Approaches to Increase Colorectal Cancer Screening Rates: Key Information for the Primary Care Provider

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INTRODUCTION

Colorectal cancer (CRC) is the fourth most common cancer diagnosed in the United States and, despite its potential for early detection, remains the second most common cause of oncology-related deaths for US men and women combined.[1] An estimated 140,250 patients will be newly diagnosed in 2018, and 50,630 CRC-related deaths will occur.[1] The incidence of and mortality related to CRC are greater in men than women, and CRC affects more non-Hispanic blacks than non-Hispanic whites (males: 56.4 vs 45.2 per 100,000, respectively; females: 41.7 vs 34.5 per 100,000, respectively).[2] Risk for CRC increases with age, as adults aged 65 to 74 years are most commonly diagnosed.[3] Moreover, risk increases in individuals with a family history of CRC (1.9-fold) or inflammatory bowel disease (2.9-fold).[4] Regardless of risk, screening has improved early detection rates and reduced CRC-related mortality.[5] Additionally, screening can detect adenomatous polyps and villous adenomas, with malignancy rates of 34.5% for patients with severe atypia, and 48.0% for those with severe atypia and polyp size >2 cm.[6-8] Discovery of adenomatous polyps and villous adenomas is key for detecting early-stage CRC, when the potential to treat and cure the disease is greatest.[5] Five-year survival rates are high with localized disease (stage I, 93.9%), but decrease as CRC spreads to lymph nodes and metastasizes (stage IV, 11.4%; **FIGURE 1**).[9,10] Consequently, encouraging screening for early detection of polyps and localized cancers is an important role for primary care providers.

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COLORECTAL CANCER SCREENING

The importance of screening to detect and diagnose early-stage CRC,[11,12] as well as the favorable effect of screening on CRC-related mortality, has been established.[13] In the United States, CRC-related mortality decreased 51%, from 28.6 to 14.1 per 100,000, from 1976 to 2014, in part related to a 14% decrease attributed to screening.[14,15] However, according to the findings of a national survey-based study, in 2012, only 65.1% of individuals 50 to 75 years of age in the United States were current with CRC screening recommendations, and 27.7% of individuals had never been screened.[16] In one study (N=9437 diagnoses), screening resulted in the diagnosis of a significantly greater percentage of early-stage CRC diagnoses (stages I and II) than late-stage CRC (stages III and IV; 66.7% vs 39.8%, respectively; $P<.001$).[11] A second study (N=1129 patients) reported similar findings, with a significantly greater percentage of CRCs detected in the early stage due to screening versus symptom-based detection (67% vs 45%, respectively; $P<.001$).[12] Screening colonoscopy and guaiac-based fecal occult blood testing (gFOBT) significantly decreased the risk of CRC-related mortality versus symptom-based detection (colonoscopy: hazard ratio [HR], 0.36; 95% confidence interval [CI], 0.21-0.60; gFOBT: HR, 0.47; 95% CI, 0.29-0.77).[17] A 15% reduction in the US incidence of CRC from 2007 to 2020 could save lives (~150,000 life-years saved) and result in a lifetime health care cost savings of approximately $624 million (2013 dollars).[18] Further, achieving a screening rate of 80% by 2018 in adults aged ≥50 years in the United States is projected to result in an estimated 43,000 fewer cases per year by 2030, with a mortality decrease by 203,000 total deaths from 2013 to 2030.[19]

For asymptomatic adults aged 50 to 75 years at average risk for CRC, the US Preventive Services Task Force (USPSTF) and American Cancer Society (ACS) clinical practice guidelines recommend routine screening using one of a number

FIGURE 1 Colorectal cancer stages and 5-year survival rates[9,10]

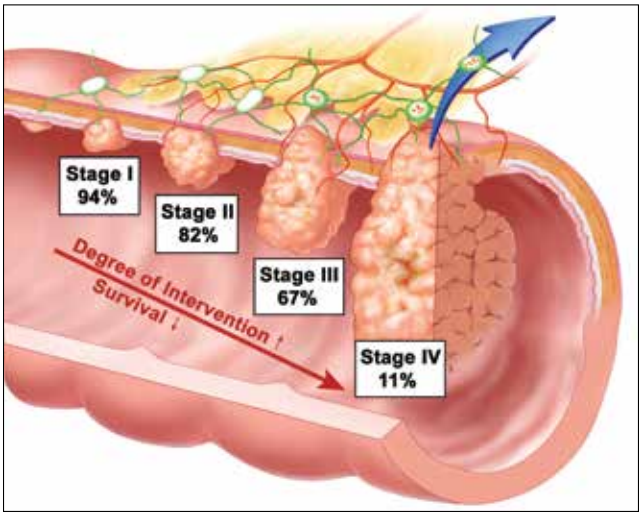

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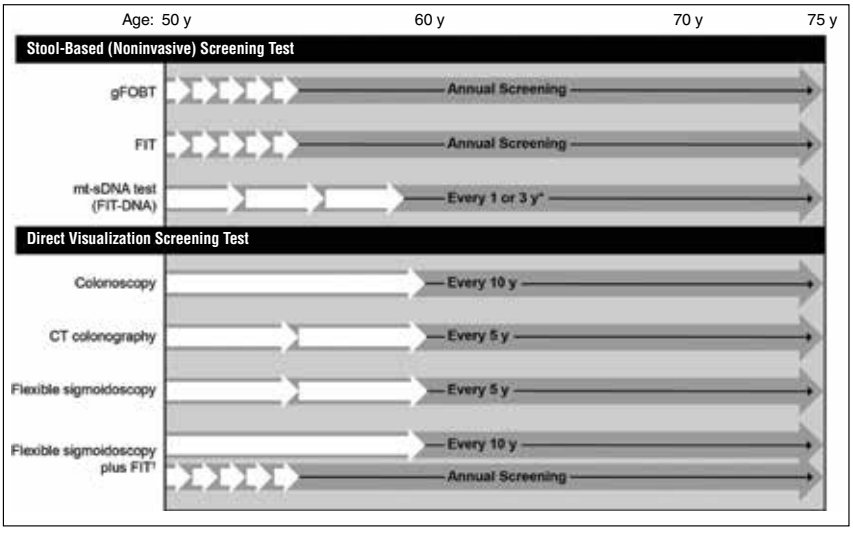
FIGURE 2 Summary of ACS and USPSTF guideline recommendations for CRC screening for individuals between ages 50 and 75 years at average risk of developing CRC[3,20]



Abbreviations: ACS, American Cancer Society; CRC, colorectal cancer; CT, computed tomography; FIT, fecal immunochemical test; FIT-DNA, fecal immunochemical test-multi-target stool DNA test; gFOBT, guaiac fecal occult blood test; mt-sDNA, multi-target stool DNA; USPSTF, US Preventive Services Task Force.

*Guideline recommendations differ between ACS and USPSTF.

†Screening option according to USPSTF, but not ACS.

Adapted from American Cancer Society CRC screening guidelines and Bibbins-Domingo et al.

of stool-based and direct visualization tests (**FIGURE 2**).[3,20] The USPSTF guidelines state there is no empirical data to support one screening method over another and, therefore, do not recommend a specific modality.[3] Rather, the USPSTF considers CRC screening for patients aged 50 to 75 years to be an "A" rated process and emphasized choice through shared decision-making, with the goal of increasing the number of individuals who undergo CRC screening.[3] Routine screening is appropriate for adults considered healthy enough to undergo treatment if CRC is detected and without comorbidities limiting life expectancy.[3] The risk of developing CRC is increased in individuals with a personal or family history of CRC or polyps, a personal history of ulcerative colitis or Crohn's disease, or a family history of a hereditary CRC syndrome (eg, familial adenomatous polyposis).[3,20] With that in mind, these individuals may need to initiate screening before age 50 years and/or may require more frequent screening, depending on the specific risk-related factor(s).[20]

As noted in clinical practice guidelines, several stool-based (noninvasive) and direct visualization methods can be used to accurately detect polyps and early-stage CRC during routine screening (**TABLE 1**[3,21-29]). Given detection considerations (eg, polyps and early-stage cancer may only bleed intermittently),[30] guidelines recommend stool-based testing be performed at more frequent intervals than direct visualization methods.[3,20] A positive result with any stool-based test requires follow-up diagnostic colonoscopy.[3] The harms associated with stool-based testing are minimal and primarily result from adverse events related to the diagnostic colonoscopy procedure following a positive stool-based test.[31] Annual screening using gFOBT, which detects the presence of the heme portion of human hemoglobulin in stool,[32,33] is convenient because 3 stool samples can be collected at home without bowel preparation prior to sample collection.[3,30] However, dietary and medication restrictions are associated with gFOBT.[34] gFOBT was shown to be associated with a 32% decrease in CRC-related mortality compared with no screening (relative risk [RR], 0.68; 95% CI, 0.56-0.82).[13] The sensitivity of gFOBT for the detection of serrated (premalignant) polyps or advanced CRC was low (2.6% and 7.4%, respectively; **TABLE 2**[21,35-39]), while specificity was high (98.4% and 98.6%).[37] In one study (N=997 patients), the percentage of patients adherent to CRC screening with annual gFOBT (n=344) over a 3-year period decreased over time, from 67% in year 1 to 27% and 14% in years 2 and 3, respectively.[40] Similarly, 46.6% of individuals in

TABLE 1 Characteristics of CRC screening methods[3,21-29]

	Stool-based (noninvasive) tests			Direct visualization tests			
Parameter	**gFOBT**	**FIT**	**mt-sDNA test**	**Colonoscopy**	**CT colonography**	**Flexible sigmoidoscopy**	**Flexible sigmoid-oscopy with FIT**
Advantages	In-home testing No bowel preparation or sedation required	In-home testing No bowel preparation or sedation required Single stool sample collection No dietary or medication restrictions	In-home testing No bowel preparation or sedation required Single stool sample collection No dietary or medication restrictions Screens for altered DNA biomarkers in stool Embedded patient compliance program Greatest benefits to harms ratio (vs other modalities)	Entire colon examined by imaging Less frequent screening requirement Biopsy or polyp removal during same procedure	Less invasive vs colonoscopy Lower volumes of bowel preparation vs colonoscopy required No sedation required Lower rate of procedural complications vs colonoscopy Detection of extracolonic abnormalities	Less invasive vs colonoscopy Complete bowel preparation not required (eg, enemas) No sedation required Low rate of complications	Less invasive vs colonoscopy Encompasses both stool-based and direct visualization tests
Disadvantages	Lower sensitivity than mt-sDNA Serial stool sample collection Potential inability to detect carcinomas with little to no bleeding Requires dietary and possible drug administration restrictions prior to testing Lower specificity than FIT Positive findings require diagnostic colonoscopy	Lower sensitivity than mt-sDNA Positive findings require diagnostic colonoscopy Potential inability to detect carcinomas with little to no bleeding	Lower specificity than FIT Positive findings require diagnostic colonoscopy	Bowel preparation and sedation required Potential adverse effects related to bowel preparation, sedation, or procedure Physician skill dependent Patient time requirement (bowel preparation and test) Test performed at health care facility Patient requires transportation home after procedure	Bowel preparation required Requires insufflation* Decreased sensitivity vs colonoscopy for polyp detection Physician skill dependent Patient time requirement (bowel preparation and test) Test performed at health care facility Positive findings require diagnostic colonoscopy Radiation exposure	Restricted to distal colon (lower half) Patient time requirement (bowel preparation and test) Test performed at health care facility Positive findings require diagnostic colonoscopy	Requires 2-step completion by patient (including annual FIT) Patient time requirement (bowel preparation and test) Test performed at health care facility Positive findings require diagnostic colonoscopy
Adherence or compliance with screening†	—	Adherence FIT vs gFOBT: RR, 1.2 (95% CI: 1.03-1.3)	Compliance 88.3%	Adherence colonoscopy vs gFOBT/FIT: RR, 0.6 (95% CI, 0.4-0.8)	—	—	Adherence flexible sigmoidoscopy plus gFOBT/FIT vs gFOBT/FIT: RR, 0.6 (95% CI, 0.4-0.9)
	—			Adherence endoscopy vs stool-based tests: RR, 0.7 (95% CI: 0.6-0.8) Adherence flexible sigmoidoscopy vs stool-based tests: RR, 0.8 (95% CI: 0.6-1.04)			

Abbreviations: CI, confidence interval; CRC, colorectal cancer; CT, computed tomography; FIT, fecal immunochemical test; gFOBT, guaiac-based fecal occult blood test; mt-sDNA, multi-target stool DNA; RR, relative risk.

*Defined as colonic distension with air or carbon dioxide.

†Data presented limited to meta-analysis[27] or study of single screening modality (mt-sDNA).[28]

TABLE 2 Sensitivity of CRC screening methods*[21,35-39]

	Stool-based (noninvasive) tests			Direct visualization tests			
Detection parameter	**gFOBT**	**FIT**	**mt-sDNA test**	**Colonoscopy**	**CT colonography**	**Flexible sigmoidoscopy**	**Flexible sigmoidoscopy with FIT**
Any CRC	61.5%-79.4%¶	73.8%† 62.3%-83.3%¶	92.3%†	93.1%-99.5%¶	75.6%-92.4%¶	37.6%	48.6%
Advanced CRC	7.4%	22.3% 15.1%-26.3%‡	—	—	—	16.3%	31.7%
Advanced adenoma	—	23.8%† 20.8%-27%#	42.4%†	—	—	—	—
Adenoma ≥6 mm	—	—	—	92.3% 75%-93%§,¶	88.7% 73%-98%§	—	—
Adenoma ≥10 mm	17.7%-49.4%#	—	—	87.5% 89%-98%§ 93.1%-99.5%#	93.8% 67%-94%§ 75.6%-92.4%#	93.1%-95%#	—
Serrated (premalignant) polyps	2.6%	4.2%-5.2%‡	—	—	—	—	—

Abbreviations: CRC, colorectal cancer; CT, computed tomography; FIT, fecal immunochemical test; gFOBT, guaiac-based fecal occult blood test; mt-sDNA, multi-target stool DNA.

*Sensitivity comparison of method on top row vs method in left column.

†*P*=.002 (CRC) and *P*<.001 (advanced adenoma: includes sessile serrated [premalignant] polyps ≥1 cm) for mt-sDNA vs FIT.

‡Sensitivity of InSure FIT and OC FIT-CHEK.

§Based on meta-analysis data from 7 studies (CT colonography) or 4 studies (colonoscopy).[38]

¶Compared with CT colonography or colonoscopy plus CT colonography.[38]

#Based on simulation models incorporating multiple screening intervals, different ages at initiation of screening, and different ages at last screening.[39]

a multicenter health care system returned for annual gFOBT testing, while 35.3% were inconsistent with annual screening and 18.1% did not return for repeat screening.[30]

Annual fecal immunochemical testing (FIT), which utilizes antibodies to detect the presence of the globin portion of human hemoglobin in stool, may have comparable sensitivity with, but improved specificity for, detection of CRC compared with gFOBT.[32] The pooled one-time sensitivity of FIT, determined from a single meta-analysis of FIT studies using colonoscopy as the reference standard, is 71%, with a specificity of 94%.[41] In another study, FIT sensitivity for all stages of CRC was 74%, which decreased to 73% for stages I-III CRC, 46% for high-grade dysplasia, 24% for advanced adenomas measuring 1 cm or greater, and 5% for sessile serrated (flat, premalignant) polyps.[21] Unlike gFOBT, FIT typically requires a single stool sample collected at home, without dietary or medication restrictions prior to sample collection; as with gFOBT, no bowel preparation is needed.[3,30,34,42] In one study, FIT (n=4662) detected a significantly greater percentage of advanced neoplasias (ie, CRC or advanced adenoma) compared with gFOBT (n=3236; 0.8% vs 0.3%, respectively; *P*=.003).[43] Meta-analysis of 5 randomized studies found FIT detected advanced neoplasia (ie, CRC, or polyp ≥10 mm or with high-grade dysplasia or villous component) and CRC with greater accuracy than gFOBT (advanced neoplasia: RR, 2.3; 95% CI, 1.7-3.1; CRC: RR, 2.0; 95% CI, 1.2-3.2) following adjustment for adherence to screening.[27] A meta-analysis of 5 studies demonstrated adherence to FIT was greater than to gFOBT (RR, 1.2; 95% CI, 1.03-1.3).[27] However, "real world" year-over-year adherence rates with FIT are often far less than 30%. In one study, only 0.3% of nearly 98,000 individuals were found to have completed 10 consecutive years of FIT testing.[44] Over a 3-year period, individuals eligible for CRC screening who received annual FIT kits by mail had greater screening completion rates compared with people receiving a screening recommendation during an outpatient visit with their provider (28.0% vs 10.7%, respectively).[45]

In August 2014, the multi-target stool DNA (mt-sDNA) test, which analyzes 11 distinct molecular biomarkers from cells that shed into the intestinal tract to simultaneously detect epigenetic changes in DNA, specific DNA mutations, and human hemoglobin in stool, was introduced as a screening test for adults at average risk of developing CRC.[21,46] mt-sDNA testing, which is performed at home, requires a single stool sample and no bowel preparation, has no dietary or medication restrictions, and has the greatest benefits-to-harms

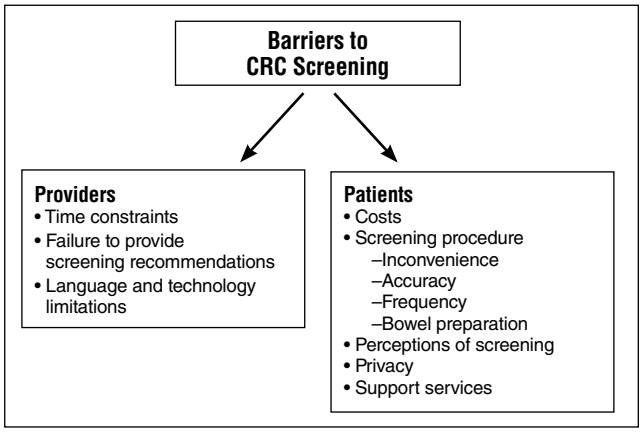
ratio of all CRC screening modalities.[3,21,46] In asymptomatic individuals at average risk for developing CRC, Imperiale et al[21] showed mt-sDNA testing had superior sensitivity for detecting CRC (any disease stage) and advanced adenomas versus FIT (CRC: 92.3% vs 73.8%, respectively, *P*=.002; advanced adenomas: 42.4% vs 23.8%, *P*<.001; **TABLE 2**).[3,21,35-39] Results from Imperiale et al demonstrated false-positive rates of 13% and 8.5% for patients aged 50 to 84 years, and 50 to 64 years, respectively.[21] For patients previously noncompliant with other screening modalities (ie, >10 years since last colonoscopy and/or >1 year since last gFOBT; N=393), 88.3% completed screening by mt-sDNA testing within 1 year.[28] An initial mt-sDNA rescreening interval of 3 years is included in nationally recognized guidelines from ACS[20]; USPSTF guidelines recommend an interval of either 1 or 3 years.[3] The Centers for Medicare and Medicaid Services has approved mt-sDNA reimbursement for a rescreening interval of 3 years.

Direct visualization screening methods include colonoscopy, computed tomography colonography (CTC), and flexible sigmoidoscopy with or without annual FIT. Direct visualization CRC screening modalities are considered more invasive than stool-based tests, typically require bowel preparation, medication and/or dietary changes, anesthesia and subsequent need for transportation following the procedure, time away from work and other responsibilities, and are performed at an outpatient health care facility or hospital.[3] Colonoscopy allows for the visualization of the entire colon and rectum through a colonoscope.[9] CTC, also referred to as virtual or CT colonoscopy, allows for detailed imaging of the entire colon and rectum by inflating the colon with air or carbon dioxide and running the patient through a CT scanner.[9,47] The recommended CRC screening intervals for colonoscopy and CTC are 10 years and 5 years, respectively.[3,20] Colonoscopy is the only CRC screening method in which polyps or masses can be identified and removed during the same procedure.[48-50] Individuals decline direct visualization screening methods (colonoscopy or CTC; N=151) for a variety of reasons, including time constraints (24%), the belief that screening was unnecessary due to perceived good health (23%), required bowel preparation (8%), discomfort or embarrassment (7%), and concerns regarding complications (7%).[47] A randomized, controlled study of individuals eligible for CRC screening by colonoscopy (n=5,924) or CTC (n=2,920) found significantly more declined colonoscopy compared with CTC (13% vs 7%, respectively; *P*<.001).[51] The most common reasons cited for declining screening by colonoscopy or CTC included "unpleasantness" of the screening modality (66% vs 30%, respectively; *P*<.001), inconvenience of the test preparation (34% vs 18%; *P*<.001), perception of screening as unnecessary due to lack of symptoms (23% vs 32%; *P*=.01), and time constraints (14% vs 20%; *P*=.04).[51] Colonoscopy adherence rates at 1 and 3 years have been reported to be 38.2%[52] and 38.4%[45], respectively.

In asymptomatic individuals, the sensitivity of CTC to detect adenomas ≥6 mm was 88.7%, which was lower than colonoscopy (92.3%; **TABLE 2**).[21,35-39] However, the sensitivity of CTC to detect large-sized polyps (ie, ≥10 mm) was greater than that of colonoscopy (93.8% vs 87.5%, respectively).[36] No high-quality studies have validated the sensitivity and specificity of colonoscopy. Colonoscopy and CTC are associated with operator-dependent factors that can affect the quality of the procedure and, in some cases, potentially harm the patient.[38,48] Factors associated with oversight of polyps during colonoscopy include poor bowel preparation and/or endoscopist training and experience.[48] Additional considerations specific to CTC include extracolonic findings leading to unnecessary testing and anxiety, and exposure to ionizing radiation during the procedure.[25,38,49] Meta-analysis of asymptomatic or screening populations showed patients undergoing colonoscopy are at low risk for perforations (n=26 studies; 4 in 10,000 procedures) or major bleeding (n=22 studies; 8 in 10,000 procedures); 36% of perforations and 96% of cases of major bleeding occurred during polyp removal (n=8 studies).[38] Similarly, meta-analysis of 11 studies showed the rate of perforation in asymptomatic individuals was low (0.02%; n=6 studies) with CTC; the rate of perforation due to insufflation was 0.03% (n=7 studies).[53]

Flexible sigmoidoscopy is not commonly used as a CRC screening test in the United States.[54] Flexible sigmoidoscopy involves endoscopic examination of the distal colon following cleansing by enema[49] and may not detect polyps and CRC localized to the proximal colon. The limitations of flexible sigmoidoscopy were confirmed in an analysis of US cancer registry data showing CRC occurred more often in the right side (proximal) than the left (distal) side of the colon (43.5% vs 37.7%, respectively).[55] The overall CRC sensitivity of flexible sigmoidoscopy is limited, but is generally assumed to be comparable to that of colonoscopy for distal colon examination. In one study, 17% of undetected lesions were beyond the reach of flexible sigmoidoscopy.[56] If the medical professional finds a lesion greater than 1 cm during flexible sigmoidoscopy examination, the patient will need to follow up with a colonoscopic polypectomy to have the lesion removed.[3,56] Current USPSTF and ACS guidelines recommend screening of asymptomatic individuals in the United States every 5 years when using flexible sigmoidoscopy.[3,20] Flexible sigmoidoscopy every 10 years, combined with annual FIT, is recommended in USPSTF guidelines (**FIGURE 2**) and demonstrated increased sensitivity for detecting advanced neoplasia or any CRC compared with either screening method alone (**TABLE 2**).[21,35-39,57]

FIGURE 3 Potential barriers to CRC screening[28,60-67]



Abbreviation: CRC, colorectal cancer.

The digital rectal exam is not recommended for CRC screening, as testing is limited to the lower rectum.[20] Further, any stool found during a digital rectal exam should not be screened for CRC by gFOBT or FIT.[20] Recently, the Septin 9 serum assay was approved by the US Food and Drug Administration for the screening of adults aged ≥50 years who have been offered, but not completed, CRC screening.[58] However, current ACS and USPSTF guidelines do not include mention of the Septin serum assay.[20,59]

POTENTIAL BARRIERS TO CRC SCREENING

Potential barriers to CRC screening include issues relevant to patients and providers (**FIGURE 3**).[28,60-67] Prior to implementation of the Affordable Care Act (ACA) in 2010, individuals with coverage through private insurers or Medicare were responsible for a portion of screening-related costs, a potential impediment to CRC screening.[68] The ACA provides individuals access to preventive care, including CRC screening, with no out-of-pocket costs.[69] It is unclear if the need for a follow-up diagnostic colonoscopy following a positive stool-based screening test, which may be associated with out-of-pocket costs, is a barrier to CRC screening.[70]

Surprisingly, after ACA implementation, the elimination of cost sharing did not increase the uptake of CRC screening among individuals with private insurance or Medicare (2009 to 2011/2012).[71] Similarly, analysis of a sample of Medicare beneficiaries showed colonoscopy use for CRC screening was unchanged or decreased following ACA implementation compared with the prior 2 years.[70,72] However, National Health Interview Survey data showed a significant increase in the percentage of adults aged 50 to 75 years undergoing CRC screening from 2008 to 2013 (57.3% to 61.2%; *P*<.001).[68] Notable increases in CRC screening occurred in individuals classified as low-income (<$35,000 annual household income; 4.3% increase; *P*=.02) and middle-income ($35,000 to <$75,000 annual household income; 3.5% increase; *P*=.04), and in adults with Medicare coverage (9.8% increase; *P*<.001) and Medicare plus private insurance (5.9% increase; *P*=.002); 61.8% of adults included in the dataset were covered by private insurance.[68] Thus, elimination of patient economic barriers is one factor of importance for increasing CRC screening in some individuals.[68]

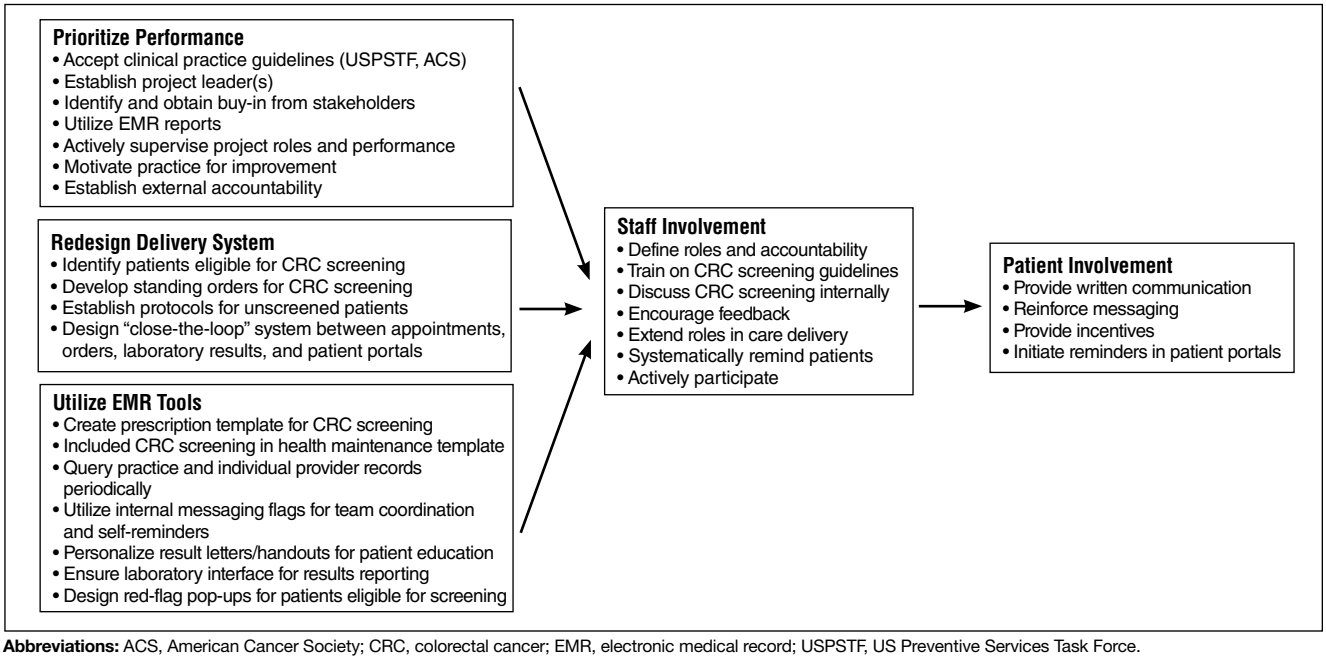
For some patients, the invasive nature of a colonoscopy presents a significant barrier. Data suggest there are 2 distinct groups: individuals who prefer colonoscopy and individuals who prefer noninvasive (stool-based) testing.[34] Another potential barrier is the role of patient perceptions, as 80.6% of 175 providers surveyed "sometimes" or "usually" encountered individuals unaware of the seriousness of CRC.[73] Additional barriers for individuals eligible for CRC screening include issues regarding privacy, inconvenience of testing, concerns with accuracy of testing, frequency of screening required, bowel preparation requirements, invasiveness of testing, and availability of patient support services.[28,61,62]

Primary care providers play an important role in preventive screening.[74] In one study, individuals with ≥1 primary care visit in 1 year were more likely to have completed CRC screening compared with patients with no annual provider contact (63.1% vs 42.2%, respectively; odds ratio [OR], 2.3; 95% CI, 2.3-2.4).[75] The substantial demand on a provider's time may also play a role in the stagnant rates of CRC screening in the United States; providers would have to work an estimated 21.7 hours per day to address all acute and chronic disease and preventive care guideline recommendations.[67] Provider time constraints are anticipated to increase as a result of expanded health care access through the ACA; thus, the role of nurse practitioners and physician assistants in preventive care, including CRC screening, is likely to expand.[76]

Shared decision-making regarding CRC screening methods is an important factor in adherence.[52] In a 2016 longitudinal study of more than 150,000 eligible adults older than 50 years of age, one-third failed to adhere to current USPSTF CRC screening recommendations over a 10-year period, whether they underwent colonoscopy, flexible sigmoidoscopy, FIT, or gFOBT.[44] However, in one study, individuals 50 to 79 years of age at average risk of developing CRC were significantly more likely to adhere to screening when permitted to choose the method (eg, colonoscopy, gFOBT) compared with individuals recommended colonoscopy only (68.8% vs 38.2%, respectively; *P*<.001).[52] Barriers primary care providers may encounter in shared decision making include language[65,66] and technological limitations, as some patients lack internet access or the skills required to navigate internet-based educational tools.[66,77]

Increasing screening rates with stool-based testing may require increased patient navigation. In a study of eligible

FIGURE 4 Suggestions for improvements to CRC screening processes in primary care



Abbreviations: ACS, American Cancer Society; CRC, colorectal cancer; EMR, electronic medical record; USPSTF, US Preventive Services Task Force.

individuals randomly assigned to receive usual care (ie, screening method recommended during outpatient visit; n=1199), reminder mailings for colonoscopy (n=2400), or FIT kits sent by mail annually (n=2400), outreach led to greater screening completion rates versus usual care over a 3-year period (colonoscopy, 38.4% and annual FIT, 28.0%, vs usual care, 10.7%).[45] However, a greater percentage of individuals in the colonoscopy group never initiated screening compared with the FIT group (44.0% vs 30.2%, respectively).[45] These findings are consistent with data from another study, in which only 25.5% of 2010 individuals receiving FIT kits in the mail completed testing; patients were 50% more likely to complete FIT testing when reminded by a live phone call compared with a mailed letter.[78]

However, while adherence rates for stool-based CRC screening may be low in some studies,[30,40] results of a meta-analysis indicated direct visualization screening tests had significantly lower adherence rates than stool-based testing (RR, 0.67; 95% CI, 0.56-0.80; **TABLE 1**).[3,21-28] Thus, while USPSTF guidelines do not recommend one screening modality over another,[3] stool-based (noninvasive) screening methods may be an option for patients who are nonadherent to direct visualization methods or indicate a preference for noninvasive testing modalities.

SUGGESTED PRACTICE IMPROVEMENTS FOR CRC SCREENING

Practice improvements to ensure CRC screening adherence for eligible individuals requires a team effort.[79] Higher CRC screening rates have been associated with a number of practice improvement programs, such as engaging patients in shared decision-making and targeting interventions to specific groups.[79,80] Indeed, practices with a commitment to CRC screening, including use of a script, have been shown to have significantly greater screening rates compared with practices less dedicated to providing CRC screening (57.2% vs 27.6%, respectively; $P<.001$).[80]

Common threads across successful programs include prioritizing CRC screening performance, redesigning the care delivery system, utilizing electronic medical record tools, involving all clinic staff, and engaging patients (**FIGURE 4**). Clinic staff should have defined roles, with accountability, in the process of improving CRC screening rates. Utilizing the medical assistant to review patients' CRC screening status increased the monthly referral rate for colonoscopy by 85% (from 6.0% to 11.1%) at a regional network of 7 community clinics in 2005.[81] At one community practice, CRC screening rates increased from 28% to 80% during a 2-year period, following reevaluation of testing used (eg, replacing gFOBT with FIT) and a redesign of the primary care team (eg, expanding the role of the medical assistant to include obtaining CRC screening status from patients, increasing outreach efforts).[82] In a single Veteran's Administration health care system (ie, multiple primary care clinics, hospital), replacing gFOBT with FIT resulted in a significantly greater percentage of patients completing testing (FIT, 42.6%; gFOBT, 33.4%; $P<.001$), which suggests that minor changes in processes, including changes

to more convenient methods of stool-based (noninvasive) testing, are effective in improving CRC screening rates.[43]

Patient care delivery system redesign may be needed to increase CRC screening rates, including determining individuals eligible for CRC screening prior to scheduled appointments, empowering clinic staff with standing orders, and establishing protocols for individuals who are nonadherent to CRC screening. For direct visualization screening, primary care clinic and specialty practice coordination may need to be implemented to ensure timely follow-up with individuals who miss testing or need assistance coordinating medications in advance of screening (eg, patients with diabetes).[83] Further, close coordination between the primary care provider and specialist can help improve scheduling, bowel preparation, and adherence with follow-up procedures.[83] While not yet documented in the literature, according to Curtis Gattis (Founder and CEO, LeadingReach, Austin, TX; written communication April 24, 2018, unreferenced), adoption of referral management software may improve accountability on both sides of the referral. By tracking and monitoring compliance, referral software can highlight at-risk patients not completing screening. Such simple but effective solutions help both primary care providers and large hospital systems to streamline referral relationships and processes, leading to better compliance and adherence to CRC screening guidelines.

Survey data indicate providers consider alerts in the electronic medical records database to be "somewhat" or "very" helpful interventions for support staff (93.7%; n=174 respondents) and providers (87.9%; n=174).[73] Additionally, generating a daily list of individuals eligible for CRC screening has been helpful for increasing screening rates (77.7%; n=175).[73] Periodic review of patients' electronic medical records (eg, every 6 months) may be used to identify individuals eligible for CRC screening based on age or family history of CRC. Additionally, inclusion of all guideline-recommended screening modalities in the health maintenance template could increase CRC screening rates.

Finally, outreach efforts to engage patients in CRC screening by initiating contact through mail, phone, emails, or patient portals have the potential to increase CRC screening rates. Upon arrival at the clinic, patients could be greeted with educational information related to CRC screening methods. However, some individuals might appreciate further discussion with their provider regarding CRC screening.[62] Reinforcing the importance of regular CRC screening with posters or written information is another suggestion for improving screening rates. At one health center, efforts to improve the convenience of CRC screening included mailing a FIT kit around the time of the patient's birthday and providing at-home screening kits when individuals arrived for other clinic visits (eg, flu shots).[30] The mt-sDNA test is currently the only USPSTF-recommended screening modality offering a patient compliance program and a multilingual (ie, 70 languages), US-based 24/7 customer support call center to address questions from patients and providers.[29] The patient compliance program proactively establishes contact before the test is shipped to a patient's home and continues communication via a series of phone calls and mailings to encourage completion of testing.[29] Thus, improving uptake of CRC screening in primary care will involve participation across the entire health care continuum.

CONCLUSIONS

Colorectal cancer is a leading cause of cancer-related deaths in the United States, yet approximately one-third of individuals eligible for CRC screening remain unscreened according to recommended clinical practice guidelines. For individuals at average risk for developing CRC, guidelines recommend screenings begin at age 50 years. Providers and patients are encouraged to use shared decision-making to choose a patient's preferred CRC screening option, ranging from noninvasive, convenient, at-home stool-based testing (eg, mt-sDNA, FIT, gFOBT) to more invasive, direct visualization methods (eg, colonoscopy, CTC), as screening by any modality is better than no screening at all. Practice improvements have been shown to increase uptake of CRC screening in clinical settings and may include replacing one method of screening with another or redesigning the patient care delivery system to increase CRC screening rates. Regardless of the screening modality used, there is a need to improve CRC screening rates in the general population by improving patient adherence to guideline recommendations and to continue to reduce CRC-related morbidity and mortality. ●

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