to undergo FBT using phone calls or letters have not been demonstrated to increase screening over outreach with FBT.^{15,16}

Surprisingly, offering financial incentives to individuals to encourage screening does not consistently increase adherence. In one study, the addition of a \$5 or \$10 incentive with a mailed FBT did not improve screening compared with a mailed FBT alone.¹⁷ In another, a \$10 incentive included with the mailing, a \$10 incentive conditional on FIT completion, or a conditional lottery with a 1 in 10 chance of winning \$100 after FIT completion failed to increase adherence compared with no incentive added to a mailed FIT.¹⁸ A similar study demonstrated that the addition of \$5 or \$10 incentive to a mailed FIT failed to increase screening completion for any of the 3 years of the study duration.¹⁹

Other studies highlight the potential for increased adherence using financial incentives. A 1 in 10 chance of receiving \$50 increased rates of FBT completion but a \$5 fixed payment, or entry into a raffle for \$500, did not.²⁰ A mailed FIT plus a \$10 reward for screening completion, or mailed FIT plus entry into a lottery for a 1 in 10 chance of receiving \$50 on screening completion achieved a higher proportion of FIT return compared with a mailed FIT alone.²¹ However, when colonoscopy adherence was included with FIT, overall CRC screening was not significantly improved with either financial incentive. Another study reported that sending an email with the phone number to schedule a colonoscopy with a \$100 incentive to undergo colonoscopy increased screening compared with the email alone, although the absolute increase in screening was less than 5%.²² The differences in outcomes among studies examining the effect of financial incentives in increasing screening uptake may be due to differences in study population, cointerventions, or the degree to which the interventions were successfully implemented. These factors are difficult to discern and thus the reasons for the variable effect of financial incentives remain unknown.

Interestingly, interventions focused on the primary care provider have been shown to only marginally increase screening rates.⁷ Academic detailing generally increased screening rates by 10%.⁷ Distributing a list to providers of patients in their panel who were not up to date with screening resulted in 24.8% adherence compared with 21.7% of patients whose primary care providers were only provided generic rates of CRC screening in their geographic region (between-group difference, 3.1%; 95% CI, 1.3%–5.0%). This difference was statistically significant, as was the difference between distributing the patient panel list and the 20.7% adherence among patients of providers in the “usual care” arm who were not given reminders (patient lists vs usual care difference, 4.2%; 95% CI, 2.3%–6.2%).²³ However, the difference in screening rates between patients of providers given general screening rates and usual care was not significant. In a different study, patients of providers randomized to receive electronic alerts reminding them to discuss CRC screening did not perform FBT at a rate greater than patients in control clinics whose providers did not receive electronic alerts.²⁴

Finally, the manner in which screening is offered seems to be associated with uptake: offering FBT alone (67.2%) or a choice of FBT or colonoscopy (68.8%) significantly increased screening adherence compared with offering colonoscopy alone (58.1%).²⁵ Increased uptake with FBT (58.8%) compared with colonoscopy (42.4%) was also seen in a randomized trial of outreach in an urban, racially and ethnically diverse environment, both being superior to usual care (29.6%).²⁶

Multicomponent Interventions to Increase CRC Screening

Combinations of interventions that address multiple barriers to screening uptake are more effective than single-component strategies (RR, 1.92 [95% CI, 1.69–2.19] vs RR, 1.43 [95% CI, 1.19–1.71]). **Table 1** highlights studies of multicomponent interventions, differences in CRC screening strategies, the levels of the Cancer Care Continuum that were targeted, and the specific interventions used in each study. Most studies have a “usual care” arm in which standard practice is used as a background to which various interventions are compared. Usual care generally consists of CRC screening recommendations provided by the primary care provider to patients during a routine clinic follow-up visit. Some studies have a single intervention arm in which multiple components are compared with usual care (patient education, provider education, navigation, outreach, etc.), whereas others have multiple arms in which different interventions are tested, most commonly adding components in successive arms (eg, outreach alone, outreach plus education, outreach plus education plus navigation) to determine whether the addition of components

Table 1. Summary of Single-Component Interventions to Increase Colorectal Cancer Screening⁶⁻⁹

Intervention	Definition	Effectiveness
Outreach	Disseminating screening outside the primary care setting	OR, 2.26 (95% CI, 1.81–2.81)
Navigation	Assisting individuals to complete the screening process	OR, 2.01 (95% CI, 1.64–2.46)
Patient education	Delivering screening information via multimedia or in-person modalities	OR, 1.20 (95% CI, 1.06–1.36)
Academic detailing	Educating providers and giving feedback on screening completion rates	3%–10% absolute increase
Inreach	Reminding providers to screen	10% absolute increase
Financial incentives	Giving monetary rewards to individuals to complete screening	Variable effectiveness
Preference	Allowing individuals a choice of screening strategies	10% absolute increase

CI, confidence interval; OR, odds ratio.

significantly increases adherence over more limited interventions.

There is a hierarchy of impact, with outreach being the most important component for increasing screening uptake compared with navigation, and patient or provider reminders.⁷ A recent single-site cohort study using a pre/postcomparison observed an over 10% absolute increase in screening rates over a 1-year period using a combination of interventions across the patient, provider and system levels.²⁷ Patients were mailed information about CRC screening and provided outreach with mailed FIT. Providers were sent messages about patient FIT results and asked whether the patient was appropriate to undergo colonoscopy and whether they needed assistance with scheduling. Telephone navigators called patients with positive FIT to help schedule the follow-up colonoscopy. Endoscopists followed up to identify the correct screening or surveillance intervals based on colonoscopy findings and pathology, as well as provide referrals to oncology or surgery for cancer diagnoses. System-level interventions included centralized colonoscopy scheduling and development of standard processes for referrals.

Programmatic Screening

It is important that CRC screening tests be repeated even in individuals who are at average-risk for development of cancer. The U.S. Preventive Services Task Force recommends CRC screening by colonoscopy every 10 years or by FBT yearly. While most intervention studies examine adherence to 1-time screening, adherence to programmatic screening, or the ability to adhere over time to multiple rounds to screening, is a more relevant factor to reduce mortality from CRC. Owing to the 10-year interval, few studies have examined repeated adherence to colonoscopy completion; therefore, we summarize studies that have examined programmatic adherence to FBT. Our review found that compared with usual care, outreach programs that included use of centralized electronic health record, academic detailing, and provider financial incentives significantly increased adherence to a second round of testing,^{28,29} whereas outreach in combination with reminders and patient

navigation significantly increased adherence through 3 rounds of testing.³⁰⁻³²

Few studies have tested multicomponent interventions through multiple rounds of screening (Table 2). The majority include local environment interventions such as using the electronic health record to automate identification of individuals who are not up to date with CRC screening, in addition to patient-level interventions such as outreach (usually mailed stool blood test), navigation, or patient reminders. Most multilevel interventions bypass the provider level in an effort to reduce the burden of implementing screening on busy clinicians.

One study by Green et al³² used a system-level intervention to identify individuals who were not up to date with CRC screening and implemented a stepped-care approach to increase screening. Compared with usual care that included clinic-based interventions to increase screening, outreach using mailed FBT and an invitation letter with a number to call schedule a colonoscopy or flexible sigmoidoscopy increased the percent covered time being up to date with screening from 47.5% to 62.1%. Additional components such as telephone navigation from a medical assistant, or from a nurse, did not provide additional benefit over outreach alone. Individuals receiving any intervention (85.7%) were more likely to complete at least 1 screening test compared with usual care (76.4%) during the 5-year observation period.

In a study by Singal et al,²⁶ outreach using patient telephone reminders plus outreach using either mailed FBT or an invitation letter with a telephone number to schedule a colonoscopy was compared with usual care to examine programmatic screening. Adherence to screening in the initial year was greater with FBT outreach (58.8%) compared with colonoscopy outreach (42.4%), and both interventions were superior to usual care (29.6%).²⁶ However, only 28% of individuals maintained annual adherence to FBT over a 3-year period, whereas 38.4% of individuals who remained in the colonoscopy outreach arm were up to date with screening.³¹

Liang et al²⁵ conducted a 3-year follow-up to a previously prevented study to examine the long-term effect of choice on uptake of screening.³³ While adherence to FBT (68%) was greater than adherence to colonoscopy

(38%) in the first year of screening, adherence to all 3 rounds of screening of annual FBT dropped to 14%, while the adherence to colonoscopy remained at 38% and increased to 42% among patients who received their choice of screening test ($P < .001$ colonoscopy or choice vs FBT; not significant between colonoscopy and choice). It is important to note that patient navigation was not provided in years 2–3 of this study, illustrating the critical nature of this intervention in maintaining programmatic adherence to strategies that require frequent rescreening such as FBT. Because of the duration of effect on cancer mortality reduction using colonoscopy screening, this strategy requires less frequent interventions, and programmatic adherence is more easily achieved.

Follow-up Colonoscopy for Abnormal (noncolonoscopy) Screening Tests

Surprisingly few studies have reported successful interventions to increase adherence to follow-up colonoscopy completion after a positive noncolonoscopy screening test such as FBT or sigmoidoscopy. Failure to complete a diagnostic colonoscopy increases CRC mortality up to 3-fold,³⁴ yet rates of follow-up colonoscopy for abnormal (noncolonoscopy) screening tests vary from 30% to 82% in screening trials.⁸ One systematic review reported moderate evidence to support the use of patient navigators and provider reminders and academic detailing (performance data feedback) to increase the rates of follow-up colonoscopy.³⁵ However, another meta-analysis was not able to confirm the combined

effectiveness of all strategies because of variation in sample size and effectiveness.⁷

Navigation^{36,37} or physician reminders and education³⁸ have been demonstrated to increase performance of colonoscopy after abnormal screening tests. A registered nurse navigator who assisted with logistical barriers and used motivational interviewing techniques increased follow-up colonoscopy rates from 80.8% to 91.0%, although this difference did not reach statistical significance.³⁶ Another randomized clinical trial examined lay navigators to follow up abnormal colorectal tests, as well as breast and prostate screening tests. Through phone, in-person, or email contact, navigators identified barriers to follow-up test completion and maintained contact with patients to address the practical barriers and social support needed to undergo colonoscopy, including accompanying patients to procedures.³⁷ Navigation significantly increased completion of follow-up testing (79% vs 58% usual care; $P < .002$), although 7 of 114 navigated patients were considered adequately followed with sigmoidoscopy or modalities other than colonoscopy.

Provider-level interventions including reminders or academic detailing using feedback of performance data have been demonstrated to increase rates of follow-up colonoscopy of 9%–25%.^{38–41} However, centralized tracking with physician-targeted mailed audit and feedback reports containing names of patients who tested abnormal for FBT did not increase colonoscopy follow-up for abnormal FBT in a large, regional CRC screening program.⁴² Thus, implementation of interventions found to be effective in

The Health Belief Model

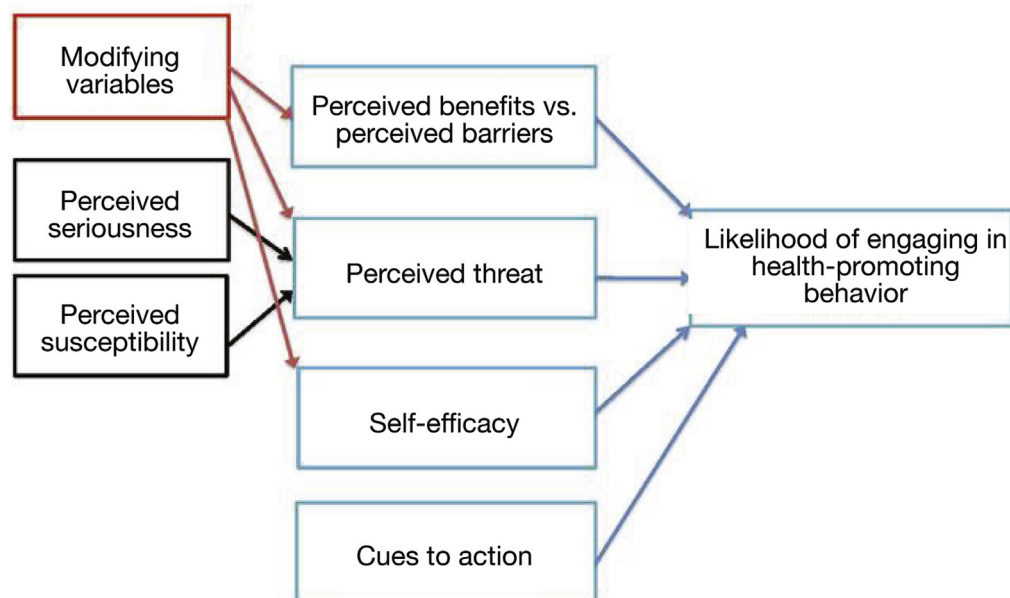


Figure 3. The health belief model.

Table 2. Multicomponent Interventions to Increase CRC Screening<

Author	Year	Screening strategies	Arms	Duration	Interventions	Effectiveness
Blumenthal ⁴⁹	2005	FBT; proctoscopy	2	18 mo	(1) usual care, (2) patient education (churches, health fairs, businesses) and marketing (newspapers, bus signs, media)	Two 2-city pre/postintervention comparisons of intervention vs usual care. Intervention increased adherence from 54.3% to 56.6% compared with usual care in which adherence decreased from 64.9% to 54.9% in one comparison ($P < .05$); however, the other comparison observed a reduction with intervention from 54.3% to 51.9% compared with an increase with usual care 53.4% to 56.0%
Tu ⁵⁰	2006	FBT	2	6 mo	(1) usual care, (2) clinic-based linguistically and culturally concordant health educator; bilingual patient information (video, pamphlet), clinic-distributed FBT	Intervention adherence 69.5% vs usual care adherence 27.6% (OR, 5.98; 95% CI, 3.29–10.85)
Percac-Lima ⁵¹	2009	colonoscopy	2	9 mo	(1) usual care; (2) patient education; navigation (phone or in-person) by community health workers to identify and address barriers to screening, scheduling, bowel preparation, transportation	Intervention adherence 27% vs 12% control adherence ($P < .001$)
Myers ¹⁶	2007	FBT; FS; BE; colonoscopy	4	24 mo	(1) usual care, (2) SI by mail (screening invitation letter, informational booklet, FBT, and reminder letter), (3) TI = SI plus letters based on Preventive Health Model survey responses, (4) TIP = TI plus tailored message pages and a telephone reminder	Screening rates were 33% in the control group, 46% in the SI group, 44% in the TI group, and 48% in the TIP group. Screening was significantly higher in all 3 intervention groups compared with the control group (odds ratio [OR], 1.7; 95% confidence interval [CI], 1.3–2.5; OR, 1.6; 95% CI, 1.2–2.1; and OR, 1.9; 95% CI, 1.4–2.6, respectively) but did not vary significantly across intervention groups
Ling ⁵²	2009	FS; colonoscopy	2 × 2 factorial	12 mo	(1) tailored vs nontailored invitation letter, (2) enhanced vs nonenhanced office and patient management interventions	1) Nontailored; nonenhanced adherence 37.9% (95% CI, 29.4%–46.4%); (2) tailored letter; nonenhanced management 43.6% (95% CI, 35.2%–52.0%); (3) nontailored letter; enhanced management 54.2% (95% CI, 47.1%–61.3%); (4) Tailored letter; enhanced management 53.3% (95% CI, 45.4%–61.2%) Enhanced management increased screening compared with nonenhanced management (OR, 1.63; 95% CI, 1.11–2.41), but tailored letter did not increase screening

Table 2. Continued

Author	Year	Screening strategies	Arms	Duration	Interventions	Effectiveness
Blumenthal ⁵³	2010	FBT; FS; colonoscopy	4	6 mo	(1) usual care, (2) one-on-one patient education, (3) group patient education, (4) financial reimbursement for screening costs (up to \$500)	Group education adherence 33.9% vs 17.7% usual care ($P = .039$). One-on-one patient education or financial incentive adherence (25.4% or 22.2%, respectively) did not significantly increase screening
Maxwell ⁵⁴	2010	FBT	3	6 mo	(1) usual care, (2) group patient education plus reminder letters to patient and their physician, (3) group patient education plus reminder letters to patient and their physician, plus FBT distributed by educator	Education plus distribution of FBT adherence 30% vs education alone 25% (nonsignificant difference); education with or without FBT increased screening compared with control (9%) ($P < .001$)
Walsh ⁵⁵	2010	FBT; FS; colonoscopy	3	12 mo	(1) usual care, (2) patient education (culturally tailored brochures) plus outreach (mailed FBT), (3) patient education (culturally tailored brochures) plus outreach (mailed FBT) plus navigation (telephone)	Patients provided usual care increased screening by 4.1% from baseline; patient education plus mailed FBT increased screening by 11.9% from baseline ($P = .002$); patient education plus mailed FBT plus navigation increased screening by 21.4% from baseline ($P < .001$ for comparisons to usual care and to other intervention)
Coronado ⁵⁶	2011	FBT	3	9 mo	(1) usual care; (2) mailed FBT; (3) mailed FBT, telephone reminders, home visits	Adherence 2% usual care; 26% mailed FBT; 31% mailed FBT plus navigation ($P < .001$ usual care vs either intervention, no significant difference between interventions)
Honeycutt ⁵⁷	2013	colonoscopy	2	18 mo	(1) usual care; (2) identify patients due for screening; provider reminders; patient education; navigation; academic detailing (education plus feedback)	Intervention group adherence 35% vs 6.5% control group ($P < .001$)
Sequist ⁵⁸	2009	FBT; FS; colonoscopy	2 × 2 factorial	15 mo	(1) outreach with mailed FBT, patient education, call number for FS or colonoscopy; (2) physician reminders	(1) patient education plus outreach increased screening: 44.0% vs 38.1% ($P < .001$); (2) physician reminders did not increase screening: 41.9% vs 40.2% ($P = .47$)
Myers ⁵⁹	2013	FBT; colonoscopy	3	12 mo	(1) usual care, (2) SI, (3) TIP	Both interventions increased adherence compared with usual care (18%); SI: 36% (OR, 2.68; 95% CI, 1.83–3.90 vs usual care); navigation intervention: 43% (OR, 3.48; 95% CI, 2.39–5.07 vs usual care). No significant difference between SI and TI
Levy ⁶⁰	2013	FBT; FS; colonoscopy	4	15 mo	(1) usual care; (2) physician chart reminder; (3) physician chart reminder, patient reminder, patient education, FBT outreach; (4) physician chart reminder, patient reminder, patient education, FBT outreach, plus navigation	Usual care adherence 17.8% no different from physician chart reminder (20.5%); FBT outreach, patient education, patient reminder significantly increased screening compared with usual care (56.5%; OR, 6.0; 95% CI, 3.7–9.6), as did addition of navigation (57.2%; OR, 6.2; 95% CI, 3.8–9.9), but the addition of navigation was not significantly different from FBT outreach

Fortuna ⁶¹	2014	FBT; FS, colonoscopy	4	12 mo	(1) patient invitation letter; (2) patient invitation letter plus automated reminder phone calls; (3) patient invitation letter plus automated phone calls plus clinic reminders (patient and provider); (4) patient invitation letter plus personal phone call from trained outreach worker	Invitation letter adherence 12.2%; Invitation letter plus automated phone calls 15.3% (NS); invitation letter plus automated phone calls plus clinic reminder 19.6% (OR, 1.9; 95% CI, 1.0–3.7); invitation letter plus outreach via personal phone call 21.5% (OR, 2.0; 95% CI, 1.1–3.9)
Basch ⁶²	2015	FBT; FS; colonoscopy	3	12 mo	(1) patient printed education; (2) physician education; (3) physician education plus patient tailored telephone education	Patient printed education adherence 18.3%; physician education 20.0%; physician education plus patient tailored telephone education 25.6% (NS)
Singal ²⁶	2016	FBT; colonoscopy	3	12 mo	(1) usual care; (2) FIT outreach (mailed FIT) plus telephone reminders; (3) colonoscopy outreach (invitation letter with telephone number to schedule colonoscopy) plus telephone reminders	FIT outreach adherence was 58.8% compared with colonoscopy adherence (42.4%) ($P < .001$), and either outreach increased adherence compared with usual care (29.6%) ($P < .0001$)
Yu ²⁷	2018	FBT; colonoscopy	1 (pre/post)	1 y	(1) patient education; (2) outreach with mailed FIT kit; (3) telephone navigation; (4) provider dashboard; (5) centralized processing of positive FIT results; (6) centralized colonoscopy scheduling	Screening rate increased from 65.1% to 76.6%
Multilevel, multicomponent interventions to increase colorectal cancer screening						
Green ²⁸	2013	FBT; colonoscopy	4	2 y	(1) usual care with clinic interventions, (2) outreach with mailed FBT and colonoscopy/FS call-in number, (3) outreach plus telephone navigation from medical assistant, (4) outreach plus telephone navigation from medical assistant, plus nurse navigation for unscreened. (years 1 and 2)	2-y adherence: usual care, 26.3%; automated, 50.8%; assisted, 57.5%; navigated, 76.4% ($P < .001$ for all pairwise comparisons)
Green ³²	2017	annual FBT; 1-time FS; 1-time colonoscopy	4	5 y	(1) usual care with clinic interventions, (2) outreach with mailed FBT and colonoscopy/FS call-in number, (3) outreach plus telephone navigation from medical assistant, (4) outreach plus telephone navigation from medical assistant, plus nurse navigation for unscreened. (years 1 and 2)	Any intervention (groups 2–4) increased percent covered-time being up to date with CRC screening (62.1%; 95% CI, 61.0–63.2%) compared with usual care (47.5% 95% CI, 45.5–49.5%) (adjusted rate ratio, 1.31; 95% CI, 1.25–1.37). Any intervention group more likely to have completed at least 1 CRC screening compared with usual care (85.7% vs 76.4%; $P < .001$) over 5 y
Singal ³¹	2017	annual FBT; 1-time colonoscopy	3	3 y	(1) usual care, (2) FIT outreach (mailed FIT) plus telephone reminders, (3) colonoscopy outreach (invitation letter with telephone number to schedule colonoscopy) plus telephone reminders	Usual care adherence was 10.7%; FIT outreach was 28.0% ($P < .001$ vs usual care); colonoscopy outreach was 38.4% ($P < .001$ vs usual care and vs FIT outreach)

BE, barium enema; CI, confidence interval; CRC, colorectal cancer; FBT, fecal blood test; FIT, fecal immunochemical test; FS, flexible sigmoidoscopy; OR, odds ratio; SI, standard intervention; TI, tailored navigation intervention; TIP, tailored navigation intervention plus message pages and telephone reminder.

smaller studies may not scale to be effective at a regional or national level. The authors of the latter study suggested that automated scheduling of follow-up colonoscopy could be necessary to minimize the barriers encountered at the provider level.

System-level interventions to improve follow-up to abnormal screening tests have included direct referral to colonoscopy scheduling, construction of registries of patients with abnormal results, and phone outreach to patients who test positive. Direct referral of positive FBT results to gastroenterologists reduced the time to completion for colonoscopy and increased the colonoscopy follow-up rate in one cluster-randomized study in a Department of Veterans Affairs setting.⁴³ Implementation of an automated registry that informed providers of their patients with positive FBT who had not completed a follow up colonoscopy in a managed care setting (Group Health, Seattle, WA) increased from 57% to 64% in the 3 years before implementation to 82%–86% in the 5 years after implementation.⁴⁴

The Road Forward

Adherence to CRC screening remains suboptimal because of barriers at every level in the cancer care continuum including national-, regional-, health system-, clinic-, provider-, and patient-level barriers. National and regional barriers include policy and reimbursement barriers. The Affordable Care Act included a provision for CRC screening without patient copayment; however, these has been a persistent “loophole” that allows insurers to charge copayments for follow-up colonoscopy performed in response to positive screening FBTs; moreover, screening colonoscopies in which polyps are discovered and removed are changed to “diagnostic,” for which copayments are applied. This financial barrier to screening completion is a policy issue that could be resolved by either congressional mandate or payor coverage changes.

Regional barriers include limited access to screening remains problematic for many individuals, especially medically underserved populations that are frequently cared for by federally qualified health centers. Access to CRC screening is also limited for those with Medicaid or Medicare insurance because of the limited number of providers who accept these federal insurance programs. Coordinated screening programs that provide screening services irrespective of insurance status have been demonstrated to effectively deliver CRC screening at the local or regional levels.¹⁴ Similar programs could be instituted at the state or national levels to resolve this barrier.

Provider barriers include knowledge deficits of screening guidelines or screening status of patients could be solved through provider education, academic detailing, or clinic- or system-based reminders. The

evolution of the electronic health record should be able to assist providers in accurately determining family history of cancer and to deliver screening in the correct individuals at the proper intervals; however, the problems with data input and retrieval and the inability of systems to share patient information have stymied attempts to provide coordinated, longitudinal care for patients. Alternatively, screening could be removed from the responsibility of the provider and implemented at the clinic or system level through dedicated programs that deliver screening at the point of care (clinic) and through outreach directly to patients via mailed fecal blood testing.

Patient barriers, however, remain enigmatic and a major barrier to successful screening. Lack of knowledge about the importance of screening, inaccurate information, health beliefs, trust in health care systems and providers, absence of social support to complete screening, and multiple other factors contribute to these barriers.⁴⁵ The health beliefs of individual patients dictate their engagement in health activities such as screening (Figure 3).⁴⁶ Perceptions of the susceptibility to develop cancer and seriousness of a cancer diagnosis form the basis of perceived threat of CRC. Even if individuals realize the threat of cancer, the benefits of screening must be perceived to outweigh the barriers to pursue screening. Self-efficacy refers to an individual's perception of their ability to successfully undergo screening and reflects one's confidence in the ability to effect change in health outcomes. Cues to action are necessary for prompting engagement in health-promoting behaviors such as cancer screening. As CRC screening is recommended in asymptomatic individuals, internal cues are often lacking. External cues may be events or information from family, friends, the media, or health care providers who promote engagement in screening.⁴⁷

Many of the barriers to increasing CRC screening adherence could be addressed through adoption of national or statewide screening programs.⁴⁸ These programs would not need to address individuals already participating in screening, but rather target individuals who (1) do not currently have access to screening tests, (2) have not been recommended screening (either because they lack primary care or because their primary care provider has not recommended screening), or (3) have been recommended to undergo screening but have not completed screening. A key aspect of organized programs is that that they are multicomponent and multilevel and would provide the following components to populations irrespective of insurance status: (1) access to CRC screening tests, follow-up for abnormal tests (colonoscopy), and treatment of CRC; (2) outreach to provide screening options to individuals without primary care, (3) education about CRC and screening tests, how screening reduces cancer mortality, and how to obtain screening; and (4) navigation to assist individuals follow through the process of screening, follow-up of abnormal screening tests, repeated screening for negative

screening tests, cancer treatment, and support for cancer survivors.

In sum, high-quality evidence illustrates the effectiveness of CRC screening to reduce cancer mortality. Uptake of screening, however, remains below the national goal of 80% of individuals up to date with screening. Interventions to increase adherence to screening have been tested and several have been validated to increase screening uptake. Multicomponent interventions may increase uptake more than single item interventions. A great of discovery remains to identify novel screening tests that increase effectiveness, reduce harms and burden on patients and their families, and minimize resource expenditures. Waiting for perfection, however, delays the opportunities provide widespread cancer screening using tools currently in our armamentarium to combat cancer mortality. The financial, political, and cultural barriers to screening must be overcome and a national CRC screening program should be adopted to improve the health of our population.

References

1. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2018. *CA Cancer J Clin* 2018;68:7–30.
2. Wender RC, Doroshenk M, Brooks D, et al. Creating and implementing a national public health campaign: the American Cancer Society's and National Colorectal Cancer Roundtable's 80% by 2018 Initiative. *Am J Gastroenterol* 2018; 113:1739–1741.
3. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System. Available at: <https://www.cdc.gov/brfss/index.html>. Accessed February 8, 2020.
4. Sabatino SA, White MC, Thompson TD, et al. Cancer screening test use - United States, 2013. *MMWR Morb Mortal Wkly Rep* 2015;64:464–468.
5. National Colorectal Cancer Roundtable. 80% by 2018. Available at: <https://nccrt.org/what-we-do/80-percent-by-2018/>. Accessed February 8, 2020.
6. Davis MM, Freeman M, Shannon J, et al. A systematic review of clinic and community intervention to increase fecal testing for colorectal cancer in rural and low-income populations in the United States - how, what and when? *BMC Cancer* 2018;18:40.
7. Dougherty MK, Brenner AT, Crockett SD, et al. Evaluation of interventions intended to increase colorectal cancer screening rates in the United States: a systematic review and meta-analysis. *JAMA Intern Med* 2018;178:1645–1658.
8. Issaka RB, Avila P, Whitaker E, et al. Population health interventions to improve colorectal cancer screening by fecal immunochemical tests: a systematic review. *Prev Med* 2019; 118:113–121.
9. Rat C, Latour C, Rousseau R, et al. Interventions to increase uptake of faecal tests for colorectal cancer screening: a systematic review. *Eur J Cancer Prev* 2018;27:227–236.
10. Taplin SH, Anhang Price R, Edwards HM, et al. Introduction: Understanding and influencing multilevel factors across the cancer care continuum. *J Natl Cancer Inst Monogr* 2012; 2012:2–10.
11. Tiro JA, Kamineni A, Levin TR, et al. The colorectal cancer screening process in community settings: a conceptual model for the population-based research optimizing screening through personalized regimens consortium. *Cancer Epidemiol Biomarkers Prev* 2014;23:1147–1158.
12. Wolf AMD, Fontham ETH, Church TR, et al. Colorectal cancer screening for average-risk adults: 2018 guideline update from the American Cancer Society. *CA Cancer J Clin* 2018; 68:250–281.
13. Inadomi JM, Kuhn L, Vijan S, et al. Adherence to competing colorectal cancer screening strategies. *Am J Gastroenterol* 2005;100:S387–S388.
14. Coronado GD, Petrik AF, Vollmer WM, et al. Effectiveness of a mailed colorectal cancer screening outreach program in community health clinics: the STOP CRC cluster randomized clinical trial. *JAMA Intern Med* 2018;178:1174–1181.
15. Levy BT, Daly JM, Xu Y, et al. Mailed fecal immunochemical tests plus educational materials to improve colon cancer screening rates in Iowa Research Network (IRENE) practices. *J Am Board Fam Med* 2012;25:73–82.
16. Myers RE, Sifri R, Hyslop T, et al. A randomized controlled trial of the impact of targeted and tailored interventions on colorectal cancer screening. *Cancer* 2007;110:2083–2091.
17. Gupta S, Miller S, Koch M, et al. Financial incentives for promoting colorectal cancer screening: a randomized, comparative effectiveness trial. *Am J Gastroenterol* 2016; 111:1630–1636.
18. Mehta SJ, Pepe RS, Gabler NB, et al. Effect of financial incentives on patient use of mailed colorectal cancer screening tests: a randomized clinical trial. *JAMA Netw Open* 2019;2:e191156.
19. Lieberman A, Gneezy A, Berry E, et al. Financial incentives to promote colorectal cancer screening: a longitudinal randomized control trial. *Cancer Epidemiol Biomarkers Prev* 2019; 28:1902–1908.
20. Kullgren JT, Dicks TN, Fu X, et al. Financial incentives for completion of fecal occult blood tests among veterans: a 2-stage, pragmatic, cluster, randomized, controlled trial. *Ann Intern Med* 2014;161:S35–S43.
21. Green BB, Anderson ML, Cook AJ, et al. Financial incentives to increase colorectal cancer screening uptake and decrease disparities: a randomized clinical trial. *JAMA Netw Open* 2019;2: e196570.
22. Mehta SJ, Feingold J, Vandertuyn M, et al. Active choice and financial incentives to increase rates of screening colonoscopy—a randomized controlled trial. *Gastroenterology* 2017; 153:1227–1229.e2.
23. Rat C, Pogu C, Le Donne D, et al. Effect of physician notification regarding nonadherence to colorectal cancer screening on patient participation in fecal immunochemical test cancer screening: a randomized clinical trial. *JAMA* 2017;318:816–824.
24. Guiriguet C, Munoz-Ortiz L, Buron A, et al. Alerts in electronic medical records to promote a colorectal cancer screening programme: a cluster randomised controlled trial in primary care. *Br J Gen Pract* 2016;66:e483–e490.
25. Inadomi JM, Vijan S, Janz NK, et al. Adherence to colorectal cancer screening: a randomized clinical trial of competing strategies. *Arch Intern Med* 2012;172:575–582.
26. Singal AG, Gupta S, Tiro JA, et al. Outreach invitations for FIT and colonoscopy improve colorectal cancer screening rates: a randomized controlled trial in a safety-net health system. *Cancer* 2016;122:456–463.
27. Yu C, Skootsky S, Grossman M, et al. A multi-level fit-based quality improvement initiative to improve colorectal cancer

- screening in a managed care population. *Clin Transl Gastroenterol* 2018;9:177.
28. Green BB, Wang C, Anderson ML, et al. An automated intervention with stepped increases in support to increase uptake of colorectal cancer screening: A randomized trial. *Ann Intern Med* 2013;158:301–311.
 29. Baker DW, Brown T, Buchanan DR, et al. Comparative effectiveness of a multifaceted intervention to improve adherence to annual colorectal cancer screening in community health centers: a randomized clinical trial. *JAMA Intern Med* 2014;174:1235–1241.
 30. Green BB, Anderson ML, Chubak J, et al. Impact of continued mailed fecal tests in the patient-centered medical home: year 3 of the Systems of Support to Increase Colon Cancer Screening and Follow-Up randomized trial. *Cancer* 2016;122:312–321.
 31. Singal AG, Gupta S, Skinner CS, et al. Effect of colonoscopy outreach vs fecal immunochemical test outreach on colorectal cancer screening completion: a randomized clinical trial. *JAMA* 2017;318:806–815.
 32. Green BB, Anderson ML, Cook AJ, et al. A centralized mailed program with stepped increases of support increases time in compliance with colorectal cancer screening guidelines over 5 years: a randomized trial. *Cancer* 2017;123:4472–4480.
 33. Liang PS, Wheat CL, Abhat A, et al. Adherence to competing strategies for colorectal cancer screening over 3 years. *Am J Gastroenterol* 2016;111:105–114.
 34. Lee YC, Fann JC, Chiang TH, et al. Time to colonoscopy and risk of colorectal cancer in patients with positive results from fecal immunochemical tests. *Clin Gastroenterol Hepatol* 2019;17:1332–1340.e3.
 35. Selby K, Baumgartner C, Levin TR, et al. Interventions to improve follow-up of positive results on fecal blood tests: a systematic review. *Ann Intern Med* 2017;167:565–575.
 36. Green BB, Anderson ML, Wang CY, et al. Results of nurse navigator follow-up after positive colorectal cancer screening test: a randomized trial. *J Am Board Fam Med* 2014;27:789–795.
 37. Raich PC, Whitley EM, Thorland W, et al. Patient navigation improves cancer diagnostic resolution: an individually randomized clinical trial in an underserved population. *Cancer Epidemiol Biomarkers Prev* 2012;21:1629–1638.
 38. Myers RE, Turner B, Weinberg D, et al. Impact of a physician-oriented intervention on follow-up in colorectal cancer screening. *Prev Med* 2004;38:375–381.
 39. Murphy DR, Wu L, Thomas EJ, et al. Electronic trigger-based intervention to reduce delays in diagnostic evaluation for cancer: a cluster randomized controlled trial. *J Clin Oncol* 2015;33:3560–3567.
 40. Larson MF, Ko CW, Dominitz JA. Effectiveness of a provider reminder on fecal occult blood test follow-up. *Dig Dis Sci* 2009;54:1991–1996.
 41. Singh H, Wilson L, Petersen LA, et al. Improving follow-up of abnormal cancer screens using electronic health records: trust but verify test result communication. *BMC Med Inform Decis Mak* 2009;9:49.
 42. Stock D, Rabeneck L, Baxter NN, et al. A centrally generated primary care physician audit report does not improve colonoscopy uptake after a positive result on a fecal occult blood test in Ontario's ColonCancerCheck program. *Curr Oncol* 2017;24:47–51.
 43. Humphrey LL, Shannon J, Partin MR, et al. Improving the follow-up of positive hemoccult screening tests: an electronic intervention. *J Gen Intern Med* 2011;26:691–697.
 44. Miglioretti DL, Rutter CM, Bradford SC, et al. Improvement in the diagnostic evaluation of a positive fecal occult blood test in an integrated health care organization. *Med Care* 2008;46:S91–S96.
 45. Honein-AbouHaidar GN, Kastner M, Vuong V, et al. Systematic review and meta-study synthesis of qualitative studies evaluating facilitators and barriers to participation in colorectal cancer screening. *Cancer Epidemiol Biomarkers Prev* 2016;25:907–917.
 46. McQueen A, Swank PR, Vernon SW. Examining patterns of association with defensive information processing about colorectal cancer screening. *J Health Psychol* 2014;19:1443–1458.
 47. Cram P, Fendrick AM, Inadomi J, et al. The impact of a celebrity promotional campaign on the use of colon cancer screening: the Katie Couric effect. *Arch Intern Med* 2003;163:1601–1605.
 48. Levin TR, Jamieson L, Burley DA, et al. Organized colorectal cancer screening in integrated health care systems. *Epidemiol Rev* 2011;33:101–110.
 49. Blumenthal DS, Fort JG, Ahmed NU, et al. Impact of a two-city community cancer prevention intervention on African Americans. *J Natl Med Assoc* 2005;97:1479–1488.
 50. Tu S-P, Taylor V, Yasui Y, et al. Promoting culturally appropriate colorectal cancer screening through a health educator. *Cancer* 2006;107:959–966.
 51. Percac-Lima S, Grant RW, Green AR, et al. A culturally tailored navigator program for colorectal cancer screening in a community health center: a randomized, controlled trial. *J Gen Intern Med* 2009;24:211–217.
 52. Ling BS, Schoen RE, Trauth JM, et al. Physicians encouraging colorectal screening: a randomized controlled trial of enhanced office and patient management on compliance with colorectal cancer screening. *Arch Intern Med* 2009;169:47–55.
 53. Blumenthal DS, Smith SA, Majett CD, et al. A trial of 3 interventions to promote colorectal cancer screening in African Americans. *Cancer* 2010;116:922–929.
 54. Maxwell AE, Bastani R, Danao LL, et al. Results of a community-based randomized trial to increase colorectal cancer screening among Filipino Americans. *Am J Pub Health* 2010;100:2228–2234.
 55. Walsh JME, Salazar R, Nguyen TT, et al. Healthy colon, healthy life: a novel colorectal cancer screening intervention. *Am J Prev Med* 2010;39:1–14.
 56. Coronado GD, Golovaty I, Longton G, et al. Effectiveness of a clinic-based colorectal cancer screening promotion program for underserved Hispanics. *Cancer* 2011;117:1745–1754.
 57. Honeycutt S, Green R, Ballard D, et al. Evaluation of a patient navigation program to promote colorectal cancer screening in rural Georgia, USA. *Cancer* 2013;119:3059–3066.
 58. Sequist TD, Zaslavsky AM, Marshall R, et al. Patient and physician reminders to promote colorectal cancer screening: a randomized controlled trial. *Arch Intern Med* 2009;169:364–371.
 59. Myers RE, Bittner-Fagan H, Daskalakis C, et al. A randomized controlled trial of a tailored navigation and a standard intervention in colorectal cancer screening. *Cancer Epidemiol Biomarkers Prev* 2013;22:109–117.
 60. Levy BT, Xu Y, Daly JM, et al. A randomized controlled trial to improve colon cancer screening in rural family medicine: an

- Iowa Research Network (IRENE) study. *J Am Board Fam Med* 2013;26:486–497.
61. Fortuna RJ, Idris A, Winters P, et al. Get screened: a randomized trial of the incremental benefits of reminders, recall, and outreach on cancer screening. *J Gen Intern Med* 2014; 29:90–97.
 62. Basch CE, Zybert P, Wolf RL, et al. A randomized trial to compare alternative educational interventions to increase colorectal cancer screening in a hard-to-reach urban minority population with health insurance. *J Community Health* 2015;40:975–983.

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Conflicts of Interest

The authors disclose no conflicts.

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