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Enhancing the Use and Quality of Colorectal Cancer Screening

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Preface

The Agency for Healthcare Research and Quality (AHRQ), through its Evidence-Based Practice Centers (EPCs), sponsors the development of evidence reports and technology assessments to assist public- and private-sector organizations in their efforts to improve the quality of health care in the United States. The reports and assessments provide organizations with comprehensive, science-based information on common, costly medical conditions and new health care technologies. The EPCs systematically review the relevant scientific literature on topics assigned to them by AHRQ and conduct additional analyses when appropriate prior to developing their reports and assessments.

To bring the broadest range of experts into the development of evidence reports and health technology assessments, AHRQ encourages the EPCs to form partnerships and enter into collaborations with other medical and research organizations. The EPCs work with these partner organizations to ensure that the evidence reports and technology assessments they produce will become building blocks for health care quality improvement projects throughout the Nation. The reports undergo peer review prior to their release.

AHRQ expects that the EPC evidence reports and technology assessments will inform individual health plans, providers, and purchasers as well as the health care system as a whole by providing important information to help improve health care quality.

We welcome comments on this evidence report. They may be sent by mail to the Task Order Officer named below at: Agency for Healthcare Research and Quality, 540 Gaither Road, Rockville, MD 20850, or by e-mail to epc@ahrq.gov.

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Structured Abstract

Objectives. To conduct a systematic review of the use and quality (including underuse, overuse, and misuse) of appropriate colorectal cancer (CRC) screening, including factors associated with screening, effective interventions to improve screening rates, current capacity, and monitoring and tracking the use and quality. Trends in the use and quality of CRC screening tests is also presented.

Data sources. We searched MEDLINE®, the Cochrane Library, and the Cochrane Central Trials Registry, supplemented by handsearches, for studies published in English from January 1998 through September 2009.

Review methods. We used standard Evidence-based Practice Center methods of dual review of abstracts, full text articles, abstractions, quality rating, and quality grading. We resolved disagreements by consensus.

Results. We found multiple problems of underuse, overuse, and misuse of CRC screening. We identified a total of 116 articles for inclusion into the systematic review, including a total of 72 studies qualified for inclusion for key question (KQ) 2, 21 for KQ 3, 12 for KQ 4, and 8 for KQ 5. A number of patient-level factors are associated with lower screening rates, including having low income or less education, being uninsured or of Hispanic or Asian descent, not being acculturated into the United States, and having less or reduced access to care. Being insured, of higher income or education, and non-Hispanic white, participating in other cancer screenings, having a family history of CRC or personal history of another cancer, as well as receiving a physician recommendation to be screened, are associated with higher screening rates. Interventions that effectively increased CRC screening with high strength of evidence include patient reminders, one-on-one interactions, eliminating structural barriers, and system-level changes. The largest magnitude of improvement came from one-on-one interactions and eliminating barriers. Purely educational small-media interventions do not improve screening rates. Evidence is mixed for decision aids, although certain designs may be effective. No studies tested interventions to reduce overuse or misuse of CRC screening. We found no studies that assessed monitoring systems for underuse, overuse, and misuse of CRC screening. Modeling studies, using various assumptions, show that if the United States were to adopt a colonoscopy-only approach to CRC screening and everyone were to agree to be screened in this way, it is likely that colonoscopy capacity would need to be substantially increased.

Conclusions. Both CRC screening and patient-physician discussions of CRC screening are underused, and important problems of overuse and misuse also exist. Some interventions hold promise for improvement. The research priority is to design and test interventions to increase screening and CRC screening discussions, building on the effective approaches identified in this review, and tailored to specific population needs. In addition, new interventions to reduce overuse and misuse should be designed and tested, along with studies of ongoing monitoring systems that are linked to feedback and continued improvement efforts.

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Appendixes and Evidence Tables for this report are provides electronically at http://www.ahrq.gov/downloads/pub/evidence/pdf/crcuse/crcuse.pdf.

Executive Summary

Introduction

Periodic screening of people at average risk for colorectal cancer (CRC) is recommended by three important national guideline groups, the United States Preventive Services Task Force (USPSTF), the American Cancer Society (ACS), and the U.S. Multi-Society Task Force on Colorectal Cancer (MSTF), as well as multiple professional societies. For CRC screening to contribute to a reduction in CRC mortality without unreasonable harms and costs, however, it must be offered to people who have a reasonable probability of net benefit, and it must be conducted effectively and efficiently. These issues of use and quality are especially salient for CRC screening because it is in some ways more complex (e.g., variation in timing and types of tests, invasiveness of most tests) than other screening programs. Underuse of CRC screening has been a clear problem for some years; evidence is now growing that overuse (i.e., screening people with little potential for net benefit) and misuse (i.e., conducting screening in ways that reduce net benefit) may also be important problems.

The RTI International-University of North Carolina Evidence-based Practice Center (RTI-UNC EPC) prepared this report, under the auspices of the Agency for Healthcare Research and Quality, for the National Institutes of Health (NIH) State-of-the-Science Conference on Enhancing Use and Quality of Colorectal Cancer Screening, which is scheduled for February 2010. This report is a systematic review of evidence about the use and quality of screening for CRC focusing on four primary key questions (KQs). It also includes an initial background section (KQ 1) on trends and the current situation of use and quality, and it presents a concluding discussion on needed research (KQ 6). The specific KQs of interest were as follows:

KQ 1. What are the recent trends in the use and quality of CRC screening?

KQ 2. What factors influence the use of CRC screening?

KQ 3. Which strategies are effective in increasing the appropriate use of CRC screening and followup?

KQ 4. What are the current and projected capacities to deliver CRC screening and followup at the population level?

KQ 5. What are the effective approaches for monitoring the use and quality of CRC screening?

KQ 6. What research is needed to make the most progress and have the greatest public health impact in promoting the appropriate use of CRC screening?

Methods

We searched MEDLINE®, the Cochrane Library, and the Cochrane Central Trials Registry for studies published in English from January 1998 through September 2009. We searched data sources using Medical Subject Heading (MeSH) terms when available or key words when appropriate. MeSH terms for our searches included colorectal neoplasms, colonoscopy, sigmoidoscopes (including flexible sigmoidoscopy [FS]); major headings included mass screening; and key terms included stool test, fecal occult blood test (FOBT), and DNA stool).

We used standard EPC methods of dual review of abstracts, full text articles, data abstraction for evidence tables, rating quality of articles, and grading strength of evidence. Specifically, we rated the internal validity of studies as good, fair, or poor. We used the AHRQ EPC program's approach to grading strength of evidence as high, moderate, low, or insufficient for KQs 3, 4, and 5. We resolved disagreements by consensus.

KQ 1: Background on Recent Trends in Use and Quality of CRC Screening

This section summarizes trends in the use of CRC screening tests, CRC screening discussions, and the quality of CRC screening. In some cases, data were insufficient to determine trends, but we present current status where possible.

Underuse of both CRC screening and patient-physician discussions of CRC screening is clear. Self-reported screening rates by national surveys, which are likely overestimates of actual screening, have increased from less than 25 percent in the late 1980s to about 50 percent to 60 percent in 2005 to 2006; an even smaller percentage of people had had a discussion about CRC screening with their primary care physician. The increased screening can be attributed entirely to an increase in the use of screening colonoscopy; screening with FOBT and sigmoidoscopy declined over this period. We found no data on the trends of use or quality of fecal immunochemical test, fecal DNA testing, or computed tomographic colonoscopy.

Few health care systems have developed monitoring systems to provide physicians with feedback on CRC screening rates, nor have they provided incentives to physicians for improving screening. The health care system of the Veterans Health Administration (VA), which relies more on FOBT than other modalities for screening and which has developed monitoring and incentive systems, has screening rates above 75 percent.

At the same time as the underuse documented above, screening can be overused when people who are unlikely to benefit are screened: for example, people older than 85 years and/or people with severe comorbidities. Surveillance colonoscopy and, probably, polypectomy for diminutive polyps less than 5mm where benefit is uncertain but increased risk is clear, may also be overused though research on this issue is still needed (i.e., the extent to which removal of small polyps is a greater or lesser harm to the patient compared to ignoring the polyps).

Finally, problems of misuse, screening in such a way as to reduce benefits and/or increase harms, are also clear. These include use of in-office rather than home FOBT; nonreturn of FOBT cards; lack of adequate followup of positive FOBT results; colonoscopy that does not reach the cecum, has too rapid withdrawal time, that misses important lesions, and colonoscopy with high adverse event rates.

Results

Our initial searches of electronic databases, along with handsearches and an updated search in October 2009 produced 3,029 unduplicated records. Ultimately, for the four main questions, we included the following numbers of articles that were rated either good or fair quality: 72 studies addressing KQ 2, 21 addressing KQ 3, 12 addressing KQ 4, and 8 addressing KQ 5. We excluded studies rated poor quality from our analyses.

KQ 2: Factors Influencing Colorectal Cancer Screening

We categorized studies examining factors associated with the use of CRC screening tests into five domains: patient factors, physician factors (including physician characteristics, physician-patient connectedness, and physician recommendations about screening), patient-physician communication factors, the periodic health examination, and system factors. We further categorized the patient factors into four groups: patient demographics, access to care, personal health or risk factors, and psychosocial factors.

All studies focused on factors associated with underuse of CRC screening. None focused on factors associated with underuse of CRC discussions or on factors associated with overuse or misuse of CRC screening.

Factors consistently and significantly associated with reduced CRC screening include

- low household income,
- no health insurance,
- being Hispanic or Asian,
- not being acculturated into the United States,
- limited access to care (i.e., lack of a regular source of primary care and no visits in previous year to provider), and
- no physician recommendation to be screened.

Factors positively associated with CRC screening include having private insurance, being non-Hispanic white, having a higher education level, participating in regular screenings for other cancers, having a family history of CRC or personal history of another cancer, having regular access to care, having effective patient-provider communication, and having a physician recommendation for screening. We found two studies that focused on patient factors that seem to influence followup rates after receipt of an abnormal result. We found one study each that examined the association between screening and specific physician characteristics, patient-physician connectedness, and periodic health examinations. Thus, we did not draw conclusions about these relationships because the evidence was insufficient. Studies on system level factors that might influence CRC screening did not consistently measure the same variables but seem to support counseling by nonclinicians, reminder systems, and assisting patients to keep appointments.

KQ 3: Effective Strategies for Increasing Appropriate Use of Colorectal Cancer Screening

We first categorized studies into three intervention targets: patients, physicians, and health care systems. Following similar categories recently used to develop recommendations for the Task Force on Community Preventive Services (TFCPS), we further divided the patient-level interventions into five categories: (1) patient reminders; (2) small media (with and without decision aids); (3) group education; (4) one-on-one interactions; and (5) eliminating structural barriers. All studies of interventions focused on reducing underuse of CRC screening and/or followup after receiving a positive FOBT. We found one study that examined an intervention to increase patient-physician discussions about CRC screening. No study tested an intervention to reduce overuse or misuse of CRC screening.

Interventions that provided patient reminders led to small to moderate increases in CRC screening, with high strength of evidence (5.0 to 15.0 percentage point increase). Studies of small media (educational print or video messages) to increase CRC screening showed no benefit, with high strength of evidence. Evidence concerning decision aids to increase screening was mixed. With two of three studies showing benefit, some types of decision aids may be effective for increasing screening (14.2 to 23.0 percentage point increase in screening rates reported in the two positive studies; 3.0 percentage point increase in the one negative study), although overall strength of evidence was low. Evidence was also mixed (i.e., low strength of evidence) concerning the effect of group education, with one study showing a negative effect on screening and another finding a small positive effect. One-on-one interactions, especially with intensive contact with patients by a nurse, a health educator, or on the phone, increased screening rates, sometimes to a large degree, with percentage point increases such as 14.6 percentage points in FOBT completion, 20.9 percentage points of any CRC test, and 41.9 percentage points in FOBT completion. Strength of evidence for this type of intervention was high. Interventions that eliminated structural barriers, such as by providing FOBT tests to use at home or providing access to individuals who can help to address barriers, also increased screening rates, with high strength of evidence (absolute rate change from 14.6 to 41.9 percentage points).

Two studies of physician-targeted reminder interventions found either no effect or a very small effect on appropriate screening, with low strength of evidence. More evidence was available for evaluating various system-level interventions (e.g., implemented changes to improve referral of patients for screening or identified a person such as a patient navigator or someone in a similar role (i.e., Prevention Care Manager or PCM) to help patients navigate the health care system). These studies found consistently positive effects on screening (7.0 to 28.2 percentage point difference in screening rates compared to control groups), with high strength of evidence.

KQ 4: Capacity to Deliver Colorectal Cancer Screening and Followup

Initially, we examined three aspects of this issue: current capacity to conduct CRC screening (six studies in seven articles), projected capacity (five studies), and ability to meet projected demand (i.e., nation's ability to meet the projected demand under various scenarios, such as screening the entire eligible US population with a specific test). Several modeling studies, using various assumptions, addressed these issues.

These modeling studies found that if the United States were to adopt a colonoscopy-only approach to CRC screening and if everyone were to agree to be screened in this way, colonoscopy capacity would need to be substantially increased to do the "catch-up" screening required to screen people who have not been screened and to continue to screen in a steady state for all eligible people. The strength of evidence for all the data and estimates from these studies is low.

KQ 5: Effective Approaches for Monitoring CRC Use and Quality

We found no studies that directly answered the question of how CRC screening use and quality have been effectively monitored and tracked in the past decade. Included studies addressed only one specific component of monitoring, namely data quality; we found no studies that described or compared other monitoring system attributes. Overall in our review we found that some national surveys (e.g., the National Health Interview Survey [NHIS], the Behavioral

Risk Factor Surveillance System [BRFSS]) monitor self-reported CRC screening by the US population. Current national registries are inadequate to monitor accurately the CRC screening rates of medical practices, and few practices (with the exception of the VA system and the National Committee on Quality Assurance Healthcare Effectiveness Data and Information Set [HEDIS]) monitor their own CRC screening rates or the quality of CRC screening. No current national registries monitor either CRC discussions or overuse or misuse (including adverse events) of CRC screening. Registries for conditions other than CRC may provide some models for CRC screening.

Discussion

Although recent trends have shown a gradual increase in CRC screening, these increases still leave levels of CRC screening considerably below levels for breast cancer screening. Some differences between the rates for CRC screening and breast cancer screening may occur because of the nature of CRC screening, with several options for screening strategies, each with its own set of preparation and completion difficulties for the patient. The implications of this review are related primarily to the findings specific to the interventions tested to increase screening, and to three cross-cutting themes that underlie our findings: access to CRC screening; communication about CRC screening; and the organization of CRC screening.

Interventions to Improve Screening

The interventions reviewed in KQ 3 deserve further comment. Although we found high strength of evidence and positive effects for patient reminders, one-on-one interactions, eliminating structural barriers to screening, and system-level interventions, whether any specific set of interventions would effectively increase screening rates across the country remains unclear. First, whether we have the ability to implement these interventions on a broad scale within medical practices, and for the general population, is uncertain. To implement and maintain these interventions properly, an effective monitoring and feedback system (KQ 5) is needed. These systems are not in place in most primary care practices. Second, overcoming the focus in primary care practices on nonpreventive care, and overcoming the time and cost barriers to implementing and maintaining these types of screening systems within busy primary care practices, both present uncertainties. Partly because of the lack of positive incentives and the required time and effort from primary care practices, the durability of interventions that initially seem successful is uncertain. Finally, the cost effectiveness of the sometimes intensive interventions to gain disproportionately small increases in screening is also unknown. Until these more fundamental issues are dealt with, widespread implementation of any interventions may not have a large, sustained effect at reasonable costs (including time and effort of the patient, the physician, and the medical practice).

Access to CRC Screening

A critical underlying issue in this literature is access to care, a necessary precursor to access to CRC screening. Among the most striking findings from our review of factors associated with lower rates of CRC screening (KQ 2) is that people without health insurance, people with no source of usual care, people with no recent physician visits, and people with lower income status have quite low CRC screening rates. Improved communication can only be effective for people

who are connected (KQ 2) to a primary care provider. For CRC screening rates to improve dramatically, providing more standard access to this care for people who will benefit the most is essential.

Communication About CRC Screening

One positive finding of this report is the overall importance of communication specific to CRC screening between medical staff and patients in improving appropriate CRC screening (i.e., reducing underuse, overuse, and misuse). CRC screening requires a great deal of patient understanding and effort (e.g., knowing which tests to take and when, and how to get them done). Communicating such information to patients and guiding them in making decisions specific to their medical and family history all take time. To make appropriate decisions about individually optimal screening, to carry out the preparation and follow-through correctly, and to obtain screening at recommended intervals all require patient knowledge, motivation, and assistance from medical personnel. When few CRC discussions take place (KQ 1), when many eligible patients do not know that they should be screened (KQ 2), when medical personnel make few recommendations for screening (KQ 2), when many people do not receive periodic health exams [during which time might be devoted to discussions of CRC screening (KQ 2)], and when few intensive one-on-one or system level interventions exist, including those to eliminate barriers, to assist patients to decide, prepare, and follow-through (KQ 3), suboptimal screening rates should not be surprising.

Organization of CRC Screening and Monitoring

CRC screening in the United States requires the involvement of primary care physicians, most of whom receive no regular feedback on their CRC screening rates, as might occur in the VA or other integrated health care system. Few medical practices involve nonphysician office staff in discussing CRC screening with patients; few reach out to patients who have not been screened or who miss screening appointments. As suggested by the VA's success with CRC screening (KQ 1), by the association of use of nonphysician staff with higher CRC screening rates (KQ 2), and by randomized controlled trials (RCTs) of organizational change (KQ 3) to improve screening, organizational change supported by monitoring and feedback systems (KQ 5) could have a positive effect on screening. Nonetheless, drawing conclusions on how to reduce overuse and misuse will always be difficult without adequate monitoring of these outcomes.

A second important aspect of organization is external to the primary care practice, and involves coordination of various parts of the health care system involved in CRC screening. Because these parts of the health care system are often fragmented, barriers are set up that patients must navigate to complete screening. These same barriers work against monitoring the progress of patients as they move through the system, and providing assistance to those who are not able to surmount the barriers. Finally, these barriers create problems for providing consistent and timely information to patients, and for establishing systems to reduce overuse and misuse.

KQ 6: Future Research Directions

The priority for research should be RCTs of interventions to implement appropriate CRC screening (i.e., minimizing underuse, overuse, and/or misuse) and monitoring, which is then linked to improvement initiatives. In our review, we became aware of multiple studies of the

operating characteristics of potential new CRC tests. Although improving screening tests is a reasonable research agenda (especially in finding ways to reduce the need for the most invasive and expensive tests), a greater balance with research could help find ways to implement screening programs that we already know are effective. To focus research primarily on developing newer screening tests without placing higher priority on implementation of the effective existing tests leaves people with inadequate screening.

Our review suggests that three steps are required for achieving higher rates of appropriate screening: (1) increasing patient access to care; (2) improving effective communication about screening and screening options between trained educators (physicians or nonphysicians) and patients; and (3) simplifying and coordinating organizational structures to better facilitate patients in completing screening. At least as important as developing newer screening tests is research to test interventions to improve access, communication, and organization of health.

Not only must the organizational and system features needed to increase screening be understood, but research also needs to consider the interaction of system features with characteristics of the population. Several studies testing interventions (KQ3) were implemented within clinic settings, limiting the generalizability of the findings. More needs to be understood about how interventions work in increasing screening among those receiving services through different settings. Since studies show that people who have access to a regular source of care are more likely to be screened (KQ2), research should focus more on those without this facilitator. In addition, access, communication, and organizational requirements to increase appropriate screening will most likely differ depending on the population involved. The most efficient and cost-effective approaches to increase appropriate screening will probably include some tailoring of the intervention to these and other specific populations.

After determination of the effectiveness and cost effectiveness of various interventions, pragmatic trials focused on implementation of successful strategies within different types of health care systems and populations are needed. Different intensities of interventions, and even wholly different interventions, will likely be needed for different populations. Interventions should be targeted at the specific steps that are problems for specific populations (e.g., those who speak other languages than English at home could likely benefit from more basic interventions to increase awareness and discussions, whereas those who are already obtaining screening on an irregular basis may benefit most from patient reminders).

Further, we also need continued research into measuring current volume and projected demand for screening strategies. Finally, we found little evidence that adequate monitoring systems that assess the full spectrum of appropriate CRC screening (including overuse, underuse, and misuse) are in widespread use, and are being used to improve screening. Such monitoring systems are critically important for continued improvement of CRC screening, especially for reduction of overuse and misuse. There is a large and important research agenda in developing and testing interventions to increase discussions of CRC screening, and to reduce overuse and misuse.

Throughout this review, accurately describing results for the outcome of CRC screening has been a major challenge because of the inconsistencies in how it has been measured and/or operationalized. We see a need to develop standard measures for assessing the outcomes (and also for assessing factors associated with screening). While efforts have been completed in the past to standardize related measures for how CRC screening is to be assessed and then to develop valid measures, these measures have not been consistently used in all national surveys or studies, making it difficult to accurately assess current screening rates. Better application of these

existing measures would greatly improve the quality of the findings from studies to be done in the future, thereby expanding our understanding of what factors influence CRC screening that can actually be addressed through interventions and policy development.

This need for standard measures and mechanisms for collecting the data directly relates to the findings for KQ 5, in that we found no studies that directly answered the question of how CRC screening use and quality have been effectively monitored and tracked in the past decade. Without more information that is systematically collected through provider practices, hospitals, clinics, and other primary care organizations, our understanding of CRC screening will continue to be less than optimal.

Conclusions

Our review suggests that the United States is yet some distance from fully realizing the promise of appropriate and high-quality CRC screening. Problems of underuse, overuse, and misuse are not being adequately addressed at present. By focusing our research effort on the issues that matter most—access to screening, communication between patient and medical staff, the organization of care—and by further researching how to implement effective and cost-effective strategies into actual primary care practice, we will have the greatest opportunity to reduce the burden of suffering of CRC for the people of the United States.

Evidence Report

Chapter 1. Introduction

Periodic screening of people at average risk for colorectal cancer (CRC) is recommended by three important national guideline groups, the United States Preventive Services Task Force (USPSTF), the American Cancer Society (ACS), and the U.S. Multi-Society Task Force on Colorectal Cancer (MSTF),[3-4] as well as multiple professional societies. For CRC screening to contribute to a reduction in CRC mortality without unreasonable harms and costs, however, it must be offered to people who have a reasonable probability of net benefit, and it must be conducted in an effective and efficient manner. These issues of use and quality are especially salient for CRC screening because it is in some ways more complex than other screening programs. We understand "quality" to refer to "underuse," "overuse," and "misuse"[5] rather than simply test performance. Underuse of CRC screening has been a clear problem for some years; evidence is now growing that overuse (i.e., screening people with little potential for net benefit) and misuse (i.e., conducting screening in ways that reduce net benefit) may also be important problems.

This report is a systematic review of four key questions (KQs) concerning the use and quality of screening for CRC. As part of the first KQ, a background section on trends and the current situation of use and quality are presented. Literature was not systematically reviewed for this KQ but are instead summarized to provide the reader with a sense of the current status of trends in CRC testing. The purpose of the remaining five KQs is to inform recommendations for improving the use and quality of CRC screening. To achieve this goal, we provide information about factors associated with the use of CRC screening (KQ 2), effective strategies for increasing the appropriate use of CRC screening and followup (KQ 3), the current and projected capacity of the US health care system to deliver tests (especially colonoscopy) for the population needing screening (KQ 4), and approaches for monitoring the use and quality of CRC screening (KQ 5). We then conclude the review in Chapter 5 with a discussion that includes recommendations for research needed to make progress and have greatest public health impact in promoting the appropriate use of CRC screening (KQ 6). The RTI International-University of North Carolina Evidence-based Practice Center (RTI-UNC EPC) prepared this report for the National Institutes of Health (NIH) State-of-the-Science Conference on Enhancing Use and Quality of Colorectal Cancer Screening, which is scheduled for February 2010.

Development of Evidence and Recommendations for CRC Screening

Several screening tests for CRC are in current use, including guaiac-based fecal occult blood test (gFOBT, which can be either high or low sensitivity), fecal immunochemical test (FIT), flexible sigmoidoscopy (FS), and colonoscopy. Two other tests have been used in the past but are less used today: digital rectal examination and double contrast barium enema (DCBE). Two newer tests have been proposed but are not in widespread use: fecal DNA and computed tomographic colonography (CTC).[6] This report will focus on the current and newer tests.

Since the early 1990s, four randomized controlled trials (RCTs) of screening with gFOBT[7-10] have found a relative reduction of 16 percent to 33 percent in CRC mortality (absolute risk reduction = 2.9 deaths/1,000 over 13 years in the US trial), first appearing 5 to 7 years after start of screening. Although the USPSTF found insufficient evidence to recommend screening in 1989,[11] before the RCTs had reported, it recommended screening with gFOBT or FS (supported

by a good-quality case-control study) in 1996,[12] after several RCTs were published. The 1996 USPSTF recommendation, however, found insufficient evidence to recommend screening with colonoscopy, noting the lack of RCT evidence to determine the magnitude of benefit. In 2002, the USPSTF broadened its recommendation to include screening with any of several tests, including gFOBT, FS, and colonoscopy. The recommendation for colonoscopy was based on extrapolation of benefits from studies of FOBT and FS.[13-15]

In 2008, the USPSTF updated its recommendation again, recommending screening with any of several tests, including gFOBT, FIT, FS, and colonoscopy. It recommended that adults ages 76 to 85 not be screened routinely (i.e., screening should be determined by modeling a history of sufficient screening up until that point) and that adults ages 85 years and older not be screened at all. It found insufficient evidence to make any recommendation concerning screening with fecal DNA or CTC.[3]

The USPSTF placed emphasis on the need for discussion between providers and individual patients to determine the optimal screening strategy. As noted in the 2002 recommendation statement:

> The choice of specific screening strategy should be based on patient preferences, medical contraindications, patient adherence, and available resources for testing and follow-up. Clinicians should talk to patients about the benefits and potential harms associated with each option before selecting a screening strategy.[13]

The MSTF has issued three sets of guidelines over the past 12 years (1997, 2003, and 2008) on screening for CRC; they were joined in the 2008 guideline by the American Cancer Society (ACS) (which had developed its own guidelines over previous years) and the American College of Radiology (ACR). The 1997 guideline recommended screening using one of five options: annual FOBT, FS every 5 years, annual FOBT and FS every 5 years combined, double-contrast barium enema every 5 to 10 years, and colonoscopy every 10 years.[16] The 2003 recommendation repeated the same options, noting that "these guidelines offer screening options and encourage the physician and patient to decide together which is the best approach for them."[17] The 2008 recommendation suggested the same tests but added CTC and fecal DNA testing.[4] The 2008 guideline departed from the previous MSTF recommendations in that it separated screening tests into those that primarily detect CRC (gFOBT, FIT, fecal DNA) and those that detect both CRC and colonic polyps (FS, colonoscopy, CTC, barium enema). It recommended a test from the latter group most strongly but also approved screening with a test from the former group if the patient refused a test that detects both CRC and polyps. The guideline states "When possible, clinicians should make patients aware of the full range of screening options, but at a minimum they should be prepared to offer patients a choice between a screening test that primarily is effective at early cancer detection and a screening test that that is effective at both early cancer detection and removal of polyps". (p. 1570)[4] Because of the changes and, often, the inconsistencies in the national guidelines, and because of such issues as patient preferences, medical contraindications, patient adherence, and available resources,[13] a number of factors can affect whether or not a patient is screened. These factors are described and literature presented under KQ 2 in Chapter 4.

Four issues emerge from this brief review above. First, although only gFOBT has been tested in full RCTs of CRC screening, guideline groups have determined that other tests that find early CRC would also be effective in reducing CRC mortality. This allows a range of screening options, each with its own set of potential benefits and harms.

Second, this range of options has presented problems in making recommendations, making screening for CRC more complex in some ways than screening for such conditions as breast cancer where fewer tests (mammography, clinical breast examination) are recommended. The solution proposed by both the USPSTF and the MSTF has been discussion with patients to make individualized screening decisions. The variation in potential benefits and harms of the range of options, however, makes it unlikely that brief discussions can achieve a truly informed decision. Longer discussions to fully address all related issues are problematic because of the limited time already afforded to the physician to address preventive care during a specific medical appointment.

Third, experts disagree about whether tests that detect polyps in addition to CRC (so-called "structural tests," such as colonoscopy) should be preferred over tests that primarily detect CRC ("nonstructural tests" such as FOBT and FIT, which are among the tests recommended by the USPSTF). Most of the mortality reduction in the RCTs of gFOBT (over 10 to 15 years of followup) has likely come from detection of early CRC rather than removal of polyps, although polypectomy has been shown to reduce the incidence of CRC by about 20 percent over 18 years of followup.[18] In addition, the primary structural test (colonoscopy) carries greater potential harm and cost than non-structural tests. Thus, the evidence is not clear that the net benefits (benefits minus harms) of structural tests are greater than those of non-structural tests.

Fourth, the USPSTF recommends stopping routine CRC screening after age 75 (and all CRC screening after age 85). The MSTF acknowledges that a different screening recommendation may be appropriate for older people, but they delayed comment in the current guideline.[4]

Implementation of Guidelines: Use and Quality

Although a substantial range of effective options exists, CRC screening cannot optimally reduce CRC mortality without unreasonable harms and costs unless two conditions are met: (1) screening is used by a large percentage of eligible people and (2) screening minimizes problems of quality such that patients are being screened appropriately, according to current national guidelines (i.e., underuse, overuse, and misuse are addressed). By underuse of CRC screening we mean that people who would likely derive a net benefit (in which benefits exceed risks or harms by a meaningful amount) are not screened at all or not screened at an appropriate frequency. Underuse is a common issue at the beginning of screening programs. Mammography screening for breast cancer, for example, took some years to become widespread; the 2005 Behavioral Risk Factor Surveillance System found that 74.6 percent of women ages 40 years and older reported having had a mammogram within the previous 2 years.[19] An important question is whether the greater complexity of CRC screening (e.g., variety of tests, timing of each, benefits/harms of each, invasiveness of most) will result in a lower percentage of eligible people being screened, a concern of special importance for disadvantaged populations where underuse is often most severe. In addition to the underuse of CRC screening tests, there is a parallel underuse of discussions between patients and clinicians about CRC screening, as recommended by both major guideline groups.

By overuse of CRC screening we mean the screening of people (or the use of screening techniques) with a low probability of net benefit. Among the common overuse issues are screening people with severe comorbidities and screening people over age 85 (as both groups would be unlikely on a population level to live long enough to benefit from screening). Another overuse concern is overly frequent surveillance colonoscopy after a previous polypectomy; the

natural history of colonic polyps is that only a small percentage progress to invasive cancer, and this progression takes many years. Thus, the frequency of surveillance should be determined by the probability of a patient developing a lesion that needs to be detected to extend life. Finally, although little literature exists on this issue, another potential problem of overuse of polypectomy may involve small polyps less than 5 mm in size. Because the current colonoscopy policy is to remove all polyps regardless of size, removal of small, low-risk polyps may yield little benefit. Yet evidence is clear that any polypectomy increases the risk of such adverse events as colonic bleeding.[20]

By misuse of CRC screening we mean conducting screening in ways that reduce net benefit for the people being screened. For example, misuse occurs when positive FOBT screening tests are not followed up within a reasonable time by full colon examination (such as colonoscopy). Another misuse problem is high rates of adverse events (e.g., colonic bleeding) from colonoscopy. These adverse events occur more frequently in people who have biopsies or polypectomies and in older people.[20] Colonoscopy that misses clinically important lesions is also an example of misuse. This can result from such factors as lack of full insertion of the colonoscope, too rapid withdrawal time, poor bowel preparation, or lack of skill of the colonoscopist.

Scope of this Report

In Chapter 2, we begin by presenting an overview of the methods used to address each KQ, including a description of the analytical framework used to guide our review. It is in Chapter 2 that we present the inclusion and exclusion criteria used for developing the systematic review. We note that although this report draws on the literature of the effectiveness of CRC screening, it does not review specific benefits and harms of screening. The presented literature notes gaps in the evidence base at appropriate times and states uncertainties where they exist. It does not, for example, examine the evidence of the operating characteristics of various CRC screening tests.

The first KQ, "what are the recent trends in the use and quality of colorectal cancer screening?" is presented in Chapter 3 and provides background information relative to patterns of use of CRC screening tests. The other four KQs entailed formal systematic reviews of the literature and results are presented in Chapter 4. The following are the four KQs for which we systematically reviewed available evidence:

- KQ 2: What factors influence the use of colorectal cancer screening?
  - There are two ways that this information may assist policymakers in improving the use and quality of CRC screening. One way is by uncovering modifiable factors that could be targeted in a future intervention. Another way is to show that problems in use and quality are more prevalent in one population than another. This would allow interventions to be targeted to specific population groups.
- KQ 3: Which strategies are effective in increasing the appropriate use of colorectal cancer screening and followup?
  - There are many types of interventions that could, and have been, considered to improve problems in use and quality of CRC screening. Policymakers need to know whether certain ones have been shown to be effective enough to implement immediately, and which ones are most promising for future research.

- KQ 4: What are the current and projected capacities to deliver colorectal cancer screening and surveillance at the population level?
  - The primary issue here is whether screening capacity is adequate to meet expected demands, assuming that screening rates increase to optimal levels. This is a special concern with colonoscopy, which is used for both screening and surveillance. If colonoscopy capacity is inadequate for a screening policy that prioritizes structural tests, then other approaches will need to be considered.
- KQ 5: What are the effective approaches for monitoring the use and quality of colorectal cancer screening?
  - To improve any health care program, one must be able to measure the expected outcome to determine when various interventions are achieving their intended result. Thus, we need to know whether we have systems in place to monitor adequately appropriate use and quality.

The final KQ, KQ 6, addressed "what research is needed to make the most progress and have the greatest public health impact in promoting the appropriate use of colorectal cancer screening?" and is incorporated into the discussion in Chapter 5.

Organization of this Report

The remainder of this report describes our methods to review and synthesize the literature (Chapter 2) and then summarizes the background specific to trends in use and quality of screening (KQ 1 in Chapter 3) and presents our systematic review results for KQ 2-5 (Chapter 4). In the discussion (Chapter 5), we summarize the findings and discuss the implications for practice and further research. A complete list of references is located immediately following the discussion chapter, along with a glossary of terms and a list of abbreviations used throughout this report. This report also contains the following appendices: Appendix A contains the exact search strings we used; Appendix B is all of the data abstraction forms used; Appendix C are our evidence tables; Appendix D is a list of our excluded studies; Appendix E lists the members of our Technical Expert Panel as well as our Peer Reviewers of a draft report; Appendix F lists our poor quality studies; and Appendix G contains supplemental information for KQ 4.[*]

[*] Appendixes and Evidence Tables for this report are provides electronically at http://www.ahrq.gov/downloads/pub/evidence/pdf/crcuse/crcuse.pdf.

Chapter 2. Methods

In this chapter, we document the procedures that the RTI International–University of North Carolina Evidence-based Practice Center (RTI–UNC EPC) used to develop this comprehensive evidence report on use and quality of screening tests for colorectal cancer (CRC). To provide a framework for the review, we first present the key questions and their underlying analytic framework. We then describe our inclusion and exclusion criteria, search and retrieval process, and methods of abstracting relevant information from the eligible articles to generate evidence tables. We also discuss our criteria for rating the quality of individual articles and for grading the strength of the evidence as a whole.

Technical Expert Panel (TEP)

In designing the study questions and methodology at the outset of this report, we consulted several technical and content experts, seeking broad expertise and perspectives. We identified five technical experts, in addition to the chair for the National Institutes of Health State-of-the-Science Conference on Enhancing Use and Quality of Colorectal Cancer Screening, for a total of six members (Appendix E).[†] The TEP provided assistance throughout the project and contributed to the Agency for Healthcare Research and Quality (AHRQ's) broader goals of (1) creating and maintaining science partnerships as well as public-private partnerships and (2) meeting the needs of an array of potential customers and users of its products. Thus, the TEP was both an additional resource and a sounding board during the project.

Divergent and conflicting opinions are common; we perceive them as healthy scientific discourse that contributes to a thoughtful, relevant systematic review. Nonetheless, in the end, study questions, design, and/or methodologic approaches do not necessarily represent the views of individual technical and content experts.

To ensure robust, scientifically relevant work, we called on the TEP to provide reactions to work in progress and advice on substantive issues or possibly overlooked areas of research. Specifically, TEP members participated in conference calls and discussions through e-mail to:

- refine the analytic framework at the beginning of the project;
- discuss the preliminary assessment of the literature, including inclusion/exclusion criteria; and
- provide input on the information and categories included in evidence tables.

Because of their extensive knowledge of the literature, including numerous articles authored by TEP members themselves, and their active involvement in the field, we also asked TEP members to participate in the external peer review of the draft report.

Key Questions and Analytic Framework

Based on the key questions (KQs) described in Chapter 1, we developed an analytic framework to guide our systematic review. To recap, the KQs are as follows:

[†] Appendixes and Evidence Tables cited in this report are provided electronically at http://www.ahrq.gov/downloads/pub/evidence/pdf/crcuse/crcuse.pdf.

- KQ 1: Background (recent trends in the use and quality of CRC screening tests);
- KQ 2: Factors influencing use of CRC screening;
- KQ 3: Effective strategies for increasing appropriate use of CRC screening and followup;
- KQ 4: Current and projected capacities to deliver CRC screening and surveillance at the population level;
- KQ 5: Effective approaches for monitoring use and quality of CRC screening; and
- KQ 6: Needed research to make progress and have greatest public health impact in promoting the appropriate use of CRC screening.

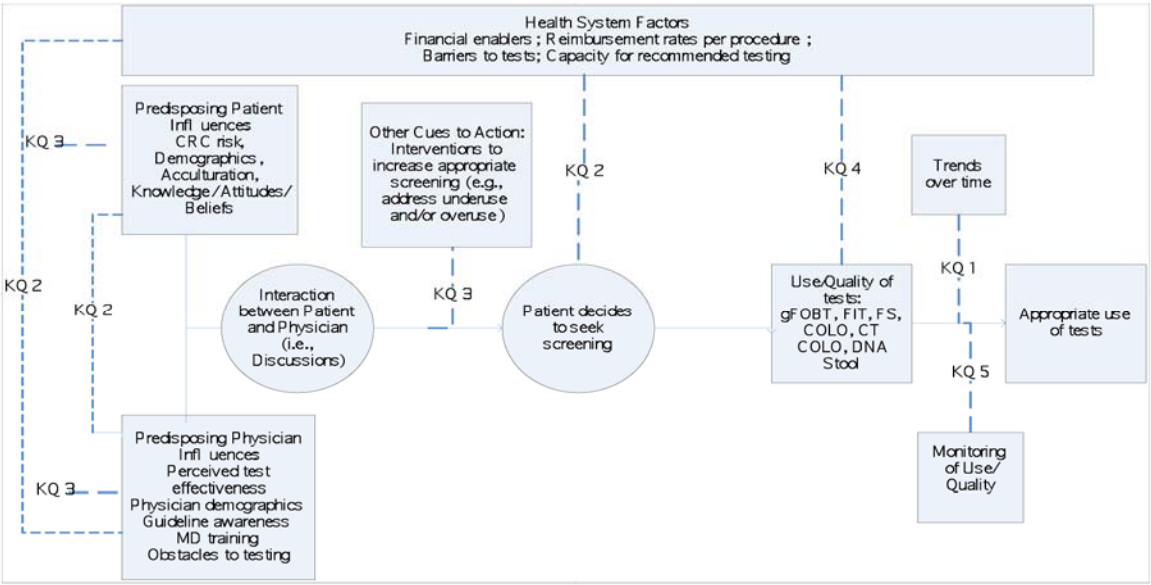
Figure 1 depicts how we believe various factors interact to influence the appropriate use of CRC screening tests. The boxes are indicative of factors or outcomes of the process of obtaining appropriate tests; the circles are meant to depict some interaction or decision point in the process (i.e., the interaction between physician and patient and the patient's decision point). KQs 1-5 are called out in the figure (dotted lines); the societal and health system factors are assumed to affect all steps in the process.

Figure 1. Analytic framework for the appropriate use of colorectal cancer screening

COLO, colonoscopy; CRC, colorectal cancer; CT COLO, computed tomographic colonography; DNA Stool, Deoxyribonucleic acid fecal test; FIT, fecal immunochemical test; FS, flexible sigmoidoscopy; gFOBT, guaiac-based fecal occult blood test; KQ, key question; MD, medical doctor.

Specifically, both KQ 1, which pertains to trends in use and quality of colorectal cancer screening, and KQ 5, which pertains to monitoring the use and quality, are considered to be outcomes of the process depicted in Figure 1. In the remainder of this systematic review, we assess the changes in trends over time and how the use and quality of the specific tests (i.e.,

Figure 1. Analytic framework for the appropriate use of colorectal cancer screening



COLO, colonoscopy; CRC, colorectal cancer; CT COLO, computed tomographic colonography; DNA Stool, Deoxyribonucleic acid fecal test; FIT, fecal immunochemical test; FS, flexible sigmoidoscopy; gFOBT, guaiac-based fecal occult blood test; KQ, key question; MD, medical doctor.

colonoscopy, sigmoidoscopy, computed tomography [CT] colonography, and stool tests) are

monitored. This includes paying particular attention to issues such as the extent to which overutilization and/or underutilization of tests is evident.[21-22]

Many factors have been shown in the literature to influence both the use and quality of tests. Although the patient is ultimately the one to decide whether to obtain screening,[23] a discussion with the health care provider about screening needs and options can directly affect the decision.[24-25] This discussion is depicted in the analytic framework as the point at which an interaction between key patient and provider characteristics occurs to guide the discussion.

As shown in the two boxes on the far left of the analytic framework (Figure 1), both the patient and the provider bring characteristics to this interaction that are immutable yet likely to influence the provider's recommendations for CRC screening and the patient's ultimate decision to seek it. Termed "predisposing" by Green and Kreuter, these factors exert their effects before a behavior occurs by increasing or decreasing a person's or a population's motivation to undertake that particular behavior.[26] Predisposing patient characteristics that may influence the ultimate decision related to CRC screening include

- family history of CRC;
- perceived risk or understanding of whether they are likely to be diagnosed with CRC;
- education level, income, and other socioeconomic factors;[27] and
- location of residence (i.e., proximity to screening facilities and/or providers).[28]

Predisposing physician characteristics that have been shown to influence screening recommendations[24,29] include

- perceived effectiveness of each type of CRC screening test;
- physician demographic characteristics such as age, whether solo or group practice, and location of practice; and
  medical training and awareness of current screening guidelines.

Literature Search

To identify articles relevant to each KQ we searched three electronic databases—MEDLINE®, the Cochrane Library, and the Cochrane Central Trials Registry—for articles published from January 1998 through September 2009. We used either Medical Subject Headings (MeSH or MH) as search terms when available or key words when appropriate. MeSH terms for our searches included colorectal neoplasms, colonoscopy, sigmoidoscopes; major headings included mass screening; and key terms included stool test, FOBT, and DNA stool. The full search strategy of exact search strings is presented in Appendix A.[‡]

Our initial searches of electronic databases produced 3,029 unduplicated records. We supplemented our electronic searches by manually searching reference lists of included studies, pertinent review articles, and editorials. Additional included studies were identified from recommendations of members of the TEP and by peer reviewers. We imported all citations into an electronic database (EndNote X.3).

[‡] Appendixes and Evidence Tables cited in this report are available electronically at http://www.ahrq.gov/downloads/pub/evidence/pdf/crcuse/crcuse.pdf.
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Study Selection Process

Inclusion and Exclusion Criteria

As noted in Chapter 1, this systematic review focuses on the use and quality of CRC screening procedures. We developed detailed eligibility criteria with respect to population, interventions, outcomes, time period, and study design (Table 1). We limited eligible studies to those conducted in the United States so that the data would reflect domestic health care concerns, practices, and guidelines. We also restricted our searches to studies published in 1998 or later to ensure that results had relevance to current trends and practice for CRC screening. We excluded studies that (1) were published in languages other than English, (2) did not report information pertinent to the KQs, (3) had fewer than 30 subjects for randomized or nonrandomized controlled trials or fewer than 100 subjects for observational studies, (4) were not original research, or (5) evaluated interventions that were conducted in academic settings that would not be applicable to most practice settings.

Table 1. Inclusion/exclusion criteria

Category	Inclusion Criteria	Exclusion Criteria
Study population	Humans, all races, ethnicities, cultural groups Asymptomatic for CRC and not at increased risk for CRC *OR* at increased risk for CRC because of a family history of CRC or polyps, or because of a history of polyps at prior colonoscopy	Studies that exclusively focus on CRC screening for patients with a family history Patients with diagnosis of any of the following: • Genetic diagnosis of FAP or suspected FAP without genetic testing evidence • Genetic or clinical diagnosis of HNPCC (also known as Lynch syndrome) or individuals at increased risk of HNPCC • Inflammatory bowel disease, chronic ulcerative colitis, or Crohn's disease • Colon and/or rectal cancer • Other hereditary polyposis syndromes Studies that assess whether certain groups are at greater risk for CRC than others (e.g., people with comorbidities such as diabetes, liver transplant)
Study outcomes	KQ 2: Factors influencing testing/screening rates only or CRC screening discussions (e.g., predisposing patient and provider characteristics, health system factors, interventions) or quality of CRC screening KQ 3: Interventions focused on changing appropriate CRC screening rates among a specified population and the rates are presented	KQ 2: Outcomes of knowledge, risk perception, providers' attitudes toward testing, and/or their referrals to testing (which include no screening outcome data) KQ 3: Changes in attitudes, beliefs, or intentions to obtain screening Other criteria specific to outcomes: Outcomes not directly addressing at least one KQ Cost-effectiveness, cost/benefit, or cost-utility of CRC screening for both included or excluded procedures

CAD, computer-aided detection; CRC, colorectal cancer; CT, computed tomography; CTC, computed tomographic colonography; DNA Stool, Deoxyribonucleic acid fecal test; FAP, familial adenomatous polyposis; FIT, fecal immunochemical test; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; gFOBT, guaiac-based fecal occult blood test; GI, gastrointestinal; FS, flexible sigmoidoscopy; HNPCC, hereditary nonpolyposis colorectal cancer; KQ, key question; MR, magnetic resonance; MRI, magnetic resonance imaging; N, number; PET, positron emission tomography; RCT, randomized controlled trial.

Table 1. Inclusion/exclusion criteria (continued)

Category	Inclusion Criteria	Exclusion Criteria
Study outcomes (continued)	KQ 4: Available number of screening providers and related equipment/facilities and support personnel to conduct the tests (nurses, etc.) KQ 5: Existence and adequacy of systems for monitoring CRC screening, CRC screening discussions, quality of CRC screening	Assessment of whether a procedure (usually two procedures compared to each other) is better at diagnosing/more effective than other procedures (usually retrospective) Assessment of different risk factors for CRC (e.g., diet in relation to diagnosis of CRC, calcium supplements, women taking hormone replacement therapy) and relation to incidence and/or mortality Treatment of complications (e.g., perforation) Treatment of CRC itself
Study geography	United States	All other countries
Time period for data collection	1/1/1998–9/30/2009	Data collection began before 1/1/1998
Interventions	Colonoscopy Sigmoidoscopy (or FS) CTC (or virtual colonoscopy with only CT) Double Contrast Barium Enema (DCBE) Stool tests: • DNA stool • FIT • gFOBT (including Hemoccult® II and Hemoccult® SENSA®)	Office FOBT (unless described/tested along with one of the included interventions) • MRI colonoscopy (or virtual colonoscopy with MRI) • Genetic testing • Ultrasound Any other tests, including: • Any unapproved tests • Included procedures combined with others (CTC with stool tagging, CTC with CAD technology) • Carbon dioxide insufflation during colonoscopy • Whole colonic imaging • Chromoendoscopy • PET and/or PET in combination with CTC, etc. • Bidirectional endoscopy • Laparoscopy with colonoscopy • Molecular screening • Submucosal injection polypectomy • Upper GI scope/gastroscope Studies examining the use of any of the included tests for the monitoring or assessment of a condition or disorder (e.g., diverticulitis) and therefore not for screening or surveillance of abnormal screenings for CRC Studies reporting on the use of included procedures in the surveillance of CRC Use of any included procedures to stage cancer (e.g., CTC) Studies testing the differences in sedation, dyes, and bowel cleansing methods during included procedures
Publication language	English	All other languages

Table 1. Inclusion/exclusion criteria

Category	Inclusion Criteria	Exclusion Criteria
Admissible evidence (study design and other criteria)	Original research that provides sufficient detail regarding methods and results to enable use and adjustment of the data and results; relevant outcomes must be able to be abstracted from data presented in the papers Eligible study designs: • RCTs • Nonrandomized controlled trials • Observation studies—prospective and retrospective cohort studies, case-control studies, and cross-sectional studies • Modeling studies Eligible sample sizes: • RCTs: N ≥30 • Nonrandomized controlled trials: N ≥ 30 • Observational studies: N ≥ 100	• Single case reports or small case series • Systematic reviews • Ecologic studies • Historical comparisons KQ 3: Studies without comparison group (e.g., pre/post only were excluded because they are generally unable to determine whether any changes in outcomes were due to a particular intervention as opposed to secular trends or other changes within a practice or setting)

We examined abstracts of all articles to determine whether studies met our eligibility criteria. Two members of our research team reviewed each abstract independently for inclusion or exclusion, using an Abstract Review Form (Appendix B).[§] If one reviewer concluded on the basis of the abstract that the article should be considered in the review, we obtained the full text. Two members of our research team then independently reviewed each full-text article for inclusion or exclusion using a Full Text Review Form (Appendix B). The two relevant reviewers discussed disagreements; when they could not reach consensus, the team met and discussed the article to determine as a group whether the study met eligibility criteria. Articles that did not meet criteria for inclusion are listed in Appendix D along with reasons for exclusion.

KQs 1 and 6, although part of this report, are not part of the systematic review. Therefore, studies described or discussed for those KQs did not have to satisfy final inclusion/exclusion criteria; such articles are not included in the overall number of included studies for the systematic review. We developed a "Background" category for articles that could provide useful information for KQ 1, KQ 6, the introduction, or the discussion.

Literature Synthesis

Data Abstraction

We designed and used a structured data abstraction form. Trained reviewers abstracted data from each study and assigned an initial quality rating. A second reviewer read each abstracted article, evaluated the accuracy, completeness, and consistency of the data abstraction, and

[§] Appendixes and Evidence Tables for this report are provides electronically at http://www.ahrq.gov/downloads/pub/evidence/pdf/crcuse/crcuse.pdf.

confirmed the quality rating. If differences in quality ratings could not be resolved by discussion, a third senior reviewer was involved. The full research team met regularly during the article abstraction period to discuss global issues related to the data abstraction process.

The final evidence tables are presented in their entirety in Appendix C.[**] Studies are presented in the evidence tables alphabetically by the last name of the first author. A list of abbreviations and acronyms used in the tables appears at the beginning of Appendix C.

Rating Quality of Individual Studies

To assess the quality (internal validity or risk of bias) of studies, we used predefined criteria based on those described in the AHRQ Methods Guide for Comparative Effectiveness Reviews (ratings: good, fair, poor).[30]

Elements of quality assessment for trials included, among others, the methods used for randomization, allocation concealment, and blinding; the similarity of compared groups at baseline; maintenance of comparable groups; overall and differential loss to followup; and the use of intention-to-treat analysis. We assessed observational studies based on the potential for selection bias (methods of selection of subjects and loss to followup), potential for measurement bias (equality, validity, and reliability of ascertainment of outcomes), adjustment for potential confounders, and statistical analysis.

In general terms, a "good" study has the least bias and results are considered to be valid. A "fair" study is susceptible to some bias but probably not sufficient to invalidate its results. The fair-quality category is likely to be broad, so studies with this rating will vary in their strengths and weaknesses. A "poor" rating indicates significant bias (stemming from, e.g., serious errors in design, analysis reporting large amounts of missing information, or discrepancies in reporting) that may invalidate the study's results.

Studies that met all criteria were rated good quality. The majority of studies received a quality rating of fair. This category includes studies that presumably fulfilled all quality criteria but did not report their methods to an extent that answered all our questions. Thus, the fair-quality category includes studies with quite different strengths and weaknesses. Studies that had a fatal flaw (defined as a methodological shortcoming that leads to a very high probability of bias) in one or more categories were rated poor quality and excluded from our analyses. Poor-quality studies and reasons for that rating are presented in Appendix F.

Grading Strength of Evidence

We evaluated the overall strength of evidence for the questions addressing the main outcomes of our review (KQs 3, 4, and 5) based on an approach devised for AHRQ's Method Guide.[30-31] Developed to grade the overall strength of a body of evidence, this approach incorporates four key domains: risk of bias, consistency, directness, and precision. It also considers other optional domains that may be relevant for some scenarios, such as a dose-response association, plausible confounding that would decrease the observed effect, strength of association (magnitude of effect), and publication bias. The evaluation of risk of bias includes assessment of study design and aggregate quality of studies.[31]

[**]Appendixes and Evidence Tables for this report are provides electronically at http://www.ahrq.gov/downloads/pub/evidence/pdf/crcuse/crcuse.pdf.

We graded evidence as consistent when effect sizes across studies were in the same direction and had a narrow range. When the evidence linked the interventions directly to our outcomes of interest, we graded the evidence as being direct. We graded evidence as being precise when results had a low degree of uncertainty. At least two members of our research team evaluated the overall strength of evidence for each outcome based on a qualitative assessment of strength of evidence for each domain and reconciled all disagreements.

The levels of strength of evidence are shown in Table 2. As mentioned, we present the strength of evidence assessments only for KQs 3, 4, and 5. These are the three KQs that are analytic and required an assessment of the body of literature available for this review. KQ 2 is descriptive and did not lend itself to an assessment of the strength of evidence. The strength of evidence tables appear in Chapter 4 as part of the presentation of results for KQs 3, 4, and 5.

Table 2. Strength of evidence grades and definitions

Grade	Definition
High	**High confidence that the evidence reflects the true effect.** Further research is very unlikely to change our confidence in the estimate of effect.
Moderate	**Moderate confidence that the evidence reflects the true effect.** Further research may change our confidence in the estimate of effect and may change the estimate.
Low	**Low confidence that the evidence reflects the true effect.** Further research is likely to change our confidence in the estimate of effect and is likely to change the estimate.
Insufficient	**Evidence either is unavailable or does not permit estimation of an effect.**

Source: Owens et al., 2009[31]

Applicability

We evaluated the applicability of the evidence based on a qualitative assessment of the population, intensity or quality of treatment, choice of the comparator, outcomes, and timing of followup. We based our parameters for evaluation on guidance provided by AHRQ's Methods Guide.[30] Specifically, we considered whether enrolled populations differ from target populations, whether studied interventions are comparable with those in routine use, whether comparators reflect best alternatives, whether measured outcomes are known to reflect the most important clinical outcomes, and whether followup was sufficient.

Peer Review

This draft report was subjected to external peer review by eight individuals who were experts in fields relevant to CRC screening or from various stakeholder and user communities (listed in Appendix E).[††] We provided the draft report to them on September 14, 2009. All eight provided thoughtful feedback on the report, including providing us with additional references that we should consider for inclusion in the final report. We reviewed all additional references and included those that were appropriate and within the scope of this report. We also addressed all comments and revised the report accordingly.

[††] Appendixes and Evidence Tables for this report are provides electronically at http://www.ahrq.gov/downloads/pub/evidence/pdf/crcuse/crcuse.pdf.

Chapter 3. Overview of Trends in Use and Quality of CRC Screening

We present here the results of our summary of information specific to trends in the use and quality of colorectal cancer (CRC) screening. Based on instructions from the Office of Medical Applications of Research (OMAR) at the National Institutes of Health (NIH) and from the Agency for Healthcare Research and Quality (AHRQ), we treated this question as a background question rather than a question for systematic review. For that reason, we present our findings here, separate from the four key questions (KQs) for which we present our analysis and synthesis of literature (Chapter 4). The articles that inform this section came from the general search that we conducted for all KQs, from multiple hand-searches of reference lists in those articles, and from suggestions of our expert Technical Expert Panel (TEP) and Peer Reviewers.

KQ 1: What are the Recent Trends in the Use and Quality of CRC Screening?

Trends in Incidence and Mortality from Colorectal Cancer

Colorectal cancer is the third most common nonskin cancer among men and among women; an estimated 146,970 people in the United States were newly diagnosed with this disease in 2009.[32] The overall age-adjusted incidence rate for CRC has decreased in both men and women and in all ethnic groups since the mid-1980s, with an overall 3 percent annual decline between 1998 and 2005.[33] CRC incidence is higher among non-Hispanic blacks than among non-Hispanic whites; it is lower among Asian-Pacific Islanders and Hispanics than among non-Hispanic whites.

Colorectal cancer is the also the third-highest cause of cancer death among men and women; an estimated 49,920 deaths were attributed to this disease in 2009 in the United States.[32] The overall age-adjusted mortality rate from CRC has decreased in both men and women since the mid-1980s; the annual percent decline between 2002 and 2005 was 4.3 percent.[33] CRC mortality rates declined for non-Hispanic black, non-Hispanic white, and Asian-Pacific Islander men and women. The rates dropped for Hispanic men but not for Hispanic women.[33] CRC mortality is higher in non-Hispanic blacks than non-Hispanic whites; it is lower in Asian-Pacific Islanders and Hispanics than in non-Hispanic whites. The gap in CRC mortality between non-Hispanic blacks and non-Hispanic whites did not change between 1997 and 2005.[34]

Measures of CRC Screening

Several approaches have been used for measuring the percentage of a population that is up to date on CRC screening according to the national guidelines. Research studies of this question have most often used patient self-reports, but administrative databases, medical record reviews, and physician reports have also been used. A field study for the National Committee on Quality Assurance (NCQA) compared three different measurement approaches for assessing rates of CRC screening: patient surveys, administrative datasets, and a hybrid approach that performed medical record review for patients who did not have evidence of screening by administrative data.[35] Among the five health plans examined in the NCQA study, two did not show much

difference between administrative and hybrid approaches, but the other three plans had 5 percent to 15 percent higher rates by the hybrid approach than by administrative data alone.[35]

In all five plans, patient surveys (surveys patterned on the standard questions used by the Behavioral Risk Factor Surveillance System [BRFSS] from the Centers for Disease Control and Prevention [CDC]) gave screening rates higher than the hybrid and administrative approaches; the differences ranged from 2.4 percent to 23.3 percent for the hybrid approach and from 7.9 percent to 34.8 percent for the administrative approach. The differences between the survey and administrative approaches were lower for fecal occult blood test (FOBT) screening (difference ranged from 0.4 percent to 11.3 percent) than for flexible sigmoidoscopy (FS) and colonoscopy (difference for colonoscopy ranged from 7.1 percent to 26.9 percent).

One major reason for higher estimates from surveys is that nonrespondents are likely to have had less screening over time than respondents. Thus, one would expect that surveys would overestimate screening when response rates are low. When response rates are high, other studies have found a smaller degree of overestimation of screening rates, although some overestimation is still present.[36-38] Other studies have found that self-report overestimates screening rates more with FOBT than with colonoscopy.[39-40] Ultimately, because of changes in guidelines, as well as how questions are asked and current use is operationalized, measures of CRC screening have been challenging to standardize. For this reason, drawing valid conclusions on use is problematic.

Changes in Medicare Coverage of CRC Screening

In January 1998, the Centers for Medicare and Medicaid Services started covering CRC screening for Medicare beneficiaries; the tests included FOBT and FS as recommended by the American Cancer Society (ACS). On July 1, 2001, Medicare extended coverage for screening to colonoscopy every 10 years.

Changes Over Time in National Surveys of Screening

We found reports of screening rates from large, national surveys in two major sources: the National Health Interview Survey (NHIS), administered by the National Center for Health Statistics (NCHS), and BRFSS. NHIS is a personal household interview that contains a core set of questions plus additional supplements on specific topics. The CRC screening questions were revised in the late 1990s. [41] Before 2000, the NHIS did not distinguish between home and office FOBT and did not distinguish among endoscopic tests (e.g., proctoscopy, FS, colonoscopy). In addition, the 2000 NHIS asked about screening longer than 3 years before the survey. [42] Thus, screening rates before 2000 included some number of office FOBTs within the previous 1 or 2 years and proctoscopy (as well as FS and colonoscopy) within the previous 3 years. Starting in 2000, up-to-date screening is defined as home FOBT within the previous year, FS within the previous 5 years, or colonoscopy within the previous 10 years. The earlier rates from NHIS are thus likely an overestimate of the actual screening rates at the time (because of including in-office FOBT and proctoscopy, and how questions were asked) compared with rates starting in 2000. Also, since respondents had been asked about endoscopy use in the past 3 years only, this rate could be an underestimate of screening for these tests. NHIS interviewers read test descriptions to all eligible respondents for the first time in 2003. [43]

BRFSS is a national, random-digit-dial telephone survey administered in the United States to respondents 18 and older. BRFSS asked about FS and proctoscopy (not distinguishing between

them) until 1999, when the question was changed to ask about FS or colonoscopy (again, not distinguishing between them). Before 2001, BRFSS did not allow for screening intervals longer than 5 years. Thus, BRFSS estimates before 2001 are for FOBT within the past year or lower endsocopy within the past 5 years. Starting in 2001, most estimates are for FOBT in the past year or lower endoscopy within the previous 10 years.

BRFSS response rates vary by state. For 1997, the overall median response rate by state was 62.1 percent, in 1999 it was 55.2 percent, and in 2001 it was 51.1 percent (range 33.3 percent to 81.5 percent). In 2002, the median response rate was 58.3 percent; in 2004 it was 52.7 percent, and in 2006 it was 51.4 percent. Thus, not all state estimates have the same validity.[44] About 3 percent of respondents were eliminated from the 2002 and 2004 analyses because they refused to answer or did not know the answer; in 2006, 4.5 percent were eliminated.[45]

Estimates from NHIS and BRFSS

In 1987 by NHIS data (Table 3), 22 percent of men and 24.2 percent of women had had an FOBT within the previous 2 years or FS, proctoscopy, or colonoscopy within 3 years.[41] For women, these screening rates increased to 28.2 percent in 1992 and 30.2 percent in 1998. For men, rates increased to 29.4 percent in 1992 and 37.1 percent in 1998.[41] In 2000 (using the more restrictive definition of screening), 37.1 percent of both men and women had had at least one of these tests.[42] In 2003, NHIS found that 46.5 percent of men and 43.1 percent of women had been screened[43] and in 2005, 50.0 percent of both men and women had been screened.[46]

Table 3. Trends in screening according to the National Health Interview Survey

Year	Men	Women	Combined
1987[a]	22%	24.2%	NR
1992[a]	29.4%	28.2%	NR
1998[a]	37.1%	30.2%	NR
2000[b]	NR	NR	37.1%
2003[b]	46.5%	43.1%	NR
2005[b]	NR	NR	50.0%

NR, not reported.
[a] Any fecal occult blood test (FOBT) within past 2 years or flexible sigmoidoscopy (FS), proctoscopy, or colonoscopy within past 3 years.
[b] Home FOBT within the past year, FS within the past 5 years, or colonoscopy within the past 10 years.

The 1997 BRFSS (Table 4) found that 41 percent of respondents ages 50 years and older had had either an FOBT in the previous year or lower endoscopy (either FS or proctoscopy) in the previous 5 years. In 1999, this percentage had increased to 44 percent.[47] The 2001 BRFSS found that 53.1 percent of people in this age group reported having either an FOBT within the previous year or lower endoscopy (either FS or colonoscopy) within the previous 10 years.[44] In 2002, this percentage was 53.9 percent; in 2004, it was 56.8 percent and in 2006, it was 60.8 percent.[45]

Table 4. Trends in CRC screening according to the Behavioral Risk Factor Surveillance Survey

Year	Men	Women	Combined
1997[a]	NR	NR	41%
1999[b]	NR	NR	44%
2001[c]	NR	NR	53.1%
2002[c]	55.3%	53.1%	53.9%
2004[c]	58.0%	55.9%	56.8%
2006[c]	61.5%	60.4%	60.8%

NR, not reported.
[a] Any fecal occult blood test (FOBT) within the past year or lower endoscopy (proctoscopy or flexible sigmoidoscopy [FS]) within the past 5 years.
[b] Any FOBT within the past year or lower endoscopy (FS or colonoscopy) within the past 5 years.
[c] Home FOBT within the past year or lower endoscopy (FS or colonoscopy) within the past 10 years.

Population Subgroups

The changes in definitions of tests and testing intervals noted above cloud the data concerning CRC screening rates among population subgroups, including racial, ethnic, age, sex or gender, income, and educational groups. One BRFSS study used common coding and standard definitions over the years 2002 to 2006 for the data in Table 5.[45] Although the absolute percentages here are slightly higher than those from the NHIS (partly because of higher response rates in NHIS and the use of telephone rather than in-person interviews), the

trends are the same in both surveys. Higher overall absolute screening rates are seen in older versus younger people, in white versus black populations, and in non-Hispanic versus Hispanic people. Higher education, higher income, and health insurance coverage are also associated with higher screening rates.

Table 5. Percentage of respondents 50 years of age or order who reported receiving a fecal occult blood test within 1 year and/or a lower endoscopy* within 10 years, by selected characteristics—BRFSS, United States, 2002, 2004, and 2006[†]

Characteristic	2002		2004		2006[‡]	
	%	(95% CI)	%	(95% CI)	%	(95% CI)
Total	53.9	(53.4 – 54.5)	56.8	(56.3 – 57.3)	60.8[§]	(60.4 – 61.3)
Age Group (years)						
50–64	47.9	(47.1 – 48.6)	50.2	(49.6 – 50.9)	54.7	(54.1 – 55.4)
≥65	62.3	(61.5 – 63.1)	65.9	(65.2 – 66.6)	69.3	(68.6 – 69.9)
Sex						
Male	55.3	(54.4 – 56.1)	58.0	(57.2 – 58.8)	61.5	(60.8 – 62.3)
Female	53.1	(52.4 – 53.8)	55.9	(55.3 – 56.5)	60.4	(59.8 – 61.0)
Race						
White, non-Hispanic	55.4	(54.9 – 55.9)	58.4	(57.9 – 58.8)	62.6	(62.1 – 63.0)
Black, non-Hispanic	52.0	(49.8 – 54.2)	55.2	(53.3 – 57.1)	59.0	(57.3 – 60.6)
Asian/Pacific Islander	42.7	(36.4 – 49.1)	47.6	(41.0 – 54.4)	55.9	(51.0 – 60.7)
American Indian/Alaska Native	51.2	(45.6 – 56.8)	47.0	(41.7 – 52.4)	48.4	(43.5 – 53.2)
Other	43.3	(39.4 – 47.2)	46.2	(42.1 – 50.3)	46.2	(42.7 – 49.8)
Ethnicity[‖]						
Non-Hispanic	54.8	(54.3 – 55.4)	57.8	(57.3 – 58.2)	62.0	(61.5 – 62.4)
Hispanic	43.9	(40.6 – 47.3)	46.2	(43.2 – 49.2)	47.2	(44.5 – 49.9)
Education level						
Less than high school diploma	41.0	(39.3 – 42.7)	43.9	(42.1 – 45.6)	45.5	(43.8 – 47.2)
High school diploma or equivalent	50.7	(49.7 – 51.6)	52.9	(52.1 – 53.8)	56.7	(55.9 – 57.4)
Some college/technical school	56.5	(55.5 – 57.5)	58.5	(57.5 – 59.4)	62.6	(61.8 – 63.5)
College degree	62.0	(61.0 – 63.0)	64.8	(63.9 – 65.6)	68.7	(67.9 – 69.5)
Annual household income						
<$15,000	43.4	(41.5 – 45.2)	45.0	(43.3 – 46.7)	48.4	(46.8 – 50.1)
$15,000–$34,999	49.1	(48.1 – 50.1)	51.2	(50.2 – 52.2)	53.9	(53.0 – 54.9)
$35,000–$49,999	56.0	(54.7 – 57.4)	58.6	(57.4 – 59.8)	62.0	(60.8 – 63.1)
$50,000–$74,999	59.4	(57.5 – 61.3)	62.1	(60.7 – 63.5)	67.2	(66.1 – 68.3)
≥$75,000	64.8	(63.2 – 66.4)	68.1	(66.8 – 69.3)	70.4	(69.3 – 71.4)
Health insurance coverage						
Yes	55.9	(55.3 – 56.5)	58.9	(58.3 – 59.4)	63.0	(62.5 – 63.5)
No	33.1	(30.8 – 35.5)	34.7	(32.2 – 37.3)	36.7	(34.3 – 39.1)

BRFSS, Behavioral Risk Factor Surveillance System; CI, confidence interval.
* Sigmoidoscopy or colonoscopy.
[†] Adapted from Use of colorectal cancer tests—United States, 2002, 2004, and 2006"; *Morbidity and Mortality Weekly Report;* 2008 March 14; 57(10);253-258.
[‡] Age standardized to the 2006 BRFSS population ages 50 years or older.
[§] Wald F-test of significance for differences across the three survey years, $P < 0.001$.
[‖] Race and ethnicity are not mutually exclusive.

Medical Practice Rates

Several studies provided information about CRC screening rates in medical practices, although we found no practice with uniform methods that could provide trend data over time. One chart review study of a sample of 12 diverse primary care practices in Michigan in 2003 found that CRC screening rates varied from 24 percent to 60 percent of eligible patients being up to date (FOBT in the past year, FS in the previous 5 years, or colonoscopy in the previous 10 years).[48] Another study examined CRC screening for 21,833 patients who were continuous members of an integrated health plan in the Midwest for the 5-year period ending December 31,

2003. Using automated records, the authors classified 54 percent of patients as being up to date for CRC screening (having received at least three FOBT kits, one FS, one colonoscopy, or one barium enema over that period).[49]

Frequency of Discussions about CRC Screening

We found no trend data about this topic, but we did find several relevant articles. One study from 1998 to 2006 in southern California collected data from surveys with 191 physicians and 5,978 patients, asking about previous screening and discussions about several conditions, including FOBT and FS.[50] In this study, 37 percent of patients had discussed FOBT with their physician and 31 percent had discussed FS.

A second study audiotaped interactions between patients of the Veterans Health Administration (VA) eligible for CRC screening and their physicians.[51] The study defined nine elements of informed decisionmaking and scored the occurrence of each element in 91 audiotapes of patients who had a CRC screening test ordered during that visit. Informed decisionmaking elements included such issues as discussion of the patient's role in decisionmaking, discussion of alternatives, discussion of uncertainties, assessment of patient understanding, and asking for patient preferences. The median number of elements addressed was 1. No single element was addressed in more than 50 percent of interactions. Only 6 percent of interactions discussed uncertainties or patient understanding. A telephone and in-person survey asked 65 academic and community primary care physicians to present CRC screening to the investigator as if the investigator were a patient.[52] Only 33.8 percent of respondents discussed the patient's role in the decision, 16.9 percent discussed benefits and risks of screening strategies, and 10.8 percent provided alternative screening strategies.

A 2005 survey asked 270 primary care physicians connected with Northwestern University Feinberg School of Medicine to rate the importance of various general communication tasks relevant to CRC screening and to report how often they accomplish those tasks with screening-eligible patients.[53] Talking with patients was rated 9.5 out of 10 in importance; physicians reported that they accomplished this with 84.4 percent of patients. Discussing colonoscopy was rated 9.2; physicians reported accomplishing this with 84.8 percent of patients. Explaining test benefits was rated 9.0; physicians reported that they accomplished this for 79.3 percent of patients. Explaining test risks was rated 8.1; physicians reported this behavior for 63 percent of eligible patients. Eliciting patient views or preferences was rated 8.0; physicians reported accomplishing this for 65.7 percent of patients. Presenting more than one option was rated only 6.4 on the same scale and discussing FOBT was rated as 5.0; physicians reported accomplishing an FOBT discussion with 54 percent of eligible patients.

This same study also examined videotapes from an existing dataset of primary care encounters.[53] The authors found 18 videotaped encounters from a database of 271 interactions with patients' ages 49 to 80 years in which the physician discussed CRC screening for the first time. Two authors viewed each videotape to determine to what extent physicians achieved the tasks they rated in the survey above. The benefits of the screening test were described in 28 percent of encounters; the risks were described in 0 percent of the encounters. In 28 percent of videotaped encounters in which CRC screening was discussed, physicians elicited patient views or preferences for CRC screening.

A survey of 2,501 patients of an integrated health care delivery system in southeastern Michigan who were continuously enrolled from 1999 to 2003 was able to link patients' responses to an automated health record system to determine CRC screening over the 5-year

study period.[54] Only 54 percent of this cohort was screened during the 5 years. About 80 percent of respondents (50.4 percent response rate) reported having a discussion with their physician about CRC screening. Of those having a discussion, 71 percent reported discussing colonoscopy and 41 percent FOBT. About 66 percent of patients reported that their physician discussed the pros and cons of different tests; 33 percent said that they had been asked about their preference for different types of tests and 39 percent were offered a choice among available tests. The association between those who had been offered a choice and receipt of a CRC screening test was negative; in this case, being offered a choice was associated with a lower screening rate. The usual length of these discussions and the relationship between patient report and actual discussion was not reported.

In this report, we distinguish between discussions of CRC screening between physicians and patients (covering such areas as pros and cons of screening options and eliciting patient preferences) as opposed to a simple physician recommendation of CRC screening (which is discussed in KQ 2). Although discussion and recommendation are not the same, recommendation would likely be a part of most discussions of CRC screening between physician and patient. Patient awareness of CRC screening is another likely result of CRC discussions. When there has been no physician recommendation and when patients are unaware of CRC screening, it is likely that there have been no discussions. Thus, lack of awareness and lack of a physician recommendation are two of the more frequent reasons that people who have not been screened give for not having obtained such tests.[21,55-57]

Test-Specific Trends

Over time, the percentage of eligible people screened with FOBT and FS has declined while the percentage screened with colonoscopy has increased. For example, the proportion of BRFSS respondents who had had an FOBT within 1 year declined from 2002 to 2006: 21.6 percent in 2002, 18.5 percent in 2004, 16.2 percent in 2006. The percentage who had had a lower endoscopy (either FS or colonoscopy) in the previous 10 years increased over the same period: 44.8 percent in 2002, 50.1 percent in 2004, and 55.7 percent in 2006.[45]

One national study examined the Medicare administrative database to determine trends in the use of various CRC screening tests between 1995 and 2003. Medicare started reimbursing for screening colonoscopy on July 1, 2001.[58] In 1995, 18.0 percent of Medicare beneficiaries received FOBT; in 2003, the figure was 14.3 percent. The percentage of people who received FS in 1995 was 3.9 percent, decreasing to 1.2 percent in 2003. The rate for colonoscopy, by contrast, rose: in 1995, 3.9 percent of Medicare beneficiaries received colonoscopy; in 2003, the figure was 9.4 percent. The relative decline in FS and the relative increase in colonoscopy was greater in white patients than in nonwhite patients. These changes were most pronounced after July 2001. These percentages are for screening received within a 1-year period, rather than the percentage of people who are up to date. A second analysis examined the test-specific trends within the Medicare population from 1998 to 2005, with similar findings.[59]

Other studies using information from the administrative databases of health plans or large gastroenterology practices have also found increased use of screening colonoscopy after July 2001.[49,60-62]

In an important study of trends in specific CRC screening test use between 1992 and 2002 in the Medicare population, use of FS increased from a mean rate per calendar-year quarter per 100,000 beneficiaries of 570.6 in 1996-1997 to 691.9 in 1999-2000 (after it was covered by Medicare in 1998) and then decreased to 267.5 in 2002-2003, after colonoscopy coverage started

in 2001.[63] Colonoscopy use, by contrast, increased from a mean rate per quarter per 100,000 beneficiaries of 284.6 in 1996-1997 to 1,918.9 in 2002-2003. This study also found that the percentage of CRCs diagnosed at an early stage rose for proximal but not distal cancers after 2001, indicating the effect of colonoscopy in detecting proximal cancers. Even with this increase in screening associated with Medicare reimbursement, many Medicare beneficiaries remained unscreened.

A study of CRC screening test use from 1998 to 2003 in the VA system, in which physicians have no financial incentives to perform colonoscopy, found an increase in overall screening, driven primarily by an increased number of FOBTs.[64] FOBT as a proportion of all screening tests increased from 81.7 percent to 90.4 percent over the study period while screening colonoscopy declined from 5.7 percent to 4.7 percent and FS declined from 8.3 percent to 3.6 percent. A 2007 study of 17,252 patients in the Western Region Tricare Insurance system of the Department of Defense found that 71 percent of these beneficiaries were up to date with standard CRC screening guidelines, and 83 percent of those who were up to date had had a colonoscopy within the previous 10 years.[65]

Trends toward screening colonoscopy may be less pronounced among disadvantaged groups than among the more advantaged. Although disadvantaged people (e.g., those without health insurance) are less up to date with screening, those who are screened may be more likely to be screened with FOBT than colonoscopy. One study conducted telephone interviews with 570 users of private physician offices (3 percent without insurance) and 500 registrants of county health centers (44 percent without insurance) in a single geographic area of New York State. Fifty-four percent of users of private physician offices and 28 percent of county health center registrants had had colonoscopy within the previous 10 years, while more county health center registrants had had an FOBT in the past year (31 percent private physician users versus 37 percent county health center registrants). Seventy percent of the private physician users and 55 percent of county health center registrants were up to date with national guidelines for CRC screening.[66]

Beyond the United States, the International Colorectal Cancer Screening Network surveyed CRC screening programs that started before May 2004.[67] They found 10 organized CRC screening programs in seven countries. Of these, five used FOBT only, three used FS only, one used FOBT and FS, and one offered colonoscopy only. The program offering only colonoscopy was in Poland; the United States was not listed as having an organized program. The FOBT programs were split between gFOBT and iFOBT. A variety of pilot programs and research initiatives were also listed.

Patient Preferences for CRC Screening Tests

We found several studies that asked people about their preferences for CRC screening tests. In general, the studies found diversity of opinion, with some people preferring colonoscopy (often because of its accuracy) and others favoring FOBT (often to avoid the discomfort and inconvenience of colonoscopy).

One study recruited 323 colonoscopy-naïve supermarket shoppers from a low-to-middle-class neighborhood in Denver, Colorado.[68] About half of respondents were non-Hispanic white with most of the rest evenly split between African-Americans and Latinos. After a description of the tests, 53 percent preferred FOBT and 47 percent preferred colonoscopy. Another study recruited 212 primary care patients from the waiting rooms of 3 community health centers and one academic medical center.[69] Patients were divided nearly equally among white, African-

American, and Hispanic people. Of the guideline-recommended tests, 37 percent preferred colonoscopy, 31 percent FOBT, 15 percent barium enema, and 9 percent sigmoidoscopy. One further study recruited 4,042 people who were participating in a multi-center study (84 sites) comparing fecal DNA testing with FOBT and colonoscopy.[70] Eighty-nine percent of participants were white. The participants were asked to complete a questionnaire after completing all three study tests. When asked which test they preferred for routine testing, 45 percent selected the fecal DNA test, 32 percent FOBT, and 15 percent colonoscopy.

Geographic Differences

We found no data on trends about differences in CRC screening rates by geographic factors; we did find several relevant reports. Using 2001 BRFSS estimates, states varied dramatically in the percentage of people having had an FOBT within the previous 2 years and in the percentage of people ever having had FS or colonoscopy.[71] For FOBT for white men, the rates ranged from 14.3 percent in Alabama to 43.7 percent in Vermont. For FS/colonoscopy for white men, the rates ranged from 33.5 percent in Oklahoma to 63.5 percent in Delaware. For FOBT for white women, the rates ranged from 11.6 percent in Alabama to 46.7 percent in North Carolina. For FS/colonoscopy for white women, the rates ranged from 38.3 percent in Kentucky to 62.1 percent in North Dakota.

For FOBT for black men, the rates ranged from 4.7 percent in Alabama to 48.6 percent in North Carolina. For FS/colonoscopy for black men, the rates ranged from 13.7 percent in Tennessee to 56.4 percent in California. For FOBT in black women, the rates ranged from 10.5 percent in Alabama to 43.3 percent in Massachusetts. For FS/colonoscopy in black women, the rates ranged from 35.6 percent in New York to 59.2 percent in Virginia.

The 2004 BRFSS found variation among the states in the percentage of respondents ages 50 years and older reporting having had either an FOBT within the previous year or lower endoscopy within the previous 10 years.[72] Rates ranged from 47.9 percent in Mississippi to 68.2 percent in Minnesota.

Health System Rates

The VA has a performance measure from medical record review for screening for people ages 50 to 80 years (FOBT within the past year, FS within the past 5 years, or colonoscopy within the past 10 years). With respect to being up to date on CRC screening, 78 percent of patients were up to date in 2007 and 79 percent in 2008.[73] The VA system has annual CRC screening rates from 1996 to the present. A few representative years are the following: 1996: 34 percent; 2000: 68 percent; 2004: 72 percent; and 2006: 76 percent.

NCQA, for its Healthcare Effectiveness Data and Information Set (HEDIS) commercial plans and using the same definition for being up to date as the VA, reported for 2007 that 55.6 percent of patients were up to date. The HEDIS measure is calculated from administrative data followed by a chart review for patients with no evidence of screening. No HEDIS trend data were available to us.

Overuse of CRC Screening

Although most of the previous discussion concerns underuse of CRC screening, overuse is also a concern. The two aspects of overuse for which we found evidence in the literature are

overuse in people who, because of severe comorbidity or advanced age, have little potential to benefit and overuse of surveillance colonoscopy. By surveillance colonoscopy, we are referring to colonoscopy for patients who have had a previous colonic polyp (and, usually, polypectomy).

Overuse among persons unlikely to benefit. We found no data concerning trends for overuse but did find several relevant reports. Overuse of CRC screening has been documented in three studies in the VA system, questioning whether some patients are being screened inappropriately.[74-76] Some patients are less likely than others to survive for the 5 to 10 years necessary to have a chance of benefit from screening. In one study, 18 percent of patients given an FOBT kit at a single VA facility had severe comorbidities.[76] In the other two studies, of multiple VA system sites, people with severe comorbidities were screened as often as people with no co-existing illnesses.[74-75]

Recently, the US Preventive Services Task Force (USPSTF) recommended that people over age 75 not be screened routinely and that people over age 85 not be screened at all.[3] Thus, screening people over age 85 may also be considered overuse of screening.

Overuse of surveillance colonoscopy. Another potential for overuse is the frequency of surveillance colonoscopy after polypectomy. A 1999-2000 survey of a nationally representative sample of 317 gastroenterologists and 125 general surgeons active in colonoscopy surveillance (response rate 83 percent) asked for their suggestions for surveillance colonoscopy for four clinical scenarios.[77] One scenario, the finding of a hyperplastic polyp, confers no additional CRC risk and requires no surveillance over routine screening. Yet 24 percent of gastroenterologists and 54 percent of general surgeons recommended surveillance colonoscopy, most of them at a frequency of 5 years or less. A second scenario, finding a single small adenoma less than 1.0 cm in size, is generally classified as a “low risk” situation, and the MSTF guideline is surveillance colonoscopy at 5 to 10 years.[78] Yet 52 percent of gastroenterologists and 77 percent of general surgeons recommended surveillance colonoscopy every 3 years or more often. The authors concluded that “these findings suggest considerable over-performance of surveillance colonoscopy.”[77] A similar study of primary care physicians found even more frequent recommendations for surveillance of low-risk patients.[79] A study of endoscopists’ recommendations for repeat colonoscopy in 10 primary care practices in Virginia and Maryland found that endoscopists often recommend colonoscopy more frequently than guidelines recommend.[80] The mean number of years in which repeat colonoscopy was recommended by endoscopists was 7.8 years following normal colonoscopy, 5.8 years following the finding of a hyperplastic polyp, and 4.4 years following the finding of 1 or 2 small adenomas.

An innovative followup study of 1,297 participants in the Polyp Prevention Trial (an RCT of a dietary intervention to prevent colorectal adenomas) found evidence of both underuse and overuse of surveillance colonoscopy. Among patients with high-risk adenomas (who, according to national guidelines, should receive surveillance in 3 years[81]), only 36 percent had received surveillance within 3 years, and only 65.2 percent had had a surveillance examination within 5 years. Among patients with low-risk adenomas (who should receive surveillance only between 5 and 10 years of initial screening), however, 39.7 percent had had a surveillance examination within 4 years.[82]

Misuse Rates

We define misuse as performance of screening tests in such a way that benefits are reduced or harms are increased compared with optimal performance. “Optimal” performance is

sometimes difficult to define. Thus, we provide frequencies for clearly suboptimal performance and harms that could be potentially reduced by improved procedures.

We found literature on three types of misuse regarding FOBT: use of in-office FOBT when the literature is clear that home FOBT is preferable, nonreturn of FOBT cards given to patients, and nonfollowup of positive FOBT results with a full colon examination. We also found literature on two types of misuse of colonoscopy: high rates of adverse events such as colonic perforation and bleeding and nondetection of important colonic lesions. We found little data concerning trends for these problems and thus present the current situation as documented in the literature.

Reliance on in-office FOBT is clearly a problem of misuse, substituting a less effective test for a more effective one.[83] A 1999-2000 national survey of primary care physicians found that 32.5 percent of physicians used in-office FOBT exclusively; another 41.2 percent used a combination of in-office and home-based FOBT.[84] Nearly one-third of patients in the 2000 NHIS who reported having an FOBT said that the only test they had had was an in-office FOBT.[84] Whether these percentages have changed after this study was done remains unclear.

Another type of misuse of CRC screening tests is nonreturn of FOBT cards given to patients. We found only one study concerning this issue, an RCT of an intervention to improve return of FOBT cards in a VA primary care clinic.[85] In the control (usual care) arm of this study, 51.3 percent of patients returned the FOBT cards they were given (mean time to return cards in this group was 143 days).

Still another type of misuse is nonfollowup of positive FOBT screening results. We found one study in an integrated health care system that examined trends between 1993 and 2005 in the percentage of positive FOBTs that were followed by a complete diagnostic examination within 1 year.[86] This percentage increased from between 57 percent and 64 percent in 1993-1996 to between 82 percent and 86 percent in 2000-2005. The authors noted the introduction during those periods of tracking systems and screening guidelines.

Other studies provided information about follow-up rates for positive FOBTs but not trends over time. Two studies from the VA (data from 2000-2002) have documented lack of followup of positive FOBTs. One study of national VA data found that 41 percent of patients with a positive FOBT had not received or been referred for a follow-up test (either colonoscopy or barium enema) within 6 months.[87] A second study at a single VA center examined chart reviews on 538 men who had had a positive FOBT. About 77 percent were referred to gastroenterology; only 44 percent underwent full colon examination within 12 months.[88] In a study of positive FOBTs (76 percent from a screening FOBT) in a large integrated health care system (data from 2004-2006), fewer than 10 percent of patients had no action taken; colonoscopy was completed in 62 percent within a year.[89] Three older single-institution studies[90-92] (one using 1986 data, one using 1998 data, and one using 1993 data) and one study of community medical practices (using 1994-1996 data)[93] examining positive FOBTs from screening programs found from 23 percent to 46 percent of patients had no follow-up colon evaluation.

A 1999-2000 survey of 182 health plans (52 percent response rate) by the National Cancer Institute found that only 41 percent of plans had any system for delivering and/or monitoring CRC screening use; 25 percent had a mechanism for reminding patients when they are due for screening; 16 percent had a system for reminding physicians when a patient is due. Fewer than 15 percent of plans monitored receipt of follow-up care after a positive FOBT.[94]

Another form of misuse is a high rate of adverse events during or after colonoscopy. We found no data on trends for this topic, but we did find two important reports to highlight. One

study examined the Medicare database to count adverse events requiring an emergency department visit or hospitalization within 30 days of a colonoscopy.[20] The risk of colonic perforation was about 0.6 per 1,000 colonoscopies. The risk of gastrointestinal bleeding or transfusions was 2.1 per 1,000 in a group that was screened and did not have a polypectomy and 8.7 per 1,000 in a group that had a polypectomy. Some patients also suffered a cardiovascular event within 30 days: 9.9 per 1,000 procedures in the screening but no polypectomy group and 23.4 per 1,000 in the polypectomy group. Adverse events increased with age; people over age 85 suffered more than twice as many adverse events as people ages 66 to 69. A systematic review that pooled US studies before January 2008 found a combined rate of serious complications of screening colonoscopy of 2.5 per 1,000 procedures, with 85 percent of the complications occurring in patients who had had a polypectomy.[95]

Misuse of colonoscopy also includes lack of detection of important lesions. Studies have found that from 2.1 percent to 5.9 percent of people diagnosed with CRC had had a colonoscopy within 3 years of the cancer diagnosis,[96-98] raising the issue of missed cancers. One study of back-to-back colonoscopies done on the same day found that 6 percent of adenomas at least 1 cm in size and 13 percent of adenomas 6 to 9 mm in size were missed on the first colonoscopy.[99] Other studies of CRC found by short-term follow-up colonoscopy after previous colonoscopy have raised the same question.[81,100]

One variable that has been studied to provide insight into important missed lesions at colonoscopy is the adenoma detection rate. Several studies have shown variation among endoscopists in this rate. One factor associated with adenoma detection rates at colonoscopy is withdrawal time, which is the time required for the endoscopist to withdraw the colonoscope after full insertion.[101-103] Although longer withdrawal times are associated with increased detection of advanced adenomas (i.e., adenomas greater than 1 cm in size, or with dysplastic or villous components), longer times are also associated with increased detection and removal of small, low-risk polyps of uncertain clinical importance. A follow-up study found that instituting a practice-wide policy of at least 8 minutes for withdrawal reduced variation in adenoma detection rates among endoscopists; specifically the new policy increased detection of any neoplasia from 23.5 percent to 34.7 percent and increased detection of advanced adenomas from 5.5 percent to 6.3 percent of subjects.[104] Thus, most of the increase in adenoma detection was due to detection of nonadvanced adenomas.

Another factor associated with lower adenoma detection rates is depth of insertion, in particular the percentage of colonoscopies in which the cecum was reached. One study used an Ontario, Canada, database to explore the percentage of colonoscopies that were coded as incomplete (i.e., did not reach the cecum), finding variation in incomplete rates.[105] Colonoscopies performed in a clinician's office were more likely to be incomplete than ones performed in an academic center (24.6 percent versus 12.6 percent). The percentage of incomplete colonoscopies declined over time (18.9 percent in 1999 to 10 percent in 2003). Similar data are not available from the United States.

Summary

National surveys show that CRC screening rates have been slowly increasing since 2000, reaching 50 percent to 60 percent in 2006. Screening rates in medical practices are also at about the same level. There are disparities in screening between white people and other racial and ethnic groups; Hispanic people have some of the lowest screening rates. Low income, low

educational level, and lack of health insurance are also associated with lower screening rates. States vary greatly in CRC screening rates.

The increase in CRC screening since 2001 has come primarily from increasing rates of colonoscopy; use of FS and FOBT has declined. This national trend toward increased colonoscopy and reduced FOBT is different than trends within the US VA program and in other countries, where FOBT remains the most common screening test.

In addition to underuse of CRC screening, good evidence suggests underuse of adequate discussions about CRC screening. For some patients, discussions do not provide comparative information about the benefits and risks of alternative strategies or do not allow patient participation in decisionmaking. For other patients, likely no discussion with their clinicians takes place at all.

In addition to the evidence of underuse of CRC screening and discussion is evidence of overuse. Some people are screened who have severe comorbidities and are unlikely to benefit. Older people above an age at which benefits are limited are also likely being screened. Surveillance colonoscopy after polypectomy is probably also occurring too frequently, thus reducing capacity for screening colonoscopy and increasing discomfort, inconvenience, and risk for many people.

Misuse of screening is also a problem. Some people receiving in-office rather than home FOBT, others not returning FOBT cards, and people with positive FOBTs not getting appropriate followup. Few health plans have systems for monitoring and improving these problems. Misuse of colonoscopy occurs because adverse events occur (e.g., bleeding or colonic perforation) and because endoscopists miss important lesions (and perhaps find and remove unimportant lesions).

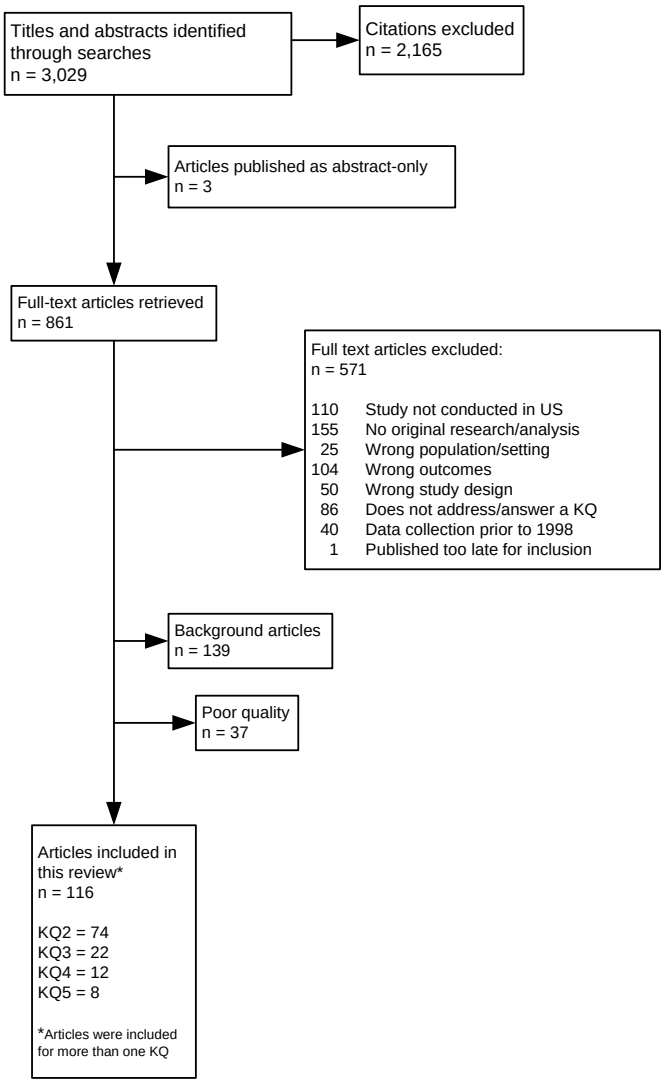
Chapter 4. Results

This chapter presents the results of our evidence review for the following four key questions (KQs): KQ 2, factors associated with colorectal cancer (CRC) screening; KQ 3, interventions that have been tested to increase CRC screening; KQ 4, current capacity in the United States to increase CRC screening; and KQ 5, methods for tracking and monitoring the use and quality of CRC screening. As noted in Chapter 2, we identified 3,029 citations from our searches (Appendix A).[‡‡] Figure 2 documents the disposition of articles for the review. Working from 861 articles retrieved for full text review, we included 139 for background and excluded 571 at this stage. A total of 72 studies (74 articles) qualified for inclusion for KQ 2, 21 studies (22 articles) for KQ 3, 12 studies for KQ 4 and 8 studies for KQ 5.

Appendix C-1 provides the detailed evidence tables for KQs 1, 2, and 3. Appendixes C-2 and C-3 present individual quality ratings for randomized clinical trials (RCTs) and observational studies, respectively. Appendix C-3 provides detailed abstractions for KQ 4. Appendix C-4 provides detailed abstractions for KQ 5. Evidence tables for each key question are presented in alphabetical order by last name of the first author.

As noted in earlier chapters, an overall assessment of the CRC screening and related factors requires evaluation of sources of heterogeneity, including clinical context, population served, and for the randomized control trials (RCT), the type of comparator. CRC screening is conducted in a variety of clinical contexts and assessed through the completion of one or several tests (i.e., fecal occult blood test (FOBT), done at home or in the office, and/or some type of endoscopy (i.e., flexible sigmoidoscopy [FS], colonoscopy, or double contrast barium enema [DCBE]). Most studies we assessed measured the outcome of screening by completion of a FOBT at home, and included one or more of these endoscopy tests. However, since national guidelines about which tests should be

Figure 2. Quorum tree/disposition of articles



[‡‡] Appendixes and Evidence Tables for this report are provides electronically at http://www.ahrq.gov/downloads/pub/evidence/pdf/crcuse/crcuse.pdf.

used and when have been altered several times over the period of time for which we were reviewing studies (i.e., 1998-present day), the assessment of screening rates has also changed over time and is somewhat problematic to analyze. For the studies assessed under KQs 2, 3, and 4, there is a strong reliance on self-reported screening rates, with fewer studies incorporating claims data analysis in the assessment of CRC screening.

An additional source of heterogeneity is the type of studies conducted for each type of KQ and the descriptive or analytic nature of the literature. For KQ 2, we found the largest number of studies but all are based on observational data, primarily collected retrospectively through cross-sectional or cohort designs. Because of the extensive variables explored in relation to CRC screening, we present the findings for this KQ in much less detail than the other KQs, focusing on the study characteristics and overall results specific to each type of factor that may be associated with screening.

This literature is characterized by a few articles together constituting a single study. We refer to studies in the text and cite all relevant articles for each study; article and study counts, therefore, frequently do not match. Our summary tables below feature groups of studies organized by the factors that may be associated with CRC screening (KQ 2), the different types of interventions that have been tested to increase screening (KQ 3), or the types of studies that have been done to assess capacity for screening (KQ 4) and monitoring of use and quality of screening (KQ 5). We have organized the studies in each summary table such that those rated as good quality are listed first and organized alphabetically by the first author's last name, followed by fair quality studies organized in the same way. The summary tables also provide information to identify the study (author, and date of publication), study design, population and setting, sample size, study quality, intervention (when relevant), comparators, and results.

KQ 2: What Factors Influence the Use of Colorectal Cancer Screening?

Key question (KQ) 2 focuses on the factors that are associated with the use of CRC screening. These factors can relate to either patient or provider characteristics and to the interaction between the provider and patient. Other factors that could be associated with the use of CRC screening may be system-level characteristics, such as involvement of nonclinician staff in screening, use of reminder or recall systems, having an organized referral system, or the size or type of the medical practice.

We identified a total of 72 studies (74 articles) rated good or fair quality that examined different factors that are associated with the use of CRC screening[1-2,21,42,46,55-57,65-66,88,106-168] rated good or fair quality. For these studies, we categorized the factors into five topic areas: 1) patient level factors that influence CRC screening; 2) physician factors (physician characteristics, physician-patient connectedness, and physician recommendations); 3) patient and physician communication; 4) periodic health exams or annual checkups; and 5) system level factors that may be associated with screening rates. We also identified two articles that focused on patient level predictors of followup among patients who have received a positive FOBT result and present them separately under the patient factors section of this chapter.[88,168]

Studies for this KQ are presented somewhat differently than those for the other KQs. Because of the vast number of studies this section includes, we start by presenting findings from three nationally representative samples of respondents where the investigators present overall findings that are not stratified by some factor (e.g., race, sex). For these three studies,[21,46,151] we

present the absolute screening rates in order to provide benchmarks for assessing how screening rates change when other factors are presented separately in the remainder of this section. We then present the results of the four primary patient characteristics of demographics, access to care, personal health or risk factors, and psychosocial factors that are associated with CRC screening. For each of these characteristics, we then summarize the findings from the three national studies and present adjusted odds ratios (AOR) and other statistics as appropriate. After presentation of the three national 'overview' studies, we follow that section with all additional studies that present findings for each of the seven topic areas that may be associated with screening. In each of these sections, we provide summary tables of the key studies that examined the corresponding factor. In each table, we also present the overarching results by using the symbols of "↑" or "↓" to provide a quick assessment of each study's findings specific to the key variables and the outcome of CRC screening (i.e., the "↑" means there is a positive association between the variable and CRC screening, and the "↓" means there is a negative association). Because this KQ includes so many studies, we think the use of these symbols helps the reader to understand what the overall results convey. Since this KQ presents descriptive findings from observational studies, we have not provided an assessment of the strength of evidence here.

The following presents the study characteristics and overview of results for each of the seven topic areas potentially associated with CRC screening.

Patient Factors: Overview

The majority of studies that have examined factors that predict the likelihood of CRC screening have focused on patient characteristics. We identified a total of 56 studies that we rated as good or fair quality that reported findings related to this topic.[1-2,21,42,46,55-56,65,106-109,111-126,128-134,136-138,141,144-147,149-151,155-158,160-163,165-166] that we rated as good or fair quality that reported findings related to this topic. We also included two studies that examined patient level factors that predict followup after a positive FOBT result.[88,168]

For patient factors, we categorized studies into four primary topics:

- patient demographics: studies that explore the relationship between characteristics such as age, sex, income, insurance status, race, ethnicity, and acculturation and the completion of various CRC screening tests.
- access to care: studies that explore the impact on CRC screening rates of having a regular source of care, recently visiting a provider at least once, and proximity to health care facilities.
- personal health or risk factors: studies that focus on the relationship of health factors (e.g., health status, obesity) or healthy behaviors (e.g., obtaining screenings for other cancers); or risk factors (e.g., family history of CRC, personal history of other cancers) or risky health behaviors (e.g., smoking, sedentary lifestyle, alcohol use) to the outcome of CRC screening by any test.
- psychosocial factors: studies on patient knowledge, attitudes, beliefs, and perceptions related to either CRC or screening for that type of cancer.

All the studies for KQ 2 present observational data collected either through surveys of self-reported screening rates or through analysis of claims data. These studies include those that report on national, state, regional, and local samples of respondents or patients. These studies yield a broad array of findings in a variety of populations and examine a large number of patient

factors and their relationship to CRC screening; dealing with all of them simultaneously risks presenting an unnecessarily complex synthesis. For that reason, we have adopted an analytic strategy for this KQ in which we initially describe the three studies that have the most nationally representative samples and that did not stratify their results by any factors (e.g., race, ethnicity).[21,46,151] In our view, these studies provide a broad overview of the issues and findings and provide a robust basis for then analyzing studies with a narrower focus.

Patient Factors: Three Nationally Representative Studies

Overview of national studies of patient characteristics. *Study characteristics*. Three studies examined the overall patient characteristics that seem to predict CRC screening in a national sample.[21,46,151] We rated all three studies as good quality. All relied on national survey data for their analysis; specifically, all used National Health Interview Survey (NHIS) data, with two presenting findings from 2000[21,151] and one from 2005.[46] All three presented findings for respondents ages 50 or older.[21,46,151] All three explicitly excluded from their analysis people reporting a prior diagnosis of CRC.[21,46,151]

The studies varied slightly on how they assessed the outcome of CRC screening. Two studies used the same definition (that respondents who reported an FOBT within the past year or an endoscopy within the past 10 years were adherent with national screening guidelines).[21,46] The remaining study defined adherence to screening as obtaining an FOBT in the past year, an endoscopy within the past 10 years, or both, for screening purposes. They defined this variable as "time-screening adherence" and included those who reported being screened as part of a routine physical examination, because of a specific problem, as a followup to another screening test, or because of family history of CRC.[151]

Overview of results. For the three studies, we present the overall findings for each of the categories of patient characteristics that may influence screening rates: demographics, access to care, personal health or risk factors, and psychosocial factors (Table 6). For each set of findings, we present only those screening rates or adjusted odds ratios (AORs, with 95 percent confidence intervals or significance levels) specific to being current with any CRC test (per the authors' computation of their outcomes variables); we do not present findings for specific tests in this section unless the authors limited their measurement of CRC screening to only one or two tests. "Significant" in this discussion means statistically significant at least a $P = 0.05$ level.

Table 6. Overall findings from the three national studies for each category of patient characteristics

Patient Characteristic	Overall Findings
	Patient demographics
Age	All 3 studies reported that CRC screening rates increase for each age group, until the older age range (≥ 75 for 1 study[151] and ≥ 80 for the other 2 studies[21,46]), at which point screening rates appear to decline slightly.
Sex	Findings from both studies of 2000 NHIS data indicated that females were slightly less likely to be screened than males (AOR, 1.16 of males compared with female; 95% CI, 1.03-1.31[151] and AOR, 0.89 of females compared with male; 95% CI, 0.80-0.99[21]). By 2005, screening rates did not differ on this variable.[46]

AOR, adjusted odds ratio; CI, confidence interval; CRC, colorectal cancer; NHIS, National Health Interview Survey.

Table 6. Overall findings from the three national studies for each category of patient characteristics (continued)

Patient Characteristic	Overall Findings
Race	Blacks and whites did not differ significantly in adjusted screening rates in any of the three studies, though they did in absolute rates.[21,46,151] When the race category of "other" was included, 1 study reported that this group was less likely to be screened when compared with whites (AOR, 0.67; 95% CI, 0.50-0.92[21]); another study found no difference in screening rates in the "other" race group compared with whites.[46]
Ethnicity	Hispanics were less likely to report being screened than non-Hispanic whites in 1 study using 2000 NHIS data (AOR, 0.73; 95% CI, 0.58-0.92),[151] but the other 2 studies had no significant differences for this factor (after adjustment). One study reported a nonstatistically significant trend that Asians were less likely than whites to report being screened (41.7% and 50.0%, respectively; *P* = 0.07).[46]
Income	Only 2 studies reported findings by income. One reported a significant difference in screening rates between respondents living in higher income households and those in lower income households (a 45.5% screening rate for those reporting an income < $20,000 and a 53.2% screening rate for those with incomes at or above $75,000; *P* = 0.006).[46]
Insurance	All 3 studies reported findings based on whether respondents had health insurance or not. Each demonstrated that persons with no insurance were significantly less likely to report being screened than those who had any type of insurance (10.1% to 24.1% of those with no insurance had been screened compared with 40% to 68.2% of those with insurance).[21,46,151]
Other factors (education level and marital status)	All 3 studies reported findings indicating that subjects with higher education and those who were married were more likely to have completed CRC screening.[21,46,151]
Access to care	
Access to care	Both having a usual source of care and visiting that provider at least once in the past year were consistently associated with CRC screening.[21,46,151]
Personal health or risk factors	
Personal health/ risk factors	Family history of cancer, particularly CRC; personal history of another (non-CRC) cancer; use of other cancer screening (i.e., mammogram, Pap test); and never or former smokers were positively associated with CRC screening in all three studies.[21,46,151] General health status, alcohol use, and obesity may be variables associated with screening but the findings were less consistent.
Psychosocial factors	
Psychosocial factors	The most common reason for not being screened (either "ever" or "within the recommended time period") is that the respondent "never thought about it."[21,46]
Other findings	
Other findings	The 3 studies also reported findings that are not presented here because they were not found to be associated with CRC screening or were not reported across all 3 studies. One study reported the association between metropolitan statistical areas and screening rates and found no relationship.[151] The same study also reported screening rates by region of the country and found that those living in any areas other than the West were less likely to report current screening (AOR, range 0.79-0.82).[151]

Demographics. All three studies examined demographic characteristics, including age, sex, income, insurance status, race, ethnicity, acculturation, and other factors such as education and marital status. The adjusted screening rates reported for each study appear in Table 7. We then discuss the factors that one or more of the three studies reported as predictors of CRC screening rates. None of these studies adjusted for or reported findings for factors related to acculturation (i.e., English-language proficiency, foreign birth, years living in United States).

Age. For the three studies,[21,46,151] screening rates gradually increased for each age group from the age groups from 50 to 70 years. One study using 2000 NHIS data found that older patients were more likely to be screened than younger patients. Relative to the referent group (50-54 years), respondents 55-59 years of age were slightly more likely to report being screened (AOR,

Table 7. Adjusted CRC screening rates by key patient-level demographic characteristics, for three national studies

Demographic Characteristics	Ata et al., 2006[151] 2000 NHIS* % (95% CI)	Seeff et al., 2004[21] 2000 NHIS† % (95% CI)	Shapiro et al., 2008[46] 2005 NHIS‡ % (95% CI)
Overall screening rates			
Home FOBT within past year	15.1 (14.3-15.9)	17.1 (16.2-17.9)	12.0 (11.3–12.7)
Endoscopy within past 10 years	17.6 (16.8-18.4)	33.9 (32.9-35.0)	45.2 (44.0-46.4)
Either test within recommended time	25.8 (24.9-26.7)	42.5 (41.4-43.5)	50.0 (48.8-51.2)
Age			
50-54	19.7 (17.9-21.7)	35.3 (33.9-37.2)	40.4 (38.7-42.1)
55-59	25.6 (23.3-27.9)		
60-64	26.7 (24.4-29.1)	45.9 (43.8-48.0)	56.5 (54.3-58.6)
65-69	30.9 (28.5-33.5)		
70-74	30.5 (27.9-33.3)	52.3 (50.1-54.5)	60.2 (58.0-62.3)
75-79	26.5 (24.4-28.6)		
80+		40.7 (37.6-43.9)	50.3 (47.2-53.4)
Sex			
Female	23.9 (22.8-25.1)	41.0 (39.7-42.4)	48.7 (47.1-50.3)
Males	28.0 (26.6-29.5)	44.5 (42.9-46.1)	51.7 (49.9-53.4)
Married and living with partner	28.7 (27.4-30.0)	46.3 (44.9-47.7)	53.2 (51.6-54.7)
All others	20.9 (19.8-22.1)	36.6 (35.0-38.1)	44.4 (42.8-46.0)
Education			
< High school	17.8 (16.3-19.3)	31.4 (29.5-33.3)	37.0 (34.6-39.6)
High school	24.0 (22.4-25.6)	40.2 (38.3-42.0)	46.9 (44.8-49.0)
Some college	27.0 (24.8-29.4)	46.2 (44.1-48.3)	54.2 (52.3-56.2)
College graduate	32.6 (30.2-35.2)	54.0 (51.5-56.5)	60.7 (58.7-62.6)
Post-graduate	38.4 (35.2-41.7)	--	--
Race			
Non-Hispanic whites	27.3 (26.3-28.3)	43.6 (42.5-44.7)	51.1 (49.8-52.4)
Non-Hispanic blacks	22.7 (20.1-25.6)	37.8 (34.9-40.7)	43.5 (40.6-46.5)
Other	--	28.7 (24.5-33.0)	38.2 (27.7-49.8)
Ethnicity			
Hispanic	15.8 (13.5-18.5)	29.9 (26.4-33.3)	34.2 (30.6-37.9)
Asian	--	--	38.7 (32.8-44.9)
Annual household income			
<$20,000	19.6 (18.1-21.1)	35.2 (33.0-37.3)	37.4 (35.4-39.5)
$20,000- 34,999	25.6 (23.6-27.6)	41.1 (38.4-43.7)	47.5 (45.1-49.9)
$35,000- 44,999	25.1 (22.1-28.0)	--	--
$35,000- 54,999	--	44.1 (41.0-47.3)	50.1 (47.2-53.1)
$45,000- 65,000	27.5 (24.7-30.2)	--	--
$55,000- 74,999	--	46.6 (42.0-51.2)	54.4 (50.9-57.9)
≥$65,000	31.8 (29.7-33.9)	--	--
≥$75,000	--	56.6 (52.8-60.3)	58.5 (55.3-61.7)
Insurance status			
No (none)	10.1 (8.0-12.6)	18.1 (11.2-24.9)	24.1 (19.2-29.7)
Yes (coverage of some type)	27.0 (26.1-28.0)	--	--
Private only	--	44.4 (41.0-47.8)	48.7 (45.9-51.5)
Medicare only	--	40.0 (34.8-45.1)	44.6 (39.0-50.3)
Medicare + private/Medigap	--	50.1 (44.4-55.8)	58.1 (50.7-65.2)
Medicare + Medicaid	--	--	45.1 (38.7-51.6)
Medicaid only	--	--	27.6 (21.1-35.2)

Table 7. Adjusted CRC screening rates by key patient-level demographic characteristics, for three national studies (continued)

Demographic Characteristics	Ata et al., 2006[151] 2000 NHIS* % (95% CI)	Seeff et al., 2004[21] 2000 NHIS† % (95% CI)	Shapiro et al., 2008[46] 2005 NHIS‡ % (95% CI)
Military	--	--	68.2 (63.8-72.4)
Other/multiple carriers	--	37.8 (34.4-41.2)	49.7 (42.8-56.6)

CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; NHIS, National Health Interview Survey; '--', data not reported for corresponding range of responses.
* Multivariate adjustments were made for all independent variables in their analysis.
† Adjusted for all other variables in their analysis except for mammography and Pap test use.
‡ Adjusted using predictive margins for all other characteristics in their analysis.

1.51; 95% CI, 1.24-1.84),[151] as were those 60-64 years (AOR, 1.41; 95% CI, 1.41-2.05)[151] and even more so for those 65-69 (AOR, 2.14; 95% CI, 1.75-2.62) and 70-74 (AOR, 2.20; 95% CI, 1.80-2.70).[151] The other study using 2000 NHIS data reported the same trend (compared with subjects 50-59 years, AOR 1.45; 95% CI, 1.26-1.67 for those 60-69 years and AOR, 1.69; 95% CI, 1.41-2.03 for those 70-79[21]). The study using 2005 NHIS data showed a similar trend and presented findings as age-adjusted percentages; 42.6 percent of those 50-59 years of age (95% CI, 40.4-44.8 percent), 56.6 percent of those 60-69 years (95% CI, 54.4-58.7 percent); and 57.2 percent of those 70-79 years (95% CI, 54.5-59.9 percent) reported being screened for CRC.[46]

In all three studies, however, screening rates were lower for the oldest category of patients relative to the adjacent age group;[21,46,151] the two 2000 NHIS studies reported an AOR of 2.08 for those 75 years of age and older (95% CI, 1.70-2.53)[151] and AOR of 1.25 for those 80 years and older (95% CI, 1.01-1.56).[21] The study of 2005 NHIS data showed a similar trend: 49.9 percent of respondents 80 years or more years of age reported being current with CRC screening (95% CI, 46.1-53.8 percent).

Sex. For the two studies of 2000 NHIS data, the reported screening rate was slightly lower among females than male.[21,151] In one, males were more likely to report screening than females (AOR, 1.16; 95% CI, 1.03-1.31),[151] and in the other females were less likely to report being screened (AOR, 0.89; 95% CI, 0.80-0.99).[21] The study of 2005 NHIS data found no difference between screening rates of males (49.2 percent; 95% CI, 47.4-50.9) and females (50.4 percent; 95% CI, 48.7-52.2; $P = 0.29$).[46] For the two studies that presented screening rates for FOBT within the past year or endoscopy within the past 10 years, one reported no difference in FOBT or endoscopy screening rates among males and female,[46] and the other found similar screening rates for FOBT and only a slightly lower rate of endoscopy screening for females compared with males (AOR, 0.77; 95% CI, 0.69-0.86).[21]

Race. Comparisons are more challenging for the reports of CRC screening by race because the three studies reported the findings somewhat differently. All three studies reported findings for whites and blacks; all three reported adjusted rates that show no difference between blacks and whites.[21,46,151] In the two studies of 2000 NHIS data, blacks had a slightly nonstatistically higher odds ratio but not a statistically significant different rate of CRC screening than whites (as the referent group for both studies).[21,151] One study also reported CRC screening for the race category of "other," which could include Asians, American Indians, and others; it found that this group was less likely to report being screened than whites (AOR, 0.67; 95% CI, 0.50-0.92).[21] Another study also reported a current screening rate of 40.3 percent (95% CI, 27.7-54.4; $P = 0.07$) for subjects in the "other" race category.[46]

Ethnicity. All three studies provided CRC screening rates for Hispanics. One study reported that Hispanics were statistically less likely than whites to be screened for CRC (AOR, 0.73; 95% CI, 0.58-0.92);[151] the other two studies showed that there was no statistically significant difference between Hispanics and "non-Hispanic" whites (AOR, 0.92; 95% CI, 0.75-1.12[21] for Hispanics with whites as the referent group; and adjusted percentage of 45.9% for Hispanics; 95% CI, 41.7-50.2%; compared with 50.2% for non-Hispanic whites; $P = 0.06$[46]).

We have included Asians in our discussion of ethnicity throughout this chapter; in places, we present study findings specific to subgroups of Asians (Chinese, Japanese, Korean, Vietnamese).[46] One study reported findings specific to Asians: the percentage reporting being screened was lower than the figure for whites (41.7 percent and 50.0 percent, respectively; $P = 0.07$).[46]

In terms of the combination of racial/ethnic differences, one study highlighted unadjusted and adjusted screening rates for Hispanics and blacks,[151] whites had the highest and Hispanics had the lowest proportions of adherence to timely screening. Compared with whites, Hispanics were 50 percent ($P < 0.001$) less likely to be adherent, and blacks approximately 23 percent ($P < 0.01$) less likely to be adherent. After multivariate adjustment (for all independent variables in their analysis), the difference between blacks and whites disappeared (AOR, 1.13; 95% CI, 0.95-1.35) but remained statistically significant for Hispanics (AOR, 0.73; 95% CI, 0.58-0.92).[151] The other two studies reported similar findings in the unadjusted and adjusted rates for the different racial and ethnic groups.[21,46] In one study, race was no longer a predictor of FOBT use when the rates were adjusted;[21] in another, adjustment for all the other factors in their analysis weakened the association between screening and Hispanic ethnicity (45.9 percent for Hispanics and 50.2 percent for non-Hispanics; $P = 0.06$).[46]

Annual household income. Two studies reported findings based on annual household income,[46,151] using slightly different income categories. Using the annual household income group of $20,000 or more as a referent, one study found that each higher income group was slightly more likely to report being screened; the group reporting an income of $65,000 or more was among those most likely to report being screened (AOR, 1.28; 95% CI, 1.04-1.58).[151] In another study, screening rates differed significantly between low-income and high-income groups: 45.5 percent screening rate for those < $20,000, and 53.2 percent screening rate for those ≥ $75,000 ($P = 0.006$).[46]

Insurance status. All three studies reported findings based on whether respondents had health insurance; and all demonstrated that those with no insurance were statistically significantly less likely to report being screened than those who had any type of insurance.[21,46,151] Using those without insurance as the referent group, both studies of 2000 NHIS data reported those with any insurance were more likely to report being screened than those without (AOR, 1.42; 95% CI, 1.05-1.93[151] and AOR, ranges 1.66-1.93, with statistically significant 95% CIs[21]). The study of 2005 NHIS data demonstrated a similar finding; 31.6 percent of those without insurance versus 43.0 percent to 67.9 percent of those in other insurance categories reported screening ($P < 0.0001$).

Two studies reported screening by type of insurance. For 2000 among those with any insurance, those with private insurance were the least likely to be screened (AOR, 1.66; 95% CI, 1.28-2.15) and those with a combination of private insurance and Medicare or Medigap were the most likely to be screened (AOR, 1.93; 95% CI, 1.44-2.59).[21] For 2005 among those with any insurance, those with Medicaid were the least likely with insurance to report being screened

(43.0 percent; 95% CI, 35.7-50.6) and those from the military were the most likely to be screened (67.9 percent; 95% CI, 63.3-72.1).[46]

Other factors: Education level and marital status. Education level and marital status consistently reported as associated with CRC screening. All three studies reported that respondents with lower levels of education had lower levels of CRC screening than better educated groups. For 2000, both studies reported that those who finished high school or had any education beyond that level were more likely than those who did not complete high school to report being screened (AOR, range 1.27-2.08 with "less than high school" as the referent group;[151] AOR, range 1.27-1.83 with "less than 12 years" as referent group[21]). For 2005, reported a similar trend; rates of CRC screening increased as education levels rose (ranging from 47.9 percent to 55.5 percent compared with 43.8 percent for those with less than 12 years of education; $P = 0.01$).[46]

With respect to marital status, all studies reported that being married was associated with CRC screening.[21,46,151]

Access to care. Access to care is a patient-level characteristic that many studies in our review examined. These three studies each reported two measures of access to care—whether an individual has a "usual (or, regular) source of care" and the frequency or recency of contact with the provider (i.e., number of visits in past year or time since the last visit).[21,46,151] Table 8 provides the adjusted rates for variables related to access to care.

Table 8. Adjusted CRC screening rates by patient-level variables of access to care for three national studies

Access to Care Variables at the Patient Level	Ata et al., 2006[151] 2000 NHIS*	Seeff et al., 2004[21] 2000 NHIS†	Shapiro et al., 2008[46] 2005 NHIS‡
	% (95% CI)	% (95% CI)	% (95% CI)
Access to care			
Usual source of care			
Yes	27.0 (26.1-28.0)	44.2 (43.2-45.3)	51.9 (50.7-53.1)
No	10.1 (8.0-12.6)	17.8 (14.9-20.8)	24.7 (20.8-29.0)
Number of physician visits in past years			
None	--	14.8 (12.6-17.0)	19.5 (16.8-22.5)
1	--	36.2 (33.3-39.1)	40.2 (37.3-43.2)
2-5	--	44.6 (43.0-46.3)	52.5 (50.7-54.3)
≥6	--	51.7 (49.9-53.5)	59.8 (58.0-61.6)
Time since last doctor visit			
≤ 6 months	28.9 (27.8-30.0)	--	--
> 6 months-1 year	22.9 (20.3-25.8)	--	--
>1-2 years	11.2 (8.4-14.7)	--	--
>2 years	3.7 (2.3-5.9)	--	--

CI, confidence interval; CRC, colorectal cancer; NHIS, National Health Interview Survey; '--', data not reported for corresponding range of responses

* Multivariate adjustments were made for all independent variables in their analysis.

† Adjusted for all other variables in their analysis except for mammography and Pap test use.

‡ Adjusted using predictive margins for all other characteristics in their analysis.

Usual source of care. All three studies found that those respondents who reported having a usual source of care were more likely to obtain CRC screening than those who did not have a usual source of care.[21,46,151] The two studies of 2000 NHIS data each reported significant differences in rates of CRC screening between those who had a usual source of care and those who did not (AOR, 1.61; 95% CI, 1.17-2.21[151] and AOR 1.65; 95% CI, 1.30-2.09).[21] For 2005, findings for adjusted rates were similar; 51.0 percent of those with a usual source of care (95%

CI, 49.7-52.3%) and 30.5 percent of those without a usual source of care (95% CI, 26.5-34.8%; $P = 0.0001$) were screened.[46]

Frequency or recency of visits to physician. All three studies provided similar findings: those who had visited a physician more frequently in the past year or had seen a doctor more recently were more likely to report being screened for CRC.[21,46,151] In one study, those with no physician visits in the past year were significantly less likely to obtain screening than those who visited a physician at least once (AOR, range 2.40-4.68).[21] In another, those who had visited a physician within the past 1 to 2 years were less likely to have had a CRC screening test than those who had visited within the past 6 months (AOR, range 2.76-7.59 with less than 2 years as the referent group).[151] The third study did not report adjusted rates for this variable; unadjusted rates appear in Table 8.[46]

Personal health factors and risk factors. Personal health factors are defined as characteristics from respondents' family history or personal health history (e.g., prior polyp removal, screening behavior with regard to other cancers, general health status, family CRC diagnosis) that would place them at increased risk for CRC or that may be related to healthy behaviors that could influence the extent to which they obtain regular CRC screenings. Risk factors for health problems that may be related to CRC screening include smoking, sedentary lifestyle, poor eating habits, obesity, and any factor that may place a person at increased risk for developing CRC. Table 9 presents the absolute rates of these variables as reported by the three national studies, followed by a discussion of findings for each.[21,46,151]

Table 9. Adjusted CRC screening rates by patient-level personal health or risk factors for three national studies

Health or Risk Factors	Ata et al., 2006[151] 2000 NHIS† % (95% CI)	Seeff et al., 2004[21] 2000 NHIS‡ % (95% CI)	Shapiro et al., 2008[46] 2005 NHIS§ % (95% CI)
Family history of CRC			
Yes	30.6 (29.3-32.0)*	59.7 (56.5-62.8)	68.3 (64.9-71.5)
No	23.8 (22.4-25.3)	41.4 (40.2-42.5)	48.8 (47.6-50.1)
Personal history of cancer			
Yes	32.3 (29.6-35.0)	55.1 (51.8-58.3)	63.9 (61.0-66.8)
No	24.9 (24.0-25.9)	40.6 (39.5-41.7)	47.8 (46.5-49.0)
General health status			
Excellent	30.1 (21.8-32.1)	--	--
Very good	27.7 (26.1-29.4)	--	--
Excellent/good	--	42.6 (41.4-43.8)	--
Excellent/very good/good		--	50.5 (49.1-51.9)
Good	24.6 (23.0-26.3)	--	--
Fair	21.1 (19.1-23.4)	--	--
Fair/poor	--	42.4 (40.1-44.7)	48.1 (45.7-50.4)
Poor	20.1 (17.2-23.3)	--	--
Body mass index (kg/m^2)			
Underweight	17.6 (13.3-22.8)		49.1 (47.1-51.0)
Normal (<25)	25.5 (24.0-27.0)	40.5 (38.7-42.2)	
Overweight (25-29)	27.6 (26.1-29.2)	43.6 (41.9-45.3)	51.2 (49.4-52.9)
Obese (≥30)	26.6 (24.7-28.5)	44.3 (42.1-46.5)	50.5 (48.4-52.7)

CI, confidence interval; CRC, colorectal cancer; NHIS, National Health Interview Survey; '--', data not reported for corresponding range of responses.
* For this study, findings reported were for "family cancer history" not specific to CRC.[151]
† Multivariate adjustments were made for all independent variables in their analysis.
‡ Adjusted for all other variables in their analysis except for mammography and Pap test use.
§ Adjusted using predictive margins for all other characteristics in their analysis.

Table 9. Adjusted CRC screening rates by patient-level personal health or risk factors for three national studies (continued)

Health or Risk Factors	Ata et al., 2006151 2000 NHIS % (95% CI)	Seeff et al., 200421 2000 NHIS % (95% CI)	Shapiro et al., 200846 2005 NHIS % (95% CI)
Mammogram within 2 years			
No	--	19.1 (17.0-21.2)	24.0 (21.7-26.5)
Yes	--	49.2 (47.6-50.9)	60.6 (58.7-62.4)
Pap test within 3 years			
No	--	24.1 (21.6-26.7)	33.3 (31.0-35.8)
Yes	--	46.8 (45.2-48.3)	56.0 (54.0-57.9)
Physical activity			
None	20.5 (19.3-21.7)	35.3 (33.8-36.7)	41.9 (40.3-43.5)
Moderate/some/irregular	29.6 (27.6-31.6)	44.7 (42.3-47.1)	55.3 (52.9-57.6)
Regular or meet/exceed recommendations	33.3 (31.3-35.5)	51.2 (49.2-53.3)	57.6 (55.9-59.7)
Smoking status			
Never/nonsmokers	25.1 (23.8-26.5)	41.3 (39.8-42.9)	49.2 (47.6-50.7)
Former/quitters	30.9 (29.3-32.6)	48.2 (46.5-49.9)	56.0 (54.2-57.9)
Current/smokers	18.2 (16.3-20.3)	35.3 (32.6-38.0)	37.8 (34.9-40.8)
Alcohol use			
None	--	38.6 (37.2-40.0)	43.4 (41.7-45.0)
1-14 drinks/week	--	47.2 (45.8-48.7)	56.8 (55.2-58.4)
≥ 14 drinks/week	--	43.7 (39.0-48.5)	53.0 (48.7-57.2)

Health factors. Family history of CRC or other cancer, personal history of other non-CRC cancers, and use of mammograms or Pap tests were all found to be consistently associated with CRC screening rates.[21,46,151] One study used "family cancer history" that was not specific to CRC; those who reported this as part of their history were significantly different from those who did not (AOR, 1.27; 95% CI, 1.13-1.43). Findings in another study were specific to a family history of CRC and reported a stronger association between screening rates; those with a family history were more than twice as likely to report being screened as those who had none (AOR, 2.04; 95% CI, 1.73-2.40).[21] The third study did not present the adjusted rates for this variable; unadjusted rates appear in Table 9.[46]

Three studies assessed the relationship between personal history of other (non-CRC) cancers and CRC screening. Two studies found this variable to be strongly associated with CRC screening (AOR, 1.08; 95% CI, 0.93-1.25;[151] AOR, 1.24; 95% CI, 1.12-1.37;[21] adjusted percentage of 59.8 percent screening rate for those with a personal history versus 48.3 percent for those without; $P < 0.0001$[46]).

Two studies reported use of mammograms and Pap tests.[21,46] In one study, analyses for use of mammograms were adjusted for all variables in their analysis except sex and Pap test use, and those for use of Pap tests were adjusted for all variables except sex and mammogram use and also for hysterectomy history.[21] For the association between mammography use and CRC screening, the AOR was 2.96 (95% CI, 2.50-3.50); for Pap tests the AOR was 2.41 (95% CI, 2.03-2.86). The second study did not provide adjusted rates for these variables.[46] Their unadjusted rates indicate that 60.6 percent of females who had obtained a mammogram in the past 2 years versus 24.0 percent of females who had not and 56.0 percent of those who had obtained a Pap test in the past 3 years versus 33.3 percent of those who had not reported obtaining CRC screening within recommended time intervals.[46]

Findings specific to the association of general health status with CRC screening differed across studies. One study found little difference in CRC screening rates between respondents who considered themselves to be in excellent or good health and those in fair or poor health (AOR, 1.07; 95% CI, 0.94-1.22).[21] The other two studies reported that higher levels of perceived health seemed to be associated with higher CRC screening rates (AOR, range 0.73-0.90 with "excellent" as the referent group for one study[151] and 48.7 percent adjusted rates for those in "excellent/very good/good" health and 54.3 percent in "fair" or "poor" health; $P < 0.0001$[46]).

Risk factors. Risk factors reported by these studies included smoking status, obesity, physical activity, and alcohol use.[21,46,151] In two studies, current smokers were less likely than never or former smokers to be screened (AOR, 0.82; 95% CI, 0.70-0.95[21] and adjusted percentage of 41.5 percent screening rate for smokers compared with a 53.3 percent rate for former smokers and a 45.2 percent rate for those who never smoked; $P < 0.0001$[46]). One study reported no significant differences based on current or former smoking.[151]

None of the studies reported body mass index as a predictor of CRC screening. All three found that even some or moderate, as well as regular, respondents who reported some type of exercise had higher screening rates than those who reported no exercise.[21,46,151]

Alcohol use was reported in two studies.[21,46] One found that those who reported 1 to 14 drinks per week were more likely to report being screened than any other group (AOR, 1.14; 95% CI, 1.03-1.26).[21] The other study also reported significant differences specific to alcohol use; those who reported 1 or more drinks per week being more likely to be screened (adjusted percentages of 52.8 percent for those drinking 1 to 13 drinks/week (95% CI, 51.5-54.4%) and 51.9 percent (95% CI, 47.3-56.4%) for those drinking 14 or more drinks/week; compared with 46.5 percent (95% CI, 44.8-48.3%) for those reporting no alcohol use: $P < 0.0001$).[46]

Psychosocial factors. Two studies presented analyses based on reasons for never undergoing screening or undergoing screening beyond the recommended time intervals and include aspects of knowledge, attitudes, beliefs, or perceptions (i.e., psychosocial factors) that may be associated with CRC screening use.[21,46] One study using 2000 NHIS data examined reasons for not obtaining screening compared two age groups of respondents (those 50-64 years compared with those ≥ 65 years) and reported that lack of knowledge of either the FOBT or endoscopy as a test was a common barrier to undergoing either test (52.0 percent of those 50-64 years of age and 50.7 percent of those 65 or older reported this barrier for FOBT; 49.7 percent and 50.7 percent, respectively, reported this barrier for endoscopy).[21] Far fewer respondents reported any of the following reasons for not being screened, putting it off, or believing they did not need the test: expense or lack of insurance, the pain, unpleasantness, or embarrassment of having the test. Proportions ranged from 0.3 percent to 12.2 percent among those 50-64 and from 0.1 percent to 12.5 percent among those 65 or older.[21]

The study using 2005 NHIS data presented proportions of responses for the same items of the survey;[46] they compared individuals who never had had an FOBT or endoscopy with those who had had the test before but not in the recommended time interval. Results indicated that about half of the respondents reported "never thought about it" as a reason for not being screened ever (adjusted percentage of 53.9 percent (95% CI, 52.0-55.7%) for FOBT and 51.8 percent (95% CI, 49.9-53.6%) for endoscopy) or within the time interval (adjusted percentage of 51.7 percent (95% CI, 50.0-53.4%) for FOBT and 48.7 percent (95% CI, 47.0-50.4%) for endoscopy).[46] Far fewer respondents reported any of the psychosocial factors as reasons for not being screened ever or on time, such as their beliefs about testing ("did not need it", adjusted percentage ranges of 10.3 to 12.2 percent), or their perceptions that the tests were too painful/unpleasant/embarrassing

(adjusted percent ranges of 0.8 to 2.0 percent).[46] Neither study commented on the extent to which any of these factors may relate to overall screening rates.

Patient Factors: Overview of Additional Studies

Here we present information from other studies that present findings from a national, regional, or local database, but that stratified their findings on one or more particular patient-level factor (e.g., age, sex, race, ethnicity). We highlight these studies in the sections specific to the variable of interest. To reduce the potential for redundancies, we only present the study characteristics and overview of results for each group of studies, and not a detailed description of all the studies included in this section.

In addition to the three overview studies, we included 53 studies[1-2,42,55-56,65,106-109,111-126,128-134,136-138,141,144-147,149-150,155-158,160-163,165-166] rated as good or fair quality. We present findings in summary tables for studies that had significant or particularly important or interesting results specific to that patient-level variable. Each table first presents studies rated as good quality listed in alphabetical order by first author's last name, followed by studies rated as fair quality that are also listed in alphabetical order by the first author's last name. Also, because we are reporting findings for a large number of studies, we have attempted to streamline the text such that detailed statistics (e.g., confidence intervals [CI]) are only presented in the summary tables and overall findings are presented in the text describing the studies. We also describe, just in text, other studies that provide supporting or contradicting results for each category of factors.

Although a large number of studies may have included the factors as presented in the following sections, we only present additional description in the text and include in the tables those studies that specifically aimed to explain whether the factor of interest for the section was related to CRC screening (rather than simply looked at a large number of factors). In some cases (for studies specific to both racial and ethnic differences), we include one study in more than one summary table. However, to minimize the discussion as much as possible, we generally present one study only once in a table and a few studies are not presented in summary tables at all because their findings support others presented. At the summary of each factor, we then briefly reference all of the other studies that included the factor in their final multivariate analyses and whether and how they found the factor to be associated with CRC screening.

Age. *Study characteristics.* All studies discussed in this section included age in their analysis of factors associated with CRC screening of their sample. Two studies, both rated fair quality, focused on the association between age and CRC screening (Table 10); both presenting results for patients 65 years or older.[55,150] One study presented self-reported findings from a national database of responses to the 2003 Health Information National Trends Survey (HINTS);[55] we include it here (instead of as an overview study) because the authors explored screening specifically among older people (ages 65-89 years). The second study analyzed 2002-2003 Medicare physician/supplier billings claims data from three states (Florida, Illinois, and New York).[150] The HINTS study focused on the outcome of screening as defined by national guidelines (i.e., FOBT in the past year or FS/colonoscopy in the past 10 years), whereas the Medicare claims study defined CRC screening as any test (i.e., colonoscopy, FS, double-contrast barium enema, or FOBT) obtained during the study period (2002-2003).[150] In terms of the "age" variable, one study focused on comparing those who were ages 65-74 years with those who were 75-89 years of age[55] the other categorized the age variable into four groups (ages 65-69; 70-74; 75-79; and 80 or more years).[150]

Table 10. Studies of the association of age with CRC screening

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders/ Considered	Variables Associated with CRC Screening*	Results (95% CI)
Berkowitz et al., 2008[55] Cross-sectional, retrospective, national HINTS (2003) respondents 65-89 years old N = 1,148 (583 not up-to-date with screening) Fair	Assess beliefs and perceptions of risk about CRC and gaps in knowledge about screening in adults aged 65-89 years	FOBT (within past year) or FS or colonoscopy in past 10 years (self-report)	Age (65-74 vs. 75-89 years)	Gender, race, income, education, marital status, family history of CRC, health status, regular source of care, annual MD visits, knowledge about CRC and testing, beliefs about CRC, perceived risk	↑ Older patients (75-89 years)	Older patients were more likely than younger patients to be up to date with CRC screening (AOR, 1.92; 95% CI, 1.32-2.79; *P* < 0.001)
Ananthakrishnan et al., 2007[150] Cross-sectional, retrospective, 3 states Medicare physician/ supplier billing claims in Florida, Illinois, and New York, 2002-2003, 65+ years N = 596,470 Fair	Identify effects of some demographic characteristics on screening behavior	Any test (colonoscopy, FS, double-contrast barium enema, or FOBT) (claims)	Age (65-69; 70-74; 75-79; 80+)	Race, sex, per-capita income, education	↓ Oldest patients	Patients 80+ years were less likely to have received any CRC test than other age groups, regardless of income (RR range, 0.84-0.90).

AOR, adjusted odds ratio; CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; HINTS, Health Information National Trends Survey; MD, Medical Doctor; P, probability; RR, relative risk.
* Arrow symbols (↓or ↑) are provided as a quick reference point of overall findings and represent the association reported between each variable and CRC screening.

Overview of results. Age was a predictor of screening in the HINTS study such that older patients (ages 75-89) were more likely than younger patients (65-74) to be up-to-date with CRC screening (AOR, 1.92; *P* < 0.001).[55] Age was also associated with CRC screening in the Medicare claims study, until the age of 80 year or older; these older patients were less likely to have received any CRC test than any other age groups, regardless of income (RR range, 0.84-0.90).[150]

These findings agree somewhat with the overview studies presented previously.[21,46,151] The Medicare claims study supports those findings in that screening rates decline slightly among patients over age 80 years.[150] The HINTS study found an overall increase in screening rates from the younger age range of respondents (65-74) to the older age group (75-89).[55] If these

investigators had defined more but shorter age ranges in their analysis, they might have found rates with respect to age similar to those in the other four studies.[21,46,150-151]

Of all the studies that included age as a variable in their adjusted logistic regression models, 20 reported that older patients (i.e., ages 60-75) were more likely than younger patients (i.e., 50-60 years) to be current with CRC screening and that rates among the very old age groups (i.e., 76 years or older) were lower than those for younger age groups.[1-2,42,56,107-108,111,114,116,120,122,126,132-133,138,146,156-158,163] Four studies reported no differences in screening for age groups included in their analyses.[106,109,130,166]

Sex. *Study characteristics*. As with the age variable, all studies included this patient variable in their analyses of factors associated with CRC screening. Two, both rated as good quality, focused specifically on this demographic factor (Table 11).[42,133] Both presented national-level findings of self-reported data with all results stratified by gender; one presented findings from the 2002-2003 HINTS[133] and the second presented findings from the 2000 NHIS.[42] Both studies presented findings for respondents 50 year of age or older.[42,133] Both also used the same indicators to assess the outcome of screening (i.e., FOBT in the past year or endoscopy in the past 10 years).[42,133]

Table 11. Studies of the association of sex with CRC screening

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders/ Considered	Variables Associated with CRC Screening*	Results (95% CI)
McQueen et al., 2006[133] Cross-sectional, national HINTS, 2002-2003, 50+ years N = 2,686 Good	Examine correlates of test use by gender	Any test (endoscopy in the last 10 years or FOBT in the last year) (self-report)	Gender	Age, gender, race, education, number of physician visits in past year, family history of CRC	↑ of FOBT among female No differences by gender for other tests	Females reported slightly higher lifetime (ever) and recent use of FOBT than males (17.1% lifetime and 9.3% recent for female; and 12.1% lifetime and 5.2% recent for male)
Peterson et al., 2007[42] Cross-sectional, national NHIS, 2000, 50+ years N = 11,487 Good	Explore gender differences in use of CRC screening tests and gender-specific correlates of CRC testing	Any test (FS or colonoscopy in the last 10 years or FOBT in the last year)	Gender	Age, gender, ethnicity/ race, education, annual income, insurance type	No gender differences in current CRC screening rates	Females were not less likely than males to be current in testing for CRC (AOR 0.98; 95% CI, 0.88-1.08)

AOR, adjusted odds ratio; CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; HINTS, Health Information National Trends Survey; NHIS, National Health Interview Survey.
*Arrow symbols (↓or ↑) are provided as a quick reference point of overall findings and represent the association reported between each variable and CRC screening.

Overview of results. Much like the three national studies,[21,46,151] gender was not consistently associated with CRC screening. One study showed that females and males were similar in their

current screening rates for any test (37.0 percent and 37.1 percent, respectively),[42] and the other presented findings showing the same patterns of use (66.4 percent for females and 61.8 percent for males).[133] However, these studies did find differences among males and females for specific tests.[42,133] In one study, females were more likely than males to report having completed an FOBT in the past year (9.3 percent compared to 5.2 percent, respectively); the groups did not differ in endoscopy screening in the past 10 years.[133] The other study found no gender differences in current CRC screening rates.[42]

Of the studies in the patient characteristics section of this review that included this variable in their adjusted logistic regression models, 14 reported an association between gender and CRC screening. Males had higher rates of screening for all tests than females in seven studies;[1,113,126,137,158,163,166] females had higher rates overall than males in three studies;[56,157,169] females were more likely than males to report a recent FOBT than males in two studies;[2,133,138] and males were more likely than females to have had an endoscopy (either colonoscopy or FS) in two studies.[2,114,138] An additional 12 studies with sex as a variable in their final analyses found no differences in CRC screening.[42,55,106-109,111,116,122,132,134,160]

Race. *Study characteristics.* We consider six studies here because they focused specifically on the association between race and CRC screening (Table 12); we rated two as good quality[1,158] and four as fair quality.[114,122,129,150,165] In terms of race, we present only those findings specific to Blacks[1,114,129,150,158,165] or American Indians and Alaska Natives.[122] Studies specific to Asians appear below in ethnicity because we cite findings specific to subgroups of Asians.

Of the six studies considered here, four provided findings for non-Hispanic whites compared with non-Hispanic blacks;[1,114,129,158] one presented findings for whites and all nonwhites;[165] and one compared American Indians living in the Southwest United States with Alaska Natives.[122] Two presented findings from a national sample of respondents;[1,129] two presented findings from several states;[122,150,165] and two presented locally based findings.[114,158] Three studies reported self-reported findings from survey data;[114,122,129] two others presented findings from medical (or Medicare) claims data;[150,158,165] and the sixth presented findings from a combination of 2001-2005 Medical Expenditure Panel Survey (MEPS) and the 2000-2004 NHIS.[1] Those included in the samples were 50 years of age or older,[1,114,122] 50-75 years of age,[158] 65 years of age or older,[129,150] or 70-79 years.[165]

In terms of the screening outcome, there were several different variations of how this was operationalized:

- Three studies defined up-to-date screening as those who reported FOBT in the past year, FS in the past 5 years, or colonoscopy (double-contrast barium enema for one of these) in the past 10 years.[114,129,158]
- One study defined screening as FOBT in the past 2 years or endoscopy at any time;[1]
- One study defined CRC screening as FOBT in the past year, and FS or colonoscopy in the past 5 years, [165]; and
- Another study only included colonoscopy or FS in the past 5 years (excluding FOBT).[122]

Overview of results. All but two of these studies[122,165] gave both unadjusted (AOR age-adjusted only) rates for CRC test usage by various racial groups and rates from multivariable analysis that included factors that are known or thought to be associated with CRC screening. The four studies that compared CRC screening for non-Hispanic whites and either non-Hispanic blacks/Blacks[1,114,129,158] reported inconsistent findings. The two studies based on nationally

Table 12. Studies examining the association between race and CRC screening

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders/ Modifiers Reported	Variables Associated with CRC Screening	Results (95% CI)
Jerant et al., 2008[1] Cross-sectional, retrospective, national MEPS, 2001-2005, combined with NHIS, 2000-2004, ≥ 50 years N = 22,973 Good	Examine correlates of screening among all 4 major US racial/ethnic categories (non-Hispanic white, Asian, black, and Hispanic individuals)	FOBT in past 2 years; endoscopy at any time (combined data)	Race (non-Hispanic whites and blacks)	Age, gender, metropolitan statistical area, region, year	No differences based on race	Absolute rates for screening among blacks were 25.5% for FOBT; 38.3% for endoscopy; and 48.2% for the combined tests; among non-Hispanic whites, rates were 25.8%, 49.0, and 57.2%, respectively. Initial analysis (adjusted for demographics) showed blacks to be significantly less likely than non-Hispanic whites to have CRC tests (unadjusted OR 0.72; 95% CI, 0.65-0.80). Further adjustment to the model (i.e., when foreign birth, language spoken at home are taken into account) eliminated these differences.
Christman, et al. 2004[158] Cross-sectional, retrospective, local Community health center, 2002, Florida, 50-75 years N = 1,176 Good	Determine the rate of CRC screening in patients attending a sample of community health centers	Any test (FOBT in past year, FS in past 5 years, colonoscopy or double-contrast barium enema in the previous 10 years) (claims)	Race (Black, white, Hispanic)	Age, gender, marital status, insurance status, access to care Charlson Comorbidity Index, health status, screening behavior	↑ Blacks	Unadjusted rates for CRC screening: 40.1% whites; 51.3% Blacks Blacks were more likely to have been screened for CRC than whites (AOR, 1.38; 95% CI, 1.04-1.84; *P* = 0.03)

AOR, adjusted odds ratio; CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; MEPS, Medical Expenditure Panel Survey; NHIS, National Health Interview Survey; P, probability; MCBS, Medicare Current Beneficiary Survey; ARF, Area Resource File; SES, socioeconomic status.
* Unadjusted rates by race were not provided.
† Arrow symbols (↓or ↑) are provided as a quick reference point of overall findings and represent the association reported between each variable and CRC screening.

Table 12. Studies examining the association between race and CRC screening (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders/ Modifiers Reported	Variables Associated with CRC Screening	Results (95% CI)
Fenton et al., 2009[165] Cross-sectional, retrospective, regional Medicare claims data in 9 states, mid-1995 through 2003, 70-79 years N = 60,450 Fair	Assess changes in screening rates among which compared to nonwhite Medicare enrollees	FOBT in past year or FS/colonoscopy in past 5 years	Race (whites, blacks)	Age, sex, rural/urban, income, comorbidity, geographic region	↓ Blacks for colonoscopy No differences based on race for FOBT or FS	Up-to-date screening in whites ranged from 39.4% to 47.3%, while those in blacks ranged from 29.0% to 38.1%. (CI provided in graphic form in manuscript; all statistically significant)
O'Malley, et al., 2005[129] Cross-sectional, retrospective, national MCBS linked to Medicare claims and ARF, 2000, Medicare beneficiaries, 65 years or older N = 9985 Fair	Quantify the size of any racial differences in the receipt of CRC screening among beneficiaries	FOBT in past year, FS in past 5 years, colonoscopy in past 10 years (self-report from MCBS)	Race (white, black)	Age, sex; SES (education, income)	No differences based on race	Unadjusted rates: Whites - 48.2% (95% CI, 46.4-50.0%) Blacks - 39.1% (95% CI, 35.7-42.6%) Racial differences were eliminated after adjustment for SES (i.e., education, income)
Schumacher, et al. 2008[122] Cohort study, several states (Alaska, Southwest United States) Baseline survey, 2004-2007, American Indian/Alaska Natives, 50+ years N = 2,779 Fair	Investigate predictive factors associated with receiving each of the cancer screening tests	Colonoscopy or FS in past 5 years (self-report)	Race (American Indian and Alaska Native)	Age, location, gender, education, family history of cancer, family history of CRC, smoke cigarettes in past 5 years, history of chronic medical condition, language, residency, income, other screening tests	↓ Southwest American Indian compared to Alaska Natives	Overall screening rate was 22% Alaska Natives were more likely to have obtained CRC screening than Southwest American Indians (AOR, 3.86; 95% CI, 2.92-5.10)

Table 12. Studies examining the association between race and CRC screening (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders/ Modifiers Reported	Variables Associated with CRC Screening	Results (95% CI)
Thorpe, et al., 2005[114] Cross-sectional/ retrospective, local Community Health Survey, 2003, New York City residents ≥ 50 years N = 3,606 Fair	Examine characteristics of people undergoing screening within guidelines	Any test per guidelines (FOBT within past year, FS in past 5 years, or colonoscopy in past 10 years) or colonoscopy within past 10 years (self-report)	Non-Hispanic whites and Non-Hispanic blacks	Age, race, family and neighborhood income, ethnicity, gender, personal risk factors (i.e., current smoking, physical inactivity), access to care, insurance, regular source of care	↓ non-Hispanic blacks for colonoscopy in past 10 years; no differences for other timely tests	Respondents who were non-Hispanic blacks were less likely than non-Hispanic whites (unadjusted rates) to be up-to-date with CRC screening (52.3%; 95% CI, 48.2-56.4 compared with 60.3; 95% CI, 57.8-62.8, respectively) Adjusted rates showed no differences between non-Hispanic whites and non-Hispanic blacks in screening by any timely screening test (AOR, 0.92; 95% CI, 0.74-1.13) but did show that non-Hispanic blacks were less likely to have received a colonoscopy in the past 10 years when compared with non-Hispanic whites (AOR, 0.72; 95% CI, 0.58-0.91)

representative samples found no difference in adjusted screening rates and race;[1,129] one study reported that non-Hispanic blacks were less likely to be screened than non-Hispanic whites[114] and one study reported that Blacks were statistically significantly more likely to be screened for CRC than whites ($P = 0.03$).[158] The study of Medicare claims data in 9 states among 70-79 year olds compared changes in screening over time for whites and blacks. In 1995, 39.4 percent of White enrollees were up-to-date with CRC screening compared with 29 percent of Blacks. In 2003, overall percentages of enrollees up-to-date increased, but disparities between racial groups persisted, with 47.3 percent of Whites up-to-date compared with 38.1 percent of Blacks. The differences were statistically significant between all groups in both 1995 and in 2003.[165]

Additional studies not highlighted here used race as a variable in their final multivariate analysis. One reported that non-Hispanic blacks were more likely than non-Hispanic whites to report being screened;[107] six noted that non-Hispanic whites were more likely than non-Hispanic blacks (or non-whites) to report being current with screening[106,120,128,138,142] or ever screened;[125] and nine reported no differences by race.[42,55,111,119,132,134,147,156-157] Finally, the study giving findings specific to Southwest American Indians and Alaska Natives found that Alaska Natives

were more likely than those in the Southwest United States to report being screened (AOR, 3.86).[122]

Ethnicity - Hispanics. *Study characteristics.* Six studies (7 articles) had the specific aim of examining the relationship between Hispanic ethnicity and CRC screening (Table 13), Of these, we rated two as good quality;[1,141,147] they used self-reported findings from a nationally representative sample collected either through the NHIS in 1998[147] or a combination of the 2000-2004 NHIS and 2001-2005 MEPS.[1,141] The four studies we rated as fair quality included one of 2000 NHIS findings,[111] another of changes from 2000 NHIS compared to 2003 data,[119] one of a trend analysis of 2000 NHIS data compared with 2005 data,[113] and one of respondents living in a local county in 1998-1999 that was reported in two separate articles.[116-117]

Table 13. Studies of the association of Hispanic origin with CRC screening

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders/ Modifiers Reported	Variables Associated with CRC Screening*	Results (95% CI)†
Goel et al., 2003[147] Cross-sectional, retrospective, national NHIS, 1998, ≥ 50 years N = 32,440 (15% foreign-born) Good	Determine whether foreign birthplace‡ explains some racial/ethnic disparities in cancer screening	FOBT in past year or proctoscopy (as a proxy for FS) in past 5 years (self-report)	Hispanic vs. non-Hispanic white	Age, marital status, geographic region, education, income, health status, comorbidities, body mass index, hospitalizations in prior year, access to care (i.e., insurance status, visits in past year, usual source of care)	↓ Hispanics	Unadjusted screening rates: non-Hispanic whites: 28% FOBT, 30% FS; Hispanics: 18% FOBT, 20% FS; *P*<0.005 Hispanics were less likely than non-Hispanic whites to have been screened for FOBT (AOR, 0.75; 95% CI, 0.59-0.94) or FS (AOR, 0.77; 95% CI, 0.62-0.96) Adjusted for above plus language spoken at home, nativity: AOR, 1.0; 95% CI, 0.85-1.18
Jerant et al., 2008[141] Cross-sectional, retrospective, national MEPS, 2001-2005, combined with NHIS, 2000-2004, ≥ 50 years	Identify independent contributions of basic demo-graphics, socio-economic factors, access barriers, and language-based barriers to	FOBT in past 2 years or endoscopy ever (self-report)	Ethnicity (Mexican, Cuban, Puerto Rican, Dominican) vs. non-Hispanic white	Age, gender, region, year, income, education, insurance, usual source of care, race, ethnicity ethnicity/race, country of origin	↓ Mexican or Dominican After adjustments made for language spoken at home, there were no differences in screening rates.	Total unadjusted screening rates: Non-Hispanic whites: 55.9% Mexican: 35.2% Cuban: 51.0% Puerto Rican: 45.7% Dominican: 28.5% Adjusted for age, gender, region, and year: Mexican: (AOR, 0.46; 95% CI, 0.40-0.53) Puerto Rican: (AOR, 0.65; 95% CI, 0.47-0.91)

AOR, adjusted odds ratio; BRFSS, Behavioral Risk Factor Surveillance System; CCS, Cancer Control Supplement; CI, confidence intervals; CRC, colorectal cancer; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; MEPS, Medical Expenditure Panel Survey; NHIS, National Health Interview Survey; P, probability.

* Arrow symbols (↓or ↑) are provided as a quick reference point of overall findings and represent the association reported between each variable and CRC screening.

† Only adjusted rates that are statistically significant are presented.

‡ Results for acculturation, language, and foreign birth are presented separately below (see acculturation, language, foreign birth).

Table 13. Studies of the association of Hispanic origin with CRC screening (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders/ Modifiers Reported	Variables Associated with CRC Screening*	Results (95% CI)†
Jerant et al., 2008[141] (continued) N = 22,419 Good	disparities in CRC screening					Dominican: (AOR, 0.30; 95% CI, 0.19-0.45) Adjusted for above plus income and education: Mexican: (AOR, 0.70; 95% CI, 0.60-0.81) Dominican: (AOR, 0.44; 95% CI, 0.28-0.69) Adjusted for above plus insurance, usual source of care, health status: Mexican: (AOR, 0.79; 95% CI, 0.69-0.91) Dominican: (AOR, 0.54; 95% CI, 0.32-0.91)
Shih et al., 2006[119] Cross-sectional, retrospective, national NHIS, 2000 and 2003 CCS, Medicare beneficiaries, 65 years or older N = 6,180 (in 2000); 5,759 (in 2003) Fair	Explore whether changes in Medicare reimbursement for colonoscopy addressed ethnic disparities	Ever received endoscopy	Race/ ethnicity (non-Hispanic whites, Hispanics)	SES variables and access barriers	↓ Hispanics	Unadjusted screening rates were approximately 30% among Hispanics in 2000, with only a slight increase by 2003. Screening among non-Hispanic whites was approximately 45% in 2000, increasing to 50% in 2003 *(findings presented only in a bar chart)*. Odds of screening declined for Hispanics between 2000 and 2003 and the differences between Hispanics and non-Hispanic whites became significant in 2003 (AOR; 0.77; 95% CI, 0.59-0.99; *P* = 0.048).
Thompson et al., 2005[116] Thompson et al., 2006[117] Cross-sectional, retrospective, local Survey in 20 communities Lower Yakima Valley,	Compare CRC screening prevalence and the association between reported barriers and screening participation between Hispanics and non-Hispanic whites	FOBT in past 2 years or endoscopy in past 5 years (self-report)	Hispanics vs. non-Hispanic whites	Age, gender, income, access to health insurance, smoking, residential community	↓ Hispanic for endoscopy in past 5 years No differences for other tests	Unadjusted screening rates: FOBT ever: non-Hispanic whites 55.7%; Hispanics 40.6%; *P* = 0.003 No difference for FOBT in past 2 years Endoscopy ever: non-Hispanic whites 44.4%; Hispanics 26.9%; *P* <0.001 Endoscopy in past 5 years: non-Hispanic whites 33.7%; Hispanics 24.1%; *P* <0.05 Adjusted rates were only significant for endoscopy in

Table 13. Studies of the association of Hispanic origin with CRC screening (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders/ Modifiers Reported	Variables Associated with CRC Screening*	Results (95% CI)†
Thompson et al., 2005[116] Thompson et al., 2006[117] (continued) Washington, 1998-1999, ≥ 50 years n = 1,795 Fair						past 5 years (AOR, 0.52; 95% CI, 0.28–0.98)
Trivers, et al., 2008[113] Cross-sectional, retrospective, national NHIS, 2000 compared with 2005, 50-64 years N = 6,020 in 2000; 6,706 in 2005 Fair	Determine whether progress was made between 2000 and 2005 in reducing CRC screening disparities by race, ethnicity, income, and insurance status	Any test (FOBT within past year, FS or colonoscopy in past 10 years) (self-report)	Hispanic and non-Hispanic	Age, gender, race, ethnicity, poverty ratio, insurance, education, region, years in United States	↓ Hispanic females vs. non-Hispanic female	Unadjusted screening rates: In 2000 among male: 23.6% Hispanics compared with 39.3% for non-Hispanic whites Among female: 28.9% Hispanics compared with 37.7% non-Hispanic whites In 2005 among male: 31.3% Hispanics compared with 45.1% non-Hispanic whites Among female: 27.1% Hispanics compared with 46.3% non-Hispanic whites
Wee, et al., 2004[111] Cross-sectional, retrospective, national NHIS, 2000, 50-75 years N = 11,427 Fair	Examine whether disparities in CRC screening persist in year 2000.	FOBT in past year; FS in past 5 years; or colonoscopy in past 10 years (self-report)	Race/ ethnicity (white, black, Hispanic, other)	Age, race or ethnicity, educational level, region of the country, body weight as classified into standard body mass index categories, family history of CRC, healthcare access, smoking status, illness burden	↓Hispanic	Unadjusted screening rates: Whites FOBT 25%, endoscopy 31%; Hispanics FOBT 15%, endoscopy 19%; *P* <0.001 No difference in screening by endoscopy Adjusted rates with non-Hispanic whites as referent: FOBT: (AOR, 0.7; 95% CI, 0.5-0.9) endoscopy: (AOR, 0.8; 95% CI, 0.6-1.0) either: (AOR, 0.7; 95% CI, 0.6-0.9; all *P* < 0.05)

Studies in this section used either non-Hispanic whites or non-Hispanics (any race) as the comparison group. Three studies used all respondents 50 years of age or older in their

sample;[1,116,141,147] one focused on those 50-64 years,[113] another included those 50-75 years,[111] while one study focused on Medicare beneficiaries aged 65 or older.[119]

The definition of the outcomes of being up-to-date with screening varied across the studies and included the following:

- One study defined CRC screening as FOBT in the past year or endoscopy in the past 10 years;[113]
- One study (of the same sample) defined being screened as FOBT in the past 2 years or endoscopy in the past 5 years;[116-117]
- One study defined being screened as FOBT in the past year, FS in the past 5 years, or colonoscopy in past 10 years;[111]
- One study defined being screened as FOBT in the past year and proctoscopy in the past 5 years;[147]
- One study was focused on only screening by endoscopy (ever received);[119]
- One study defined being screened as having an FOBT in the past 2 years and ever having had an endoscopy.[1,141]

We present both unadjusted (or age-adjusted only) rates for CRC test usage by persons of Hispanic ethnicity compared with rates for some other group, as well as rates adjusted by potential confounding variables.

Overview of results. Comparisons of absolute screening rates consistently show that Hispanic ethnicity is associated with lower CRC screening test usage. Overall, adjustment for socioeconomic and health care access factors significantly attenuates, but generally does not eliminate, this disparity. Studies are mixed regarding the relative effect sizes of socioeconomic status and health care access in attenuating these differences. One study that explored the impact of changes in Medicare reimbursement on endoscopy use by different racial and ethnic groups found that, while there were increases in rates among non-Hispanic whites and blacks between 2000 and 2003 (per NHIS data), the difference between non-Hispanic whites and Hispanics in obtaining this test widened during this time period, to a statistically significant gap ($P = 0.048$).[119] One national-level study of both MEPS (2001-2005) and NHIS (2000-2004) data included in this section stratified their analysis by Hispanic subgroup and showed that disparities for persons of Mexican and Dominican origin were greater than for persons of Cuban or Puerto Rican origin.[141] Their findings indicate that respondents of Mexican or Dominican origin are less likely than non-Hispanic whites to be up-to-date with CRC screening (in a model adjusted for demographics and access to care, Mexicans had AOR, 0.70 and Dominicans had AOR, 0.44). However, no differences were found across the Hispanic subgroups once language was incorporated into the model.[141]

Additional studies not examined in detail here presented related findings. Four studies demonstrated that the adjusted rates for screening were lower among Hispanics than non-Hispanic whites;[115,120,126,163] evidence from six other studies suggested that screening rates did not differ among Hispanics.[42,55,107,112,157-158]

Ethnicity - Asians. *Study characteristics*. Because several studies provide findings for different groups of Asians, we present these findings here (Table 14).[1-2,109,118,130] We included five studies, all based on self-reported data that examine screening rates among Asians: two had data for Asians overall,[1-2] and three give data for specific groups of Asians.[109,118,130]

Of the two studies of Asians overall, one rated as good quality reported findings from a combined national dataset of 2001-2005 MEPS and 2000-2004 NHIS'[1] the other, rated as fair

Table 14. Studies of the association of Asian American origin with CRC screening

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders/ Modifiers Reported	Variables Associated with CRC Screening	Results (95% CI)
Jerant et al., 2008[1] Cross-sectional, retrospective, national MEPS, 2001-2005, combined with NHIS, 2000-2004, ≥ 50 years N = 22,973 Good	Examine correlates of screening among all 4 major US racial/ethnic categories (non-Hispanic white, Asian, black, and Hispanic individuals)	FOBT in past 2 years; endoscopy at any time	Asians vs. non-Hispanic whites	Age, gender, metropolitan statistical area, region, year	↓ Asians	Unadjusted screening rates: Asians: 14.8% FOBT; 27.5% endoscopy; 33.8% combined FOBT and endoscopy Non-Hispanic whites: 25.8% FOBT; 49.0% endoscopy; 57.2% combined FOBT and endoscopy Adjusted for age, gender, region: AOR, 0.41; 95% CI, 0.33-0.50 Adjusted for above plus income and education: AOR, 0.42; 95% CI, 0.34-0.52 Adjusted for above plus insurance, usual source of care, health status: AOR, 0.44; 95% CI, 0.35-0.55 Adjusted for above plus language spoken at home, nativity: AOR, 0.63; 95% CI, 0.49-0.81
Wong et al., 2005[2] Cross-sectional, retrospective, state California Health Interview Survey, 2001, ≥ 50 years	Factors related to screening rates among Asian Americans compared with non-Latino whites	FOBT in past year or endoscopy in past 10 years, or both (self-report)	Asian Americans (Koreans, Filipinos, Chinese, South Asian, Japanese, and Vietnamese)	Ethnic group, age, gender, education, marital status, household size and income, years in US, comorbidities, English language proficiency,	↓ Filipino for ever having had or being current for endoscopy ↓ Korean for ever having FOBT	Unadjusted screening rates: Ever screened: Any test: 75% non-Hispanic whites compared with a low of 49% for Koreans and a high range of 72% for Japanese Up-to-date screened: Any test: 62% non-Hispanic whites compared with low

AOR, adjusted odds ratio; CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; MEPS, Medical Expenditure Panel Survey; N, number; NHIS, National Health Interview Survey.
* Arrow symbols (↓or ↑) are provided as a quick reference point of overall findings and represent the association reported between each variable and CRC screening.

Table 14. Studies of the association of Asian American origin with CRC screening (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders/ Modifiers Reported	Variables Associated with CRC Screening	Results (95% CI)
Wong et al., 2005[2] (continued) N = 1,771 Asian Americans Fair				family history of CRC	↑ Vietnamese for ever having any test and for being up to date with any test but FOBT	range of 41% for Koreans and a high range of 58% among Japanese Adjusted rates showed Koreans were less likely to have ever had an FOBT (AOR, 0.40; 95% CI, 0.25-0.62; *P* < 0.001); and Filipinos were less likely to have ever received an endoscopy (AOR, 0.62; 95% CI, 0.44-0.88) or to be up-to-date for that test (AOR, 0.68; 95% CI, 0.48-0.97; *P* < 0.05) Vietnamese were more likely to have ever had or be up-to-date with any of the tests
Studies for Specific Asian Groups						
Nguyen, 2008[130] Cross, sectional, retrospective, counties in 2 states Vietnamese, 2004, residents of counties in California or Texas, 50-74 years N = 867 Fair	Identify determinants of CRC screening among Vietnamese Americans	FOBT alone, FS alone in past 5 years, FOBT + FS in past 5 years, or colonoscopy in past 10 years (self-report)	Vietnamese Americans	Demographics (age, gender, marital status, years in US, education, employment, insurance, English-language proficiency, income, residence), access (health status, usual source of care, MD ethnicity), knowledge of or attitudes about CRC and screening	No comparison group	Overall, 62% had received any CRC test; 25% were up-to-date on FOBT, 16% were up-to-date on FS, and 23% were up-to-date on colonoscopy

Table 14. Studies of the association of Asian American origin with CRC screening (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders/ Modifiers Reported	Variables Associated with CRC Screening	Results (95% CI)
Sun et al., 2004[118] Cross-sectional, retrospective, local Chinese Americans, 1999-2000, 3 senior centers in New York City, ≥ 50 years N = 192 Fair	Investigate factors associated with CRC screening among senior Chinese Americans	FOBT only in past year, FOBT + FS in past 5 years, or no test	Chinese Americans	Age, gender, marital status, home owner, citizenship, years at residence, education, income, insurance, employment, family history of CRC, worries or fears, perceived susceptibility, self-efficacy, social influence, intention, efficacy of screening	No comparison group	Overall, 27.9% reported FOBT within past year; 22.2% reported FS
Yip, et al., 2006[109] Cross-sectional, retrospective, local Chinese Americans, 2003-2004, community health center in Seattle, ≥50 years N = 383 Fair	Identify factors associated with CRC screening among Chinese Americans	FOBT in past year, FS in past 5 years and/or colonoscopy in past 10 years (claims)	Chinese Americans	Age, gender, insurance, language spoken	No comparison group	Overall, 39.7% were assessed as being screened for CRC according to guidelines. Of these, 18.9% had completed FOBT in past year, 2.9% completed FS in past 5 years, and 21.3% completed colonoscopy in past 10 years

quality, presented findings from the 2001 California Health Interview Survey (CHIS).[2] The three studies that present findings for specific subpopulations, all rated as fair quality for this specific variable, do not provide screening rates for the population in question compared with rates for other groups; they collected primarily convenience samples of patients from either communities in two states (California and Texas) with large samples of Vietnamese Americans,[130] senior centers in New York City with relatively large groups of Chinese Americans,[118] and one community health center in Seattle with a large Chinese American patient population.[109] We

include these only in this section because of limits in their samples. All but one of the studies defined their population as those 50 years or older; one focused on those 50-74 years.[130]

The outcome of screening was assessed differently across the studies as follows:

- One study defined being screened as having FOBT in the past year or endoscopy in the past 10 years[2]
- One study defined CRC screening as FOBT in the past 2 years and ever having had an endoscopy[1]
- One study defined being screened as FOBT in the past year, FS in the past 5 years, FOBT with FS in the past 5 years, or colonoscopy in the past 10 years[130]
- One study defined being screened as FOBT in the past year, FOBT with FS in the past 5 years, or no testing[118]
- One study defined CRC screening as FOBT in the past year, FS in the past 5 years, or colonoscopy in the past 10 years.[109]

Overview of results. Comparisons of absolute screening rates consistently show that being of Asian descent is associated with lower CRC screening test usage. Overall, adjustment for socioeconomic and health care access factors significantly attenuates, but generally does not eliminate, this disparity. For the large national study of MEPS and NHIS data, Asians were shown to be less likely than non-Hispanic whites to be current with screening, even when all adjustments were made for demographics, socioeconomic status, access to care, and language.[1] In the other large study that compared different Asian subgroups on screening rates, the findings were mixed, showing that the unadjusted rates of all the Asian groups were consistently lower than those for non-Hispanic whites,[2] Adjustments to the multivariate analysis eliminated these differences for all groups except for endoscopy in Filipinos (AOR, 0.62 for ever use and AOR, 0.68 for up-to-date use) and ever use of FOBT in Koreans (AOR, 0.40).[2] Vietnamese were consistently more likely than non-Hispanic whites to have ever been screened and to be up-to-date with all but FOBT (AOR, range 1.24-1.54; $P < 0.05$); for FOBT, Vietnamese were less likely than non-Hispanic whites to have ever received FOBT (AOR, 0.90; $P < 0.05$), but there were no differences for up-to-date screening by FOBT.[2]

We also found four studies with some related information that demonstrates the inconsistency in findings across studies of Asian use of CRC screening. One reported that Asians were less likely than non-Hispanic whites overall to have been screened;[114] another reported that Asian Americans and Pacific Islanders were less likely than non-Hispanic whites to have received an FOBT,[147] a third reported no difference in screening rates between Asians and non-Hispanic whites,[163] and the fourth found that Vietnamese were just as likely as whites to have had a FOBT in the past year or colonoscopy in past 10 years but were significantly less likely to have received a FS in the past 5 years ($P < 0.05$).[112]

In the three studies that presented findings specific to a subgroup of Asians, one study found that 25 percent of Vietnamese were up-to-date with screening;[130] another study reported that 27.9 percent of Chinese American respondents reported FOBT within the past year and 22.2 percent reported FS;[118] and the third study reported that 39.7 percent of their sample of Chinese Americans were current for CRC screening.[109]

Acculturation. *Study characteristics.* We assessed nine studies in terms of the extent to which acculturation was a factor in predicting CDC screening (Table 15).[1-2,118,120-122,141,147,149,161] By acculturation, we mean three possible indicators: place of birth (i.e., foreign- or US-born), years living in United States, English-language proficiency, or a combination of these. Although

Table 15. Studies of the association between acculturation and CRC screening

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders/ Modifiers Reported	Variables Associated with CRC Screening	Results (95% CI)
Afable-Munsuz et al., 2009[149] Cross-sectional, retrospective, national NHIS, 2000, 2003, 2005, Latinos 50 years or older N = 38,347 (2304 Mexicans; 503 Puerto-Ricans; 484 Cubans) Good	Examine the relationship between acculturation and CRC screening among older Mexican, Puerto-Rican, and Cuban adults	FOBT in past year; FS in past 5 years; colonoscopy in past 10 years (self-report)	Acculturation (i.e., US or foreign born; and language preference of interview)	Age, sex, income status, education, insurance, usual source of care, number of chronic diseases	↑ English language proficiency for FOBT ↑ US born for endoscopy among Mexicans ↓ US born for FOBT among Puerto Ricans	English language interview was positively associated with FOBT in past year (AOR, 2.5; 95% CI, 1.1, 5.4) US born among Mexicans was positively associated with endoscopy (AOR, 1.5; 95% 1.1, 2.2) and negatively associated with FOBT among Puerto Ricans (AOR, 0.3; 95% CI, 0.2, 0.7)
Diaz et al., 2008[161] Cross-sectional, retrospective, national BRFSS, 2006, ≥ 50 years N = 99,895 Good	Examine relationship between language and CRC screening among Latinos and non-Latinos	FOBT in past year; endoscopy in past 10 years (self-report)	English-language proficiency (non-Latinos responding to survey in English; Latinos responding in English; Latinos responding in Spanish)	Age, gender, marital status, insurance, geographic region	↑ English-language proficiency	Latinos responding in Spanish were 43% less likely to have obtained CRC screening than non-Latinos (AOR, 0.57; 95% CI, 0.44-0.74) and 36% less likely to have been screened when compared with Latinos responding in English (AOR, 0.64; 95% CI, 0.48-0.84)

AOR, adjusted odds ratio; BRFSS, Behavioral Risk Factor Surveillance Survey; CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; MEPS, Medical Expenditure Panel Survey; NHIS, National Health Interview Survey; US, United States.

* Arrow symbols (↓or ↑) are provided as a quick reference point of overall findings and represent the association reported between each variable and CRC screening.

Table 15. Studies of the association between acculturation and CRC screening (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders/ Modifiers Reported	Variables Associated with CRC Screening	Results (95% CI)
Goel, et al., 2003[147] Cross-sectional, retrospective, national NHIS, 1998, ≥50 years N = 32,440 (15% foreign-born) Good	Determine whether foreign birthplace explains some racial/ethnic disparities in cancer screening	FOBT in past year or proctoscopy (as a proxy for FS) in past 5 years	Foreign-born (born outside US)	Age, marital status, geographic region, education, income, health status, comorbidities, body mass index, hospitalizations in prior year, access to care (insurance status, visits in past year, usual source of care)	No differences for foreign-born respondents once analysis adjusted for access to care	Foreign-born Hispanics and Asian Americans and Pacific Islanders were just as likely as US-both Hispanics and Asian Americans and Pacific Islanders to have been screened by FOBT (AOR, 1.05; 95% CI, 0.68-1.64 for Hispanics; AOR, 0.62; 95% CI, 0.29-1.33 for Asian Americans and Pacific Islanders) or for proctoscopy (AOR, 0.89; 95% CI, 0.59-1.37 for Hispanics; AOR, 0.96; 95% CI, 0.44-2.09 for Asian Americans and Pacific Islanders)
Jerant, et al., 2008[1] Cross-sectional, retrospective, national MEPS, 2001-2005, combined with NHIS, 2000-2004, ≥ 50 years N = 22,973 Good	Examine correlates of screening among all 4 major US racial/ethnic categories (non-Hispanic white, Asian, black, and Hispanic individuals)	FOBT in past 2 years or endoscopy ever	Language spoken at home; foreign- or US-born	Age, sex, metropolitan statistical area (rurality), region of US, income, education, insurance, usual source of care, self-rated health	↑ English-language proficiency ↑ US-born	Respondents who reported speaking English at home were more likely to report being screened than those who did not (AOR, 1.84; 95% CI, 1.52-1.33 for combined screening with FOBT or endoscopy) Those born in the US were also more likely to be screened than those who were not (AOR, 1.16; 95% CI, 1.01-1.33)

Table 15. Studies of the association between acculturation and CRC screening (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders/ Modifiers Reported	Variables Associated with CRC Screening	Results (95% CI)
Jerant, et al., 2008[141] (continued) N = 22,419 Good						There were no differences in screening rates among other groups of Hispanics in terms of their reported screening
Shah, 2006[121] National cross sectional survey; NHIS, 2000 Hispanics age 50-80 N = 1,163 Fair	Examine whether low acculturation is a risk factor for underutilization of CRC screening examinations in the Hispanic population	Not having had FOBT (at home) in past year and not having had lower endoscopy in past 5 years	Acculturation (i.e., English language usage) in tertiles: low, moderate, high	Marital status, age, education, income	No difference in screening rates based on language usage	Adjusted rates for not being screened with low English language usage as the referent: Moderate: AOR, 0.92; 95% CI, 0.60-1.42 High: AOR, 0.75; 95% CI, 0.45-1.25
Shih et al., 2008[120] Cross-sectional, retrospective, national NHIS, 2000, ≥ 50 years N = 12,179 Good	Examine factors associated with CRC screening of US- and foreign-born groups	Ever been screened by FOBT or endoscopy (self-report)	Foreign-born by years in US (short = < 10 years; moderate = 10-14 years; long duration = ≥ 15 years)	Age, gender, race/ethnicity, geographic region, urban vs. rural	↓ Foreign-born and living in US ≤ 10 years or ≥ 15 years	Foreign-born respondents living in US ≤10 years were less likely than US-born non-Hispanic whites to be screened for CRC (AOR 0.46; 95% CI, 0.29-0.71), as were foreign-born respondents living in US for 15 years or more (AOR 0.58; 95% CI, 0.51-0.67; *P* ≤ 0.001)
Schumacher et al., 2008[122] Cohort study, several states (Alaska, Southwest United States)	Investigate predictive factors associated with receiving each of the cancer screening tests	Colonoscopy or FS in past 5 years (self-report)	English-language proficiency (language spoken at home)	Age, location, gender, education, family history of cancer, family history of CRC, smoke cigarettes in past 5 years, history of chronic	↓ American Indians using native languages at home	Respondents speaking only native languages at home were less likely to have obtained CRC screening than those speaking English at home (AOR, 0.50; 95% CI, 0.33-0.76)

Table 15. Studies of the association between acculturation and CRC screening (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders/ Modifiers Reported	Variables Associated with CRC Screening	Results (95% CI)
Schumacher et al., 2008[122] (continued) Baseline survey, 2004-2007, American Indian/Alaska Natives, 50+ years N = 2,779 Fair				medical condition, language, residency, income, other screening tests		Those speaking English and native languages at home were also less likely to have received CRC screening (AOR, 0.65; 95% CI, 0.50-0.85)
Sun et al., 2004[118] Cross-sectional, retrospective, Local Chinese Americans, 1999-2000, 3 senior centers in New York City, ≥ 50 years N = 203 Fair	Investigate factors associated with CRC screening among senior Chinese Americans	FOBT only in past year, FOBT + FS in past 5 years, or no test (claims)	Years of US residency (< 10 years; 10-19 years; ≥ 20 years)	Age, gender, marital status, home owner, ethnicity, years at residence, education, income, insurance, employment, family history of CRC, worries or fears, perceived susceptibility, self-efficacy, social influence, intention, efficacy of screening	↑ Years in US	Years living in US was a predictor of FOBT only (AOR, 0.64; 95% CI, 0.41-0.99; *P* < 0.05); or for either FOBT only or FOBT + FS (AOR, 0.54; 95% CI, 0.64-0.94)
Wong et al., 2005[2] Cross-sectional, retrospective, State California Health Interview Survey, 2001, ≥ 50 years	Factors related to screening rates among Asian Americans compared with non-Latino whites	FOBT in past year or endoscopy in past 10 years, or both (self-report)	Foreign-born and years living in US (< 15 years in the US or ≥ 15 years in US)	Ethnic group, age, gender, education, marital status, household size and income, years in US, comorbidities, English language proficiency, family history of CRC	↓ Living in US for < 15 years	Foreign-born respondents living in US for < 15 years were less likely to have ever received CRC screening (AOR, 0.48; 95% CI, 0.32-0.71) or to be up-to-date with screening (AOR, 0.58; 95% CI, 0.40-0.82)

Table 15. Studies of the association between acculturation and CRC screening (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders/ Modifiers Reported	Variables Associated with CRC Screening	Results (95% CI)
Wong et al., 2005[2] (continued) N = 1,771 Asian Americans Fair						

these factors may be important for any race or ethnicity, the studies we consider here examined them specific to non-white Hispanics,[1,121,141,149,161] Asians,[118] or both Hispanics and Asians;[2,147] one study included all racial/ethnic groups by whether or not they were born in the United States;[120] and one focused on American Indians and Alaska Natives.[122] Six of the nine studies are based on nationally representative samples of respondents collected through self-reported survey data.[1,120-121,141,147,149,161] One study was based on self-reported data from across several states,[122] one on data from a state-based survey,[2] and one on locally based claims data from three senior centers in New York City.[118] All but one[121] of the nine studies included those 50 years of age or older in their sample.

The operationalization of CRC screening differed across the nine studies as follows:

- Two studies included those who had FOBT in the past year or endoscopy in the past 10 years among those currently screened;[2,161]
- Two studies defined screening as FOBT in the past year and either FS or protoscopy in the past 5 years;[118,147]
- One study (with varied results described in two articles) defined screening as having FOBT in the past 2 years or ever having had an endoscopy;[1,141]
- One study defined screening as those who had ever had FOBT or endoscopy;[120]
- One study defined screening as having had either colonoscopy or FS in the past 5 years;[122]
- One study defined screening as a FOBT in past year, FS in past 5 years, or colonoscopy in past 10 years; [149] and,
- One study used a lack of screening as their outcome such that those who had no FOBT in the past year or no endoscopy in the past 5 years were considered to be not screened for CRC.[121]

Overview of results. Of the nine studies (reported in 10 articles), four reported findings specific to whether respondents were foreign- or US-born;[2,118,120,147] three examined the relationship between English-language proficiency and screening;[122,141,161] and three examined both place of birth and English-language proficiency.[1,121,149]

With respect to being foreign-born or years living in the United States, we considered three studies with findings specific to place of birth, three with findings specific to the number of years

living in the United States,[2,118,120] and four with information as to whether the respondent reported being born in the United States.[1,120,147,149] For place of birth, two studies found that those born in the US were more likely to have been screened than those who were foreign born[134] (or foreign born were less likely to be screened if living in US 10 years or less[119]), whereas another found no differences in screening based on place of birth once other factors were controlled. [114] Four studies also reported a negative association between number of years living in the United States and being up-to-date with CRC screening.[1-2,118,120,147,149]

Two studies presented findings specific to Asian Americans. In one analysis of a convenience sample of Chinese Americans, as a person's years in the United States increased so did their odds of being screened (AOR, 0.64; $P < 0.05$).[118] Another study based on data collected through the 2001 CHIS reported that Asian Americans living in the United States less than 15 years were less likely to be up-to-date with screening than those living here longer than 15 years (AOR, 0.58).[2]

Two additional studies not included here (because exploring acculturation was not a specific aim of their work) reported that the years of living in the United States made no difference in terms of CRC screening.[114,163]

With respect to English-language proficiency, we considered four studies.[1,121-122,141,161] All but one[150] found an association between this factor and CRC screening. The fourth study used a scale for acculturation that was based on English language usage (e.g., language most often spoken or read, everyday usage via TV, radio); it found no difference in screening rates once findings were adjusted for socioeconomic status and access to care variables.[121] One of these four studies presented findings from American Indian and Alaska Natives across several states that demonstrated an association between CRC screening and either speaking only native languages at home (AOR, 0.50) or speaking a combination of native language and English at home (AOR, 0.65; 95% CI, 0.50-0.85).[122] A similar relationship was found for any respondents of the national study of 2001-2005 MEPS and 2000-2004 NHIS data; speaking English at home was significantly associated with increased CRC screening (AOR, 1.84; 95% CI, 1.52-1.33).[1] Overall, Latinos who were interviewed in Spanish were less likely to report screening than non-Hispanic whites (AOR, 0.57, or more likely to not be screened with AOR of 2.5).[149,161]

Income. *Study characteristics.* Most studies included household income as a potential confounding variable; we highlight two studies, both rated fair quality, here because a primary study aim was to examine the association between income and screening rates (

Table 16).[114,123] One study relied on national data from the 2002 BRFSS constructed for metropolitan or micropolitan statistical areas (MMSA) to examine the predictive value of area poverty rates on CRC screening.[123] The other study presented local data collected through a Community Health Survey of New York City residents.[114] Both studies relied on self-reported data from respondents 50 years of age or older.[114,123] One study assessed the outcome of CRC screening by respondent reports of whether they had obtained an FOBT in the past year or a endoscopy in the past 5 years.[123] The other study defined CRC screening as having received FOBT in the past year, FS in the past 5 years, or colonoscopy in the past 10 years.[114]

Overview of results. Similar to the three national overview studies,[21,46,151] both of these studies found an association between income and screening rates; persons with lower incomes were less likely to receive any CRC test, and those with higher incomes were more likely to be screened.[114,123]

Table 16. Studies of the association of income with CRC screening

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders/ Considered	Variables Associated with CRC Screening*	Results (95% CI)
Shootman et al., 2006[123] Cross-sectional, retrospective, national BRFSS (2002), for 98 MMSA, ≥ 50 years N = 118,000 Fair	Analyze contextual effect of area poverty rate on never having been screened	Any test (FOBT with past year, either FS or colonoscopy in past 5 years (self-report)	MMSA; household income	Gender, age, race/ethnicity	↓ residing in high poverty areas	People residing in low income area were less likely than those in higher income areas to have never received FS/colonoscopy (AOR, 1.10; 95% CI, 1.01-1.19) or FOBT (AOR, 1.19; 95% CI, 1.12-1.27)
Thorpe et al., 2005[114] Cross-sectional/ retrospective, local Community Health Survey, New York City residents ≥ 50 years N = 3,606 Fair	Examine characteristics of people undergoing screening within guidelines	Any test per guidelines (FOBT within past year, FS in past 5 years, or colonoscopy in past 10 years) (self-report)	Personal household income; neighbor-hood income level (% of families ≤ 200% federal poverty level, if 45% or more met this definition, neighbor-hood was identified as low income)	Age, race, ethnicity, gender, personal risk factors (current smoking, physical inactivity), access to care, insurance, regular source of care	↓ Household income < $25,000[c] for any test and for colonoscopy ↓ Neighbor-hood income (medium) for any test	Groups with lowest likelihood of screening were poor (AOR, 0.68 for any test: 95% CI, 0.54-0.85) Living in a medium-income (vs. poor- or high-income) neighborhood made respondents less likely to receive any test (AOR, 0.76; 95% CI, 0.61-0.93)

AOR, adjusted odds ratio; BRFSS, Behavioral Risk Factor Surveillance System; CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; MMSA, metropolitan and micropolitan statistical area.
* Arrow symbols (↓or ↑) are provided as a quick reference point of overall findings and represent the association reported between each variable and CRC screening.

These studies also add findings at both the neighborhood and MMSA levels by suggesting that even living in lower-income areas predicts CRC screening rates. People residing in low MMSAs were less likely than those in high-income MMSA to receive an endoscopy (AOR 1.10) or FOBT (AOR 1.19);[123] respondents living in a medium-income neighborhood (versus a poor or a high-income neighborhood) were less likely to receive any test (AOR, 0.76).[114]

Of the other studies that included income level as a variable in their final multivariate analysis, 10 found either that persons with low income were less likely than those with high income to receive screening,[1-2,42,107,120,122,126,130,150,156] or that higher-income respondents were

more likely than lower-income ones to have obtained screening.[120,150] One study that focused on exploring racial differences in screening found that controlling for SES (i.e., education, income) in a nationally representative sample of Medicare beneficiaries eliminated any differences in rates. [129] An additional six studies reported no difference in screening rates by income level.[55,108,156-157,160,163]

Insurance status. *Study characteristics.* We include seven studies, one rated as good quality[56] and the rest rated as fair quality, in the highlighted results specific to insurance status[107,113-114,124,138,160] (Table 17). Of these, four are based on national samples of respondents or patients;[56,113,124,138] two are based on state-level samples;[107,160] and one was based on a local sample of New York City residents.[114] All but one study relied on self-reported data; the exception relied on a national sample of Medicare beneficiaries for their analysis.[138] The populations of interest for three studies was those 50 years or age of older;[107,114,160] two studies focused on those ages 50-64 years;[56,113] and two relied on samples of people 65 years or older.[124,138]

In terms of the outcome of screening, definitions varied

- Three studies defined CRC screening as FOBT in the past year, FS in the past 5 years, or colonoscopy in the past 10 years;[107,114,160]
- One defined being screened as having an FOBT in the past year or an endoscopy in the past 10 years;[113]
- One defined the outcome as having had an FOBT in the past 2 years or an endoscopy in the past 5 years;[124]
- One defined being screened as any CRC test in the past year;[138] and
- One defined being screened as having had an FOBT in the past year.[56]

Overview of results. Four of the seven studies compared screening rates according to whether respondents reported having any insurance or no insurance.[56,113-114,160] All four studies reported results similar to those from the three overview studies;[21,46,151] those without insurance were far less likely to report being screened than those with any type of insurance.[56,113-114,160] This relationship remained when data from of national samples of survey respondents in 2000 were compared with those in 2005; females showed no change from 2000 to 2005 in screening rates (AOR, -1.3), and males showed only a slight increase in screening over time (AOR, 3.0).[113]

Other studies also reported similar findings. Generally, for any tests, the uninsured were less likely to be up-to-date with screening than those with some insurance.[2,116,128]
Of the three studies that focused on the association between different types of insurance coverage and CRC screening, one focused on two groups, one comprising "dual" recipients of both Medicare and Medicaid and the other nondual Medicare recipients.[138] Another explored how those with managed care coverage compared with those having other insurance coverage among a Medicare-enrolled population (i.e., 65 years or older),[124] and a third examined these relationships in those 50 years or older.[107] Another study (not in summary table) compared type of insurance among a sample of low-income women residing in Washington, DC and reported (based on self-reports) that those participating in Health Maintenance Organizations (HMO) were more likely than others to be current with screening (AOR, 6.39; 95% CI, 2.05, 19.9 for private HMO; $P < 0.01$).[128]

These studies reported two main results. Persons who are dual recipients were less likely than others to receive any of the CRC tests (i.e., FOBT, FS, colonoscopy);[138] those in a managed care Medicare plan were more likely to be screened per guidelines than those with any other types of insurance (Medicare or otherwise).[107,124]

Table 17. Studies of insurance status as a predictor of CRC screening

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review (i.e., screening or followup after abnormal FOBT; completion rates or discussions)	Predictors Examined	Potential Confounders/ Modifiers Reported	Variables Associated with CRC Screening	Results (95% CI)
Cairns et al., 2006[56] Cross-sectional, national HINTS, 2002-2003, 50-64 years N = 1,253 Good	Examine the role of communi-cation factors and insurance on CRC screening.	FOBT within the past year (self-report)	Insurance coverage vs. no coverage	Age, insurance, whether there is a usual provider, gender, race/ethnicity, annual household income, employment, rural vs. urban county, education	↓ uninsured	Uninsured were 64% less likely to be screened than the insured (AOR, 0.36; 95% CI, 0.241–0.536; *P* < 0.001)
de Bosset, et al., 2008[160] Cross-sectional, state BRFSS, 2005, Virginia residents 50 years or older N = 2,887 Fair	Examine whether self-reported insurance coverage was associated with CRC screening	FOBT within past year and/or lower endoscopy within past 5 years (self-report)	Insurance coverage vs. no coverage	Gender, age, education, income, employment, having seen physician in previous year	↓ uninsured males	Insured males were more likely to report CRC screening than uninsured males (AOR, 2.02; 95% CI, 0.96-4.23) For females, there was no effect of insurance coverage (AOR, 0.86; 95% CI; 0.34-1.93)
Koroukin et al., 2006[138] Cross-sectional, national Medicare Denominator File, 1999, ≥ 65 years N = 23 million (2.5 million duals, 20.2 million nonduals) Fair	Assess disparities in CRC screening between elderly dual Medicare-Medicaid enrollees (duals) and non-duals.	Any test code (colonoscopy, FS, FOBT) within the past year (claims)	Insurance status: Medicare dual eligible vs. non dual-eligible	Dual beneficiary status, age, race, sex	↓ dual-eligibles	Use of CRC screening services decrease if dual enrollment in Medicare-Medicaid: FOBT (AOR, 0.48; 95% CI, 0.45-0.51), FS (AOR, 0.55; 95% CI, 0.49-0.61), FS or colonoscopy (AOR, 0.60; 95% CI, 0.54-0.67), colonoscopy (AOR, 0.85; 95% CI, 0.80-0.89)

AOR, adjusted odds ratio; BRFSS, Behavioral Risk Factor Surveillance System; CI, confidence interval; CRC, colorectal cancer; FFS, fee-for-service; FFS + NO SUPP, fee-for-service Medicare + no supplemental insurance; FFS + SUPP, fee-for-service Medicare + supplemental insurance; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; HINTS, Health Information National Trends Survey; HMO, health maintenance organization; MMC, Medicare managed care; N, number; RR, relative risk.
*Arrow symbols (↓or ↑) are provided as a quick reference point of overall findings and represent the association reported between each variable and CRC screening.

Table 17. Studies of insurance status as a predictor of CRC screening (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review (i.e., screening or followup after abnormal FOBT; completion rates or discussions)	Predictors Examined	Potential Confounders/ Modifiers Reported	Variables Associated with CRC Screening	Results (95% CI)
Schneider et al., 2008[124] Cross-sectional, retrospective, national Medicare Current Beneficiary Survey, 2000, ≥ 65 years N = 10,173 Fair	Assessed whether benefi-ciaries in MMC plans were more likely than those in traditional FFS insurance to receive CRC screening and whether type of insurance was associated with use of specific screening strategies	Any test (2 years for FOBT or 5 years for colonoscopy or FS) (self-report)	Insurance status categories: MMC; FFS SUPP; FFS NO SUPP	Age, gender, race, Hispanic origin, education, marital status, annual income, metro area residency	↑ MMC	MMC (52.9%) was more likely than supplemental insurance groups (FFS SUP) (50.7%, *P* = 0.15) to receive CRC screening, but time-interval appropriateness was similar between groups (no confidence intervals provided) Beneficiaries in MMC were more likely than those in the FFS SUPP group to receive interval-appropriate FOBT (36.3% vs. 32.1%; *P* = 0.013), but less likely to receive an interval-appropriate invasive screening procedure (35.9% vs. 40.8%; *P* < 0.001)
Trivers, et al., 2008[113] Cross-sectional, retrospective, national NHIS, 2000 compared with 2005, 50-64 years N = 6,020 in 2000; 6,706 in 2005 Fair	Determine whether progress was made between 2000 and 2005 in reducing CRC screening disparities by race, ethnicity, income, and insurance status.	Any test (FOBT within past year, FS or colonoscopy in past 10 years) (self-report)	Insurance status categories; public, private, or none	Age, gender, race, ethnicity, poverty ratio, insurance, education, region, years in US	↑ private health insurance	For both males and females with private insurance, there was a significant increase in screening from 2000 to 2005 (change over time for male: OR, 6.7; 95% CI, 3.4-9.9 and for female: OR, 10.0; 95% CI, 7.0-13.0) For females with no insurance, there was no change from 2000 to 2005 in screening rates (AOR, -1.3; 95% CI, -7.1-4.6) and for male, there was only a slight increase in screening over time (AOR, 3.0; 95% CI, -3.9 to 9.8)

Table 17. Studies of insurance status as a predictor of CRC screening (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review (i.e., screening or followup after abnormal FOBT; completion rates or discussions)	Predictors Examined	Potential Confounders/ Modifiers Reported	Variables Associated with CRC Screening	Results (95% CI)
Thorpe, et al., 2005[114] Cross-sectional, retrospective, local Community Health Survey, 2003, New York City residents, ≥ 50 years N = 3,606 Fair	Analysis of individual- and neighbor-hood-level factors associated with colon cancer screening practices	Any test (colonoscopy in past 10 years, FOBT in past year, and FS in past 5 years) (self-report)	Insurance status	Age, race, birthplace, gender, education, household income, neighborhood income	↓ uninsured	Any timely CRC screening test: Medicaid or Medicare (AOR 1.02; 95% CI, 0.81-1.28); uninsured (AOR 0.31; 95% CI, 0.20-0.48) Colonoscopy in past 10 years: Medicaid or Medicare (AOR 0.89; 95% CI, 0.71-1.13); uninsured (AOR 0.39; 95% CI, 0.23-0.65)
Zapka et al., 2002[107] Cross-sectional, state Community Health Survey, 1998, Massachusetts residents, ≥ 50 years N = 1,002 Fair	Assess the role of insurance status, type of plan, frequency of preventive health visits, and provider recom-mendation on utilization of CRC screening tests	Any test (colonoscopy or barium enema within 10 years, FS within 5 years, and FOBT in the past year) (self-report)	Insurance status categories: for those 50-64 years-- private (non-HMO); HMO; public, uninsured; For those 65+- non-HMO Medicare; Medicare HMO; duals	Gender, race, education, employment status, income, marital status, family history of CRC, perceived health status	↑Medicare non-HMO participants	Medicare HMO participants were somewhat more likely to be currently tested than Medicare non-HMO participants (AOR, 1.83; 95% CI, 0.91-3.71) There was an interaction between insurance status and respondents who believed their insurance did, or did not pay for CRC tests

Overall, 13 additional studies with insurance status as a variable in their final adjusted logistic regressions reported that those who were uninsured were less likely than those insured to report current CRC screening.[1-2,42,111,116,120,126,130,134,146,156-157,163] Three other studies that included insurance status in such analyses found no difference in CRC screening by this variable.[109,132,137]

Access to care. *Study characteristics.* Access to care is defined in most studies as having a usual (or regular) source of care and visiting that provider at least once within the past year. Most studies included these variables as control or potential confounding variables; here we present more detailed information on four studies that specifically highlighted the relationship between access-to-care variables and CRC screening (Table 18).[108,133-134,163]

One study, rated as good quality, based results on the 2002-2003 HINTS;[133] the others, all rated as fair quality, presented either regional[134,170] or state-level findings.[163] All four studies

Table 18. Studies of the association of access to care with CRC screening

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review (i.e., screening or followup after abnormal FOBT; completion rates or discussions)	Predictors Examined	Potential Confounders/ Considered	Variables Associated with CRC Screening*	Results (95% CI)
McQueen et al., 2006[133] Cross-sectional, national HINTS, 2002-2003, 50+ years N = 2,686 Good	Examine correlates of test use by gender	Any test (endoscopy in the last 10 years or FOBT in the last year) (self-report)	Number of physician visits in past year; having a usual source of care	Demographics, access, health status, health behaviors	↑ Visit physician regularly ↓ No usual source of care	Those who had visited a physician 1 or more times in the previous year were more likely to be screened by endoscopy than those with no visits in the prior year (AOR 5.12; 95% CI, 2.54-10.29 for males and OR 4.89; 95% CI, 1.79-13.37 for females; *P* < 0.05) "Not having a doctor" was associated with not being screened for CRC in both males (AOR, 0.1; 95% CI, 0.0-0.5 for FOBT and OR, 0.5; 95% CI, 0.1-1.9 for endoscopy) and females (AOR, 0.2; 95% CI, 0.1-0.8 for FOBT and OR, 0.5; 95% CI, 0.2-1.4 for endoscopy)

CHIS, California Health Interview Survey; CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; HINTS, Health Information National Trends Survey; OR, odds ratio; RDD, random digital dialing; RR, relative risk.
* Arrow symbols (↓or ↑) are provided as a quick reference point of overall findings and represent the association reported between each variable and CRC screening.

Table 18. Studies of the association of access to care with CRC screening (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review (i.e., screening or followup after abnormal FOBT; completion rates or discussions)	Predictors Examined	Potential Confounders/ Considered	Variables Associated with CRC Screening*	Results (95% CI)
Etzioni et al., 2004[163] Cross-sectional, state CHIS, 2001, 50+ years N = 22,343 Fair	Examine individual-level variables associated with screening	Any test (FOBT within past year, FS or colonoscopy in past 5 years) (self-report)	Access to care combined as a composite of insurance status with whether respondent reported a usual source of care. Insurance categories included: < 65 years: employer-based, private/self-purchased, public, uninsured 65+ years: Medicare + supplement, Duals, Medicare only, uninsured; Number of physician visits in past year	Age, gender, race, marital status, income, education, self-reported health status, number of visits to physician in last 12 months, percent of life lived in the US, English proficiency	↓ Uninsured individuals with and without a usual source of care ↑ Number of physician visits	Uninsured respondents with usual source of care were less likely to receive CRC testing than those in any of the other insurance categories with usual source of care (RR, 0.61; 95% CI, 0.53-0.69 for 50-64 years; RR, 0.62; 95% CI, 0.37-0.92 for 65+) Uninsured with no usual source of care were less likely to be screened than any of the other groups of individuals (RR, 0.32; 95% CI, 0.23-0.43 for 50-64; RR, 0.08; 95% CI, 0.00-1.21 for 65+) Respondents who reported visiting a physician 1 or more times in past year were more likely to report being current with screening (RR range 1.41-1.77)

Table 18. Studies of the association of access to care with CRC screening (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review (i.e., screening or followup after abnormal FOBT; completion rates or discussions)	Predictors Examined	Potential Confounders/ Considered	Variables Associated with CRC Screening*	Results (95% CI)
Matthews et al., 2007[134] Cross-sectional, regional Survey administered to 5-county region in Midwest, 2005, 50-79 years N = 1,033 Fair	Identify indicators of up-to-date CRC screening	FOBT within past year, FS in past 5 years, or colonoscopy in past 10 years (self-report)	Regular physician visits	Gender, age, race, education	↑ Visit physician regularly	Respondents who reported visiting a physician regularly were more likely to report being current with screening (AOR 2.02; 95% CI, 1.49-2.74)
Young et al., 2007[108] Cross-sectional, regional RDD survey, residents in eastern Colorado, 2005, 50 years or older N = 1,005 (weighted sample) Fair	Identify variables Associated with screening	Any CRC test (FOBT in past year, FS or double-contrast barium enema in past 5 years, colonoscopy in past 10 years)	Saw a doctor or other health care provider in past year; geographic proximity to a facility that offers testing	Age, gender, race/ethnicity, marital status, education, employment, income, patient request for screening, perceived risk, family history	↑ Visit with provider in past year No difference based on proximity to health facility	Respondents who reported visiting a doctor or other health provider in past year were more likely to be up-to-date on CRC screening than others (AOR, 1.29; 95% CI, 1.21-1.38) Up-to-date screening for those living in an area with a health care facility were no different than those without a health facility (range of *P* values = 0.38-0.78)

relied on self-reported data for their analysis.[108,133-134,163] The two regional studies relied on survey data collected in 2005 from a five-county region in the Midwest[134] or data collected in 2005 across a region in the state of Colorado.[108] The state-based study used CHIS data.[163] One study included respondents ages 50-79 years;[134] the other three included those 50 years or older.[108,133,163]

To assess the CRC screening outcome, two studies used FOBT in the past year or endoscopy in the past 10 years,[108,133] one study defined CRC screening as having obtained FOBT within the past year or endoscopy in the past 5 years,[163] and the fourth defined the outcome as FOBT in the past year, FS in the past 5 years, or colonoscopy in the past 10 years.[134]

Overview of results. As with the three overview studies,[21,46,151] usual source of care predicted CRC screening for both a study of multiple factors influencing screening in a national sample[133] and a state-based study of the relationship between screening and having a usual source of care combined with insurance status.[163] The national study found that not having a usual source of care was associated with not being screened among both males and females (AOR range, 0.1-0.5).[133] In the state-based study, uninsured respondents with no usual source of care were less likely to be screened than any of the other groups of individuals in their sample (RR, 0.32 for 50-64; RR, 0.08 for 65+).[163]

Several other studies found similar results: usual source of care was consistently associated with higher rates of CRC screening.[1-2,42,56,107-108,111,120,128,130,157] A recently published study of the 2004 BRFSS also reported a strong association between screening and having at least 1 personal health care provider (AOR, 3.95; 95% CI, 2.58-4.41).[155] Another study reported no difference in CRC screening and having a regular provider.[124]

Similar to the three overview studies,[21,46,151] other included studies consistently reported a strong association between the frequency of visits to a physician and CRC screening. Authors of the national study reported that one or more physician visits in the prior year was associated with endoscopic screening (5.12; 2.54-10.29 for males and 4.89; 1.79-13.37 for females; $P < 0.05$).[133] The three other studies also found that the number of physician visits was strongly associated with CRC screening. Seven other studies in this review reported the same association.[2,55,107,126,132,137,158,166]

Personal health and risk factors. *Study characteristics.* A total of nine studies, all of which we rated as fair quality, are included in the summary table (

Table 19) for personal health or risk factors associated with CRC screening.[55,108,114,126,132,137,145,157,166] Personal health factors are characteristics from the person's family history or personal health history (e.g., family CRC diagnosis, personal prior polyp removal, screening behavior with regard to other cancers, general health status) that would place them at increased risk for CRC and/or may be related to healthy behaviors that could influence the extent to which they obtain regular CRC screenings. Risk factors for health problems possibly related to CRC screening include smoking, sedentary lifestyle, poor eating habits, obesity, and any factor that may place a person at increased risk for developing CRC.

For this set of variables, we have included one study that specifically evaluated the association between CRC screening and family history of CRC,[108] two studies that included other cancer screenings,[137,157] one study specific to general health status,[55] and five studies specific to risk factors (i.e., obesity/overweight, smoking, or physical inactivity).[114,126,132,145,166] Eight studies relied on cross-sectional, retrospective data collected through a survey, including four of which were based on national samples;[55,126,145,157] two were based on state samples;[132,137] one reported on a regional sample;[108] and one focused on a city-based or local sample.[114] The remaining study presented findings from medical chart reviews of 22 primary care provider (PCP) practices in the states of New Jersey and Pennsylvania.[166]

Table 19. Studies of the association of personal health/risk factors with CRC screening

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders Considered	Variables Associated with CRC Screening*	Results (95% CI)
Family History of CRC						
Young et al., 2007[108] Cross-sectional, regional RDD survey, residents in eastern Colorado, 2005, ≥ 50 years N = 1,005 (weighted sample) Fair	Identify variables associated with screening	Any CRC test (FOBT in past year, FS or double-contrast barium enema in past 5 years, colonoscopy in past 10 years)	Family history of CRC	Age, gender, race/ethnicity, marital status, education, employment, income, last MD visit, patient request for screening, perceived risk, residence by zip code	↑ Family history of CRC	Respondents with a family history of CRC were more likely than others to have received colonoscopy (AOR, 2.61; 95% CI, 1.86-3.68) and be up to date on any CRC test (AOR, 1.74; 95% CI, 1.20-2.53)
Other Cancer Screenings						
Carlos et al., 2005[157] Cross-sectional, national BRFSS, 2001, females ≥ 50 years N = 52,478 Fair	Understand screening behaviors among female	FOBT within past year, FS or colonoscopy in past 5 years (self-report)	Mammogram (within past year) and Pap smear (within past year)	Age, race, educational level, employment status, income, self-reported general health, smoking, health insurance, personal doctor	↑ regular Pap smear and mammogram ↓ Preceived 'good' health status	Increased screening rates with females who reported adherence to mammograms (AOR, 2.42; *P* < 0.01) and Pap smears (AOR, 1.70; *P* < 0.01) Females who perceived their health as good were less likely to adhere to CRC screening than other females (AOR, 0.79; 95% CI, 0.66-0.93; *P* < 0.01)

AOR, adjusted odds ratio; BRFSS, Behavioral Risk Factor Surveillance System; CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; HINTS, Health Information National Trends Survey; N, number; P, probability; PCP, primary care physician; PSA, prostate-specific antigen; RDD, random digital dialing.
* Arrow symbols (↓or ↑) are provided as a quick reference point of overall findings and represent the association reported between each variable and CRC screening.

Table 19. Studies of the association of personal health/risk factors with CRC screening (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders Considered	Variables Associated with CRC Screening*	Results (95% CI)
Lemon et al., 2001[137] Cross-sectional, retrospec-tive, state level State-based telephone survey of residents 1998, ≥ 50 years N = 954 Fair	Examine relationship of personal characteristics, health and lifestyle behaviors, and cancer screening practices to current CRC screening	FOBT in past year, FS in past 5 years, colonoscopy in past 10 years, or double-contrast barium enema in past 10 years (self-report)	Mammogram (within past year) for female; PSA (within past year) for male; smoking (never, former, or current); use of any type of vitamin supplements, family history of CRC	Gender, education, insurance status, checkup at least every year	↑ Other cancer screening behavior for males and female	Males and females who were currently screened for PSA or mammography, respectively, were more likely to report being up-to-date with CRC screening (AOR, 4.40; 95% CI, 2.94-6.58; *P* < 0.001)
General Health Status						
Berkowitz et al., 2008[55] Cross-sectional, retrospective, national HINTS (2003) respondents 65-89 years old N = 1,148 Fair	Assess beliefs and perceptions of risk about CRC and gaps in knowledge about screening in adults ages 65-89 years	FOBT (within past year) or, FS or colonoscopy in past 10 years (self-report)	General health status (excellent, very good, good, fair, poor)	Gender, race, income, education, marital status, family history of CRC, health status, regular source of care, annual MD visits, knowledge about CRC and testing, beliefs about CRC, perceived risk	No statistically significant difference based on perceived health status	People who perceived their health to be excellent or very good were no more or less likely to be up-to-date with CRC screening than those who are in fair or poor health (*P* = 0.11)

Table 19. Studies of the association of personal health/risk factors with CRC screening (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders Considered	Variables Associated with CRC Screening*	Results (95% CI)
Risk Factors (Obesity, smoking, physical inactivity)						
Heo et al., 2004[145] Cross-sectional/ retrospec-tive, national BRFSS, 2001, ≥ 50 years N = 84,284 Fair	Estimate the association between body mass index and CRC screening	FOBT in past year or FS in past 5 years (self-report)	5 body mass index-defined categories: Normal weight = 18.5- < 25 Overweight = 25- < 30 Obesity Class I = 30 - < 35 Obesity Class II = 35 - < 40 Obesity Class III = ≥ 40	Age, education, race, income, general health status, smoking, employment, health insurance	↑ Obesity for FS screening No differences by obesity for FOBT	Body mass index was not associated with obtaining an FOBT (AORs ranged from 0.90-0.98) Compared with normal weight adults, those who were overweight (AOR, 1.15; 95% CI, 1.02-1.31); in the obesity class I (1.21, 95% CI, 1.09-1.35), II (1.17; 95% CI, 1.04-1.44); and III (1.27; 95% CI, 1.05-1.58) were more likely to have obtained a screening FS within the past 5 years ($P < 0.05$)
Rosen and Schneider, 2004[126] Cross-sectional, retrospec-tive, national BRFSS, 1999, 51-80 years N = 52,886 Fair	Evaluate whether association exists between body mass index and CRC screening	FOBT in past year or endoscopy in past 10 years (self-report)	Normal weight (body mass index = 18.5-24.9); Overweight (25.0-29.9); Obese (30.0-34.9); Morbidly obese (≥ 35)	Age, gender, ethnicity, education, marital status, income, census region, self-reported health status, smoking status, time since last checkup, insurance status	↓ Morbidly obese females for FOBT or endoscopy	Morbidly obese females were less likely than females with a normal body mass index to receive CRC screening (AOR, -5.6; 95% CI, -2.6 to -8.5). There were no obesity-related disparities in screening rates for males

Table 19. Studies of the association of personal health/risk factors with CRC screening (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders Considered	Variables Associated with CRC Screening*	Results (95% CI)
Ferrante et al., 2006[166] Cross-sections, retrospec-tive, 22 PCP practices Chart reviews in 22 PCP practices in New Jersey and Pennsylvania, 2003-2004, ≥ 50 N = 1,297 Fair	Examine whether obesity is associated with lower rates of CRC screening	FOBT within past year, FS or double-contrast barium enema in past 5 years, colonoscopy in past 10 years (claims)	Obesity (body mass index ≥ 30 kg/m^2) compared with non-obese	Age, gender, number of comorbidities, number of visits in past 2 years, number of years attending practice	↓ Obese for any CRC test	Obese patients had 25% decreased odds of being screened for CRC compared with nonobese patients (AOR, 0.75; 95% CI, 0.62-0.91; *P* = 0.004)
Maleis et al., 2006[132] Cross-sectional/ retrospective, state Maryland Cancer Survey, 2002, ≥ 50 years N = 3,436 Fair	Determine whether overweight or obese adults ages 50 years or older are up-to-date with CRC screening	FOBT within past year, FS in past 5 years or colonoscopy in past 10 years (self-report)	Normal or under-weight (body mass index < 25); overweight (body mass index 25-29.9); obese (body mass index ≥ 30)	Age, race, gender, marital status, education, employment, geographic area, health insurance status, having had a physical examination in past 2 years, CRC screening recommend-dations	No statistically significant difference based on weight	Overweight people had similar odds of being up-to-date with CRC screening as normal or underweight people (AOR, 1.05; 95% CI, 0.83-1.33) Obese people had slightly lower, though statistically insignificant, odds of screening (AOR, 0.84; 95% CI, 0.65-1.09)

Table 19. Studies of the association of personal health/risk factors with CRC screening (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review	Predictors Examined	Potential Confounders Considered	Variables Associated with CRC Screening*	Results (95% CI)
Thorpe et al., 2005[114] Cross-sectional/ retrospec-tive, local Community Health Survey, New York City residents, 2003, ≥ 50 years N = 3,606 Fair	Examine characteristics of people undergoing screening within guidelines	FOBT within past year, FS in past 5 years, or colonoscopy in past 10 years (self-report)	Current smoking (nonsmoker or current); physical activity (some activity or none)	Age, race, family and neighborhood income, ethnicity, gender, personal risk factors (current smoking, physical inactivity), access to care, insurance, regular source of care	↓ Current smoker ↓ physically inactive	Current smokers (AOR, 0.62; 95% CI, 0.49-0.78) and residents who reported being physically inactive (AOR, 0.74; 95% CI, 0.63-0.88) were less likely to be current on CRC screening (*P* NR)

All but two studies included respondents 50 years of age or older in their samples; persons 65-89 years were in one study,[55] and persons 51-80 years in the other.[126]

Studies defined outcomes of CRC screening differently, as follows:

- Two studies considered a respondent to be screened if they reported an FOBT in the past year or endoscopy (i.e., FS or colonoscopy) in the past 5 years;[145,157]
- Two studies defined the outcome of interest as FOBT in the past year or endoscopy in the past 10 years;[55,126]
- Four studies defined screening as FOBT in past year, FS or double-contrast barium enema in past 5 years, or colonoscopy in past 10 years;[108,114,132,166]
- One study defined it as FOBT in past year, FS or double-contrast barium enema in the past 5 years, or colonoscopy in the past 10 years.[137]

Overview of results. We have divided our overview of results into two groups. Presented first are health factors such as having a family history of CRC, participating in other healthy practices like being screened for other cancers, and general health status in relation to screening. This is followed by information on risk factors such as obesity, smoking, and sedentary lifestyle. With respect to family history of CRC, findings are generally consistent with those from the three overview studies:[21,46,151] having a family history of CRC was associated with a higher likelihood of obtaining CRC screening. One study using regional, self-reported findings yielded data showing that that those with a family history of CRC were more likely than others to be up-to-date with CRC screening in general (AOR, 1.74) and for colonoscopy (AOR, 2.61).[108]

Several other studies reported similar findings supporting a strong association between family history and screening for CRC.[2,55,122,134,137,142,158] Only one study reported that subjects with a family history of CRC were not more likely to be screened for CRC (AOR, 0.85; $P = 0.43$).[55] Five additional studies reported an association between family CRC history and screening rates in their final multivariate analysis.[2,42,107,122,134,158]

Two studies showed that, among both males and females, obtaining regular screening for other cancers was associated with CRC screening; this is consistent with the three overview studies.[21,46,151] The 1998 study that examined screening among males and females found that other cancer screening, including mammogram or prostate specific antigen (PSA) testing, was significantly associated with CRC screening (AOR, 4.40; $P < 0.001$).[137] Another, which used 2001 BRFSS data, reported that subjects up to date for mammograms and Pap smears were more likely than those no up to date to be screened for CRC (AOR 2.42 for mammograms and AOR 1.70 for Pap smears; $P < 0.01$ for both).[157] Other studies included in this report support the positive association of other cancer screening behavior with CRC screening.[42,108,122-123,133-134,156,158]

With respect to other healthy behaviors, one study that reported an association between vitamin supplement use and CRC screening (AOR, 1.87).[137]

For general health status, a few studies examined the association between perceived health status and CRC screening, as did the three overview studies,[21,46,151] but overall findings are inconsistent. The study based on the 2003 HINTS national survey showed no association between perceived general health and CRC screening ($P = 0.11$).[55] Another study reported that females who perceived their health as good were less likely to adhere to CRC screening than those perceiving their health to be fair or poor (AOR, 0.79; $P < 0.01$).[157] Another study presented related factors, including a number of chronic illnesses and Charlson scores (i.e., a weighted index of 19 selected categories of disease found to be associated with mortality and other important health outcomes, in which a higher scores equates with worse health) obtained through medical record review. This group reported that patients with more illnesses were more likely to be screened (AOR, 1.12; $P < 0.0001$) but that those with higher Charlson scores were less likely to be screened (AOR, 0.84; $P = 0.0001$).[158]

Six other studies not presented in this section but that included perceived health in their final multivariate analysis also found that those with more positive perceptions of their health (i.e., excellent, very good, good) were less likely to report current CRC screening than those with lower or less positive perceived health,[1,107,111,120,134,157] another study reported the opposite results such that those with perceived good health were more likely to be screened.[163] Another study found no association between perceived health and screening behavior.[2]

In terms of obesity, four studies reflected inconsistencies about the association of weight with CRC screening.[126,132,145,166] One study using data from 84,284 subjects from the 2001 BRFSS classified patients into five body mass index categories and found that no association between body mass index and FOBT completion.[145] For this study, the authors did find that overweight or obese males were more likely to have obtained FS within the past year compared to females ($P < 0.05$).[145] Another study based on 1999 BRFSS data found only an association between CRC screening for morbidly obese females and no differences for any other body mass index category in comparisons with respondents of normal weight (AOR, -5.6).[126] Another study used data from the Maryland Cancer Survey and found that overweight and obese people had odds of being up-to-date with CRC screening similar to those for people of normal weight (AOR, 1.05 and AOR, 0.84, respectively).[132] In the fourth study, obese patients in primary care provider practices were

less likely than normal-weight patients to be screened for CRC (AOR, 0.75; $P = 0.004$).[166] Another study (not included in summary table) explored the relationship between BMI and CRC screening in American Indian and Alaskan Native men and found no association between these two variables in a nationally representative survey conducted in 2004-2005.[131] Yet another study found that persons who were categorized as overweight were slightly more likely to have received an endoscopy and/or FOBT (RR, 1.2 and 1.1, respectively, $P < 0.05$).[111]

With respect to smoking and sedentary lifestyle (i.e., physical inactivity), one study reported findings from a community survey of New York city residents;[114] current smokers (AOR, 0.62) and residents who reported being physically inactive (AOR, 0.74) were less likely (than various comparison groups) to be current on CRC screening.[114] Similarly, another study reported that current smokers were less likely to be screened by endoscopy (AOR, 0.13; $P = 0.009$).[106] Both studies support the findings from the three overview studies, which found that current smokers were less likely to be screened for CRC than those who had never or were former smokers.[21,46,151]

Four other studies (omitted in

Table 19 because their analysis focused on other patient characteristics and CRC screening) supported the three overview studies in reporting that current smokers were less likely than former or never smokers to report being screened.[115,122,126,157] One study reported no difference in smoking status and CRC screening.[116]

Psychosocial factors. *Study characteristics.* Another topic addressed by several studies is the extent to which psychosocial factors (i.e., knowledge, attitudes, beliefs, or perceptions about cancer and/or screening) may predict CRC screening behavior. As previously noted, two of the overview studies[21,46] presented findings related to some psychosocial factors; both found that knowledge of screening tests were predictors for screening.

Table 20 presents summary information for the five studies involving the association between these factors and CRC screening; all involved self-reported responses from survey data influencing screening.[55,106,133-134,144] Two national studies were based on HINTS data collected from the fall 2002 through spring 2003.[55,133] Another study collected data from a sample residing in a five-county region of the Midwest;[134] another study collected data locally from patients using three neighborhood clinics;[106] while the remaining study collected data from Japanese Americans residing in the Greater New York region.[144]The ages of respondents in the five studies differed: two studies collected data from those 50 years or older,[133,144] another study used data from those 51 years or older;[106] a third presented findings on those 65 to 80 years of age;[55] and the remaining study presented findings specific to those ages 50-79 years.[134]

Three different definitions of screening were used to determine whether respondents were up-to-date: two studies used the definition that an FOBT had been obtained within the past year and FS or colonoscopy within the past 10 years;[55,133] two studies defined being screened as reporting an FOBT in the past year, FS in the past 5 years, or colonoscopy in the past 10 years;[134,144] and one focused on endoscopy screening (i.e., FS in the past 5 years or colonoscopy in the past 10 years).[106]

Overview of results. Various authors have tended to define psychosocial factors somewhat differently; we divide the discussion of these factors into the four categories of knowledge, attitudes, perceptions, and beliefs. Table 21 summarizes the items included in each survey analysis of the studies in this section. In terms of knowledge or awareness of CRC or the available tests, two studies presented findings about whether respondents reported:
(1) understanding the appropriate intervals of testing,[133] (2) being aware of the types or numbers of tests available,[55] and (3) knowing the expense of each test.[133]

Table 20. Studies of the association between psychosocial factors and CRC screening

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review (i.e., screening or followup after abnormal FOBT; completion rates or discussions)	Predictors Examined	Potential Confounders/ Modifiers Reported	Variables Associated with CRC Screening	Results (95% CI)
McQueen et al., 2006[133] Cross-sectional, retrospective, national HINTS, 2002-2003, ≥ 50 years N = 2,686 Good	Examine correlates of test use by gender	Any test (endoscopy in the last 10 years or FOBT in the last year) (self-report)	Perceived risk to CRC; beliefs about testing (i.e., fear of finding cancer; getting tests is too expensive) or knowledge of testing (i.e., time intervals of tests)	Demographics, access, health status, health behaviors	↑ Understood appropriate time intervals for tests ↑ Fear of finding cancer with test; perceived risk to CRC for females ↓ Did not know if tests are too expensive for endoscopy ↓ Did not know costs or believed too expensive for FOBT	Males and females were more likely to be screened if they understood the appropriate time intervals for FOBT (AOR, 5.42; 95% CI, 2.52-11.66 for males and AOR, 5.25; 95% CI, 3.23-8.52 for female) and endoscopy (AOR, 4.69; 95% CI, 2.55-8.65 and AOR, 3.18; 95% CI, 2.26-4.47, respectively) Females were more likely to be screened if they believed they were more likely than others to be diagnosed with CRC (AOR, 2.53; 95% CI, 1.43-4.46 for endoscopy); if they believed CRC testing leads to early detection (AOR, 3.03; 95% CI, 1.03-8.93 for FOBT); or if they had a fear of finding cancer (AOR, 1.78; 95% CI, 1.18-2.68)

AOR, adjusted odds ratio; CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; HINTS, Health Information National Trends Survey; MD, medical doctor; γ, gamma.
* Arrow symbols (↓or ↑) are provided as a quick reference point of overall findings and represent the association reported between each variable and CRC screening.

Table 20. Studies of the association between psychosocial factors and CRC screening (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review (i.e., screening or followup after abnormal FOBT; completion rates or discussions)	Predictors Examined	Potential Confounders/ Modifiers Reported	Variables Associated with CRC Screening	Results (95% CI)
McQueen et al., 2006[133] (continued)						Males and females were less likely to be screened if they didn't know if the tests were too expensive (0.43; 95% CI, 0.24-0.78 and 0.46; 95% CI, 0.30-0.71 for endoscopy, respectively) Females were also less likely to be screened with FOBT if they believed it was too expensive (AOR, 0.55; 95% CI, 0.32-0.93) or didn't know the costs (AOR, 0.46; 95% CI, 0.27-0.79) All *P* values < 0.05
Berkowitz et al., 2008[55] Cross-sectional, retrospective, national HINTS, 2003, 65-89 years N = 1,148 Fair	Assess beliefs and perceptions of risk about CRC and gaps in knowledge about screening in adults ages 65-89 years	FOBT (within past year) or, FS or colonoscopy in past 10 years (self-report)	Beliefs about testing (i.e., arranging to be checked is easy; fear of finding cancer; getting checked increased odds of getting cancer; getting tests is too expensive) or knowledge of testing (i.e., age of likely onset; number of available tests)	Gender, race, income, education, marital status, family history of CRC, health status, regular source of care, annual MD visits, knowledge about CRC and testing, beliefs about CRC, perceived risk	↓ Beliefs of lack of ease of testing and tests being too expensive; lack of knowledge of available tests	Respondents who believed that it is not easy to arrange to be tested (AOR, 0.47; 95% CI, 0.25-0.91) or that the tests are too expensive (AOR, of disagreeing with test being too expensive = 1.25; 95% CI, 0.80-1.97); or had a lack of knowledge about the number of available tests (AOR, 0.28; 95% CI, 0.19-0.42) were less likely to report being screened *P* values at 0.03 or better

Table 20. Studies of the association between psychosocial factors and CRC screening (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review (i.e., screening or followup after abnormal FOBT; completion rates or discussions)	Predictors Examined	Potential Confounders/ Modifiers Reported	Variables Associated with CRC Screening	Results (95% CI)
Honda and Singer, 2006[144] Cross-sectional, retrospective, regional Survey administered by phone in the Greater NY region (NY, NJ, CT), Japanese Americans 50 years or older N = 341 Fair	To develop and test a model to explain factors related to CRC screening adherence among Japanese Americans	FOBT in past year; FS in past 5 years; or colonoscopy in past 10 years (self-report)	Emotional family and friend support (family's and friends' concern for and understanding of you, reliance on family/friends)	Age, income, education, acculturation, marital status, and insurance	↑ Emotional family support indirectly related to adherence ↑ Emotional friend support directly related to adherence	Emotional friend support had direct impacts on adherence (γ = 0.15); emotional family support was indirectly related to adherence via increased subjective norms among family and friends (γ = 0.12).
Matthews et al., 2007[134] Cross-sectional, retrospective, regional Survey administered to 5-county region in Midwest, 2005, 50-79 years N = 1,033 Fair	Identify indicators of up-to-date CRC screening	FOBT within past year, FS in past 5 years, or colonoscopy in past 10 years (self-report)	Perceived beliefs (i.e., CRC tests are safe; if healthy, no need to test; irresponsible not to test); or attitudes (i.e., anxiety about tests; positive attitude toward screening in general)	Gender, age, race, education	↑ Belief that tests are safe; irresponsible not to test; positive attitude about cancer screening ↓ Anxiety about tests; and belief that if healthy, no need to test	Respondents were more likely to be screened if they believed the tests are safe (AOR, 1.39; 95% CI, 1.09-1.78); that it's irresponsible not to get tested (AOR, 2.16; 95% CI, 1.67-2.78); or had a positive attitude about screening in general (AOR, 2.35; 95% CI, 1.76-3.13) Respondents were less likely to be screened if they had anxiety about the tests (AOR, 0.50; 95% CI, 0.49-0.64) or believed that if they are healthy, they don't need to be tested (AOR,

Table 20. Studies of the association between psychosocial factors and CRC screening (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review (i.e., screening or followup after abnormal FOBT; completion rates or discussions)	Predictors Examined	Potential Confounders/ Modifiers Reported	Variables Associated with CRC Screening	Results (95% CI)
Matthews et al., 2007[134] (continued)						0.58; 95% CI, 0.42-0.79) *P* values are all 0.05 or better
Zimmerman et al., 2006[106] Cross-sectional, retrospective, local Survey administered in 3 clinics, 2003, > 50 years N = 325 Fair	Identify determinants of patient-reported receipt of CRC screening	FS in past 5 years, colonoscopy in past 10 years, or both (FOBT not included) (self-report)	Barriers to endoscopy (perceived inconvenience or trouble; unpleasantness of test)	Age, race	↓ Perceived barriers for endoscopy	People who reported barriers to endoscopy were less likely than those who did not to be screened by endoscopy (AOR, 0.33; 95% CI, 0.18-0.60; *P* < 0.0001) Perceived social support for CRC screening was not associated with screening

Table 21. Types of factors and descriptions of variables used in selected studies to examine the influence of psychosocial factors on CRC screening

Types of Psychosocial Factors Used in Selected Studies	Knowledge	Attitudes	Perceptions	Beliefs
Description of Variables Used	• Understood time intervals for taking test[133] • Does not know if test is expensive or what the cost is[133] • Knows tests that are available[55]	• Positive attitude toward cancer screening[134] • Has anxiety about test[134] • Fearful of finding cancer[133]	• Perceived barriers to screening[106] • Perceived social support to get testing[106,144] • Perceived risk/susceptibility to CRC[133,144]	• Believes: • Tests are safe[134] • Irresponsible not to test[134] • If healthy, no need to be tested[134] • Tests lead to early detection[133] • Not easy to arrange to be tested[55]

CRC, colorectal cancer.

One national study using the 2002-2003 HINTS reported that both males and females were statistically more likely to be screened if they understood the appropriate time intervals of both the FOBT and endoscopy (AOR, range 4.69-5.42 for males and 3.18 and 5.25 for females; all *P* values < 0.05).[133] The same study found that males and females who did not know whether tests were "too expensive" (for them) were less likely than those who did know to receive an endoscopy (AOR, 0.43 and 0.46, respectively; *P* < 0.05); this same finding was also reported for

females and FOBT testing (AOR, 0.55; $P < 0.05$).[133] In another study, respondents 65 years of age or older who lacked knowledge about the number of tests that were recommended for their age group were less likely to be screened that knew about the recommended guidelines for testing frequency (AOR, 0.28).[55]

With regard to attitudes about testing or CRC, one study reported findings about overall attitudes toward screening and anxieties about tests from a regional survey of residents in the Midwest.[134] If respondents had a positive attitude toward screening in general, they were more likely to report being screened (AOR, 2.35); if they had anxiety about tests in general, they were less likely to be screened (AOR, 0.58).[134] Being fearful of finding cancer was positively associated with CRC screening among women in one study (AOR, 1.78).[133]

Three studies reported findings specific to perceived barriers to screening and perceived social support for screening, as well as perceived risk to being diagnosed with cancer.[106,133,144] Perceived barriers to screening by endoscopy (e.g., inconvenience and unpleasant aspects of screening are perceived to be a problem) were associated with not being screened for CRC (AOR, 0.33; $P < 0.0001$) in one study. Another study highlighted in another section of this chapter also reported findings that support a relationship between perceived barriers to screening and adherence.[142] Perceived social support to be screened was not associated with screening in one study,[106] but was both indirectly (through perceived emotional support from family) and directly (through perceived emotional support from friends) related to adherence to screening in the one included study that tested a structural equation model to examine factors influencing screening.[144] Perceived risk to being diagnosed with cancer was positively associated with being screened for females (AOR, 2.53).[133] Two other studies not presented in this section found that perceived risk to being diagnosed with CRC was associated with screening.[108,130]

Three studies included analyses of beliefs that may be associated with CRC screening. Positive associations with CRC screening were found with the following beliefs: that the tests are safe (AOR, 1.39);[134] that it is irresponsible not to be tested (AOR, 2.16);[134] and, for females, that tests lead to early detection (AOR, 3.03).[133] Those who believed that, if they are healthy, they do not need to be tested were less likely to report being screened (AOR, 0.58)[134] as were those who thought that arranging for testing would not be easy (AOR, 0.47).[55]

Another study not presented in this section (because psychosocial factors were not a specific aim of their research) reported no association between belief that testing detects cancer early and screening rates.[108]

Patient Factors: Followup after Positive FOBT

Study characteristics. We identified two studies, both rated as fair quality, that assessed factors that may be related to followup after an abnormal FOBT result (Table 22).[88,168] Both studies were conducted using claims data from one Veterans Administration (VA) Hospital; one focused on patients 70 years of age or older[168] and the other on patients 50 or older.[88] The outcome measure of interest to both was whether a patient completed a colonoscopy or double-contrast barium enema[168] or a full colon evaluation (defined as colonoscopy or double-contrast barium enema with FS)[88] within 12 months of receiving the FOBT results.

Table 22. Studies of factors associated with followup after abnormal CRC screening results are received

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Primary Outcome of Interest for Review (i.e., screening or followup after abnormal FOBT; completion rates or discussions)	Predictors Examined	Potential Confounders/ Considered	Variables Associated with CRC Screening[a]	Results (95% CI)
Garman et al., 2006[168] Cross-sectional/ retrospective, local 1 VA hospital, patients 70 years or older N = 266 Fair	Examine comorbid disease and performance of complete full colon evaluation after positive FOBT	Completion of colonoscopy, or double-contrast barium enema after positive FOBT (claims)	Comorbidity (measured by Charlson Comorbidity Score)	Age	No association with Charlson score	Patients receiving followup who had higher Charlson scores did not differ significantly from those who had lower scores (*P* = 0.38)
Fisher et al., 2006[88] Cross-sectional, retrospective, local 1 VA hospital, 50 years or older N = 538 Fair	Explore factors associated with undergoing a full colon evaluation after a positive FOBT	Completion of a full colon evaluation (with a colonoscopy or double-contrast barium enema plus FS) within 12 months of receiving positive FOBT (claims)	Race (white, Black, missing)	Race, age, marital status, primary care clinic where FOBT obtained	No association with race	Blacks were as likely to receive full colon examination as whites (AOR, 1.14; 95% CI, 0.57-1.75)

AOR, adjusted odds ratio; CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; N, number; OR, odds ratio; VA, Veterans Administration.

Overview of results. Each study examined different predictors for receipt of a follow-up test. One explored the association of comorbidity (measured through Charlson scores)[168] and the investigated the differences in followup for white and Blacks.[88] The study focusing on comorbidities found that patients who had higher Charlson scores (i.e., more comorbidities) were no more likely than those with low scores to receive followup after a positive FOBT.[168] Follow-up rates after a positive FOBT were not associated with race; Blacks were as likely to receive a full colon evaluation as whites (AOR, 1.14).[88]

Physician Factors Associated with CRC Screening

This part of KQ 2 focuses on physician factors associated with CRC screening, CRC screening discussions, or the quality of CRC screening. Although we found many studies that

examined the association of patient characteristics and CRC screening, we found only one study that examined physician characteristics,[127] one study that examined "patient-physician connectedness,"[152] and 12 studies that examined physician recommendation of CRC screening. Of these 12 studies, 7 were national studies from two databases (NHIS and HINTS)[21,46,55-57,111,159] and 5 were regional studies from four different states or areas.[107,142,148,153]

Physician characteristics. *Study characteristics.* This cross-sectional study, which we rated fair quality, used data from the 2000-2001 Community Tracking Study (CTS) Physician Survey (response rate 59 percent), a nationally representative telephone survey of nonfederal physicians in 60 randomly selected metropolitan statistical areas (Table 23).[127] Among other items, the CTS asked physicians about their age, years in practice, specialty, board certification, and site of medical school graduation (US/Canada versus other). The investigators assessed information on CRC screening and patient care visits for Medicare beneficiaries ages 65 years and older from Medicare claims data. The investigators linked the databases by physician ID numbers, allowing them to identify 3,660 primary care physicians who cared for 24,581 Medicare beneficiaries in the database. They could then generate 1-year (2001) CRC screening rates for physicians with similar characteristics.

Table 23. Studies of the association between physician characteristics and CRC screening

Author, Year, Study Design, Population, Setting, Sample size, Quality	Primary Outcomes of Interest for Review	Predictors Examined	Potential Confounders Considered	Variables Associated with CRC Screening*	Results (95% CI)
Pham et al., 2005[127] Cross-sectional study, retrospective, National 2000-2001 Nationally representative physician survey and Medicare claims data, 2000-2001 N = 3,660 physicians 24,581 patients (≥ 50 years) Fair	1-year rates of colonoscopy or FS, excluded FOBT (self-report and claims)	Physician and practice characteristics, including use of computerized physician reminders, size and type of the practice.	Patient co-morbidity, individual income and other demographic and education factors; doctor-patient interaction factors; managed care practice factors; system factors.	↑ Family physicians ↑ Board certified ↑ US Medical school graduate No other associations identified	Association between CRC screening and physician specialty (patients cared for by family physicians 9.9% vs. patients cared for by general internists 7.8%, *P* < 0.001); board certification (board certified 9.5% vs. not board certified 6.5%, *P* < 0.05); and site of medical school graduation (US or Canada 9.3% vs. non-US or Canada 7.7%, *P* < 0.05).

CI, confidence intervals; CRC, colorectal cancer; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; N, number; P, probability; US, United States

* Arrow symbols (↓or ↑) are provided as a quick reference point of overall findings and represent the association reported between each variable and CRC screening.

Overview of results. CRC screening rates did not differ between patients with male versus female physicians; neither did they differ among physicians who had been in practice for 0-10 years versus 11-20 years versus > 20 years. Patients cared for by family physicians had somewhat higher 1-year screening rates than those cared for by general internists (9.5 percent versus 7.8 percent, *P* < 0.001); patients cared for by board certified physicians had higher screening rates than those cared for by non-board certified physicians (9.5 percent versus 6.5 percent, *P* < 0.05). Patients cared for by physicians who graduated from US or Canadian medical schools had higher screening rates than those cared for by physicians who graduated from other medical schools (9.3 percent versus 7.7 percent, *P* < 0.05). Another study (highlighted under

patient level factors) explored the relationship between race and screening among a nationally representative sample of Medicare beneficiaries and found that, controlling for other factors, patients whose usual care physician was a primary care generalist rather than another type of specialist had significantly higher odds of CRC screening (AOR, 1.31; 95% CI, 1.12-1.53).[129]

Physician-Patient connectedness. *Study characteristics.* A retrospective cohort study, which we rated good quality, examined the association between CRC screening and patient-physician connectedness (Table 24).[152] Although this variable could be seen as either a system variable or a patient-physician interaction variable, we have elected to review it under physician characteristics because the study was conducted in a single large academic practice network with large variation among physicians (e.g., specialty, number of years in practice, etc.), indicating that the variable at least partially indicated physician practice style. It was conducted in the Massachusetts General Hospital adult primary care network (181 primary care physicians working in four community health centers and nine hospital-affiliated practices). Using electronic billing records, the investigators identified all patients with at least one visit to one of these practices between 2003 and 2005. Using a validated algorithm, the investigators further divided these patients into three groups: practice-connected (i.e., patient was considered a regular user of the practice but had seen a variety of physicians within the practice), physician-connected (i.e., a patient of the practice as well as seen by the same physician for most visits), or unconnected (i.e., patient could not be assigned to either a practice or a physician). Using electronic billing and laboratory data, the investigators calculated, among other indicators, CRC screening rates (colonoscopy within 10 years, FS within 5 years, or FOBT within one year) for physician-connected patients (n = 31,215) versus practice-connected patients (n = 6,453), excluding unconnected patients (who were often either just entering or leaving the practice).

Table 24. Studies of the association between physician or practice connectedness with CRC screening

Author, Year, Study Design, Population, Setting, Sample size, Quality	Primary Outcomes	Independent Variables of Primary Interest	Potential Confounders	Predictors of CRC screening Identified	Results
Atlas et al., 2009[152] Retrospective cohort study, data collected, practice based Medical records review, 2003-2005, patients ≥ 50 N = 181 primary care physicians, n = 31,215 physician connected patients and 6,453 practice connected patients Good	FOBT within past year, FS within past 5 years, colonoscopy within past 10 years (claims)	Physician vs. practice connectedness, determined by a validated algorithm	Patient and physician characteristics, characteristics of the patient-physician interaction, financial (insurance) characteristics, all controlled for in analysis.	↑ Physician connectedness ↑ Practice connectedness	Adjusted CRC screening rates: Physician connected patients: 72.1% (95% CI, 70.5-73.7) Practice connected patients: 58.0% (95% CI, 56.7-59.4) *P* < 0.001

CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; N, number; P, probability.
* Arrow symbols (↓or ↑) are provided as a quick reference point of overall findings and represent the association reported between each variable and CRC screening.

Overview of results. Physician-connected patients had higher CRC screening rates (adjusted percentage 77.1) than practice connected patients (adjusted percentage 69.5; $P < 0.001$).

Physician recommendation. We found 12 studies that examined the association between CRC screening and physician recommendation of CRC screening. Seven are analyses from two

large national databases: NHIS and Health Information National Trends Survey (HINTS).[21,46,55-57,111,159] The other five studies are regional studies.[107,136,142,148,153] We discuss the seven national papers and then assess what additional insights come from the regional studies. Agreement of results among all these studies is high.

Study characteristics of national studies. As shown in Table 25, four of the seven national studies used the NHIS 2000 cancer control module;[21,57,111,159] one used the NHIS 2005 cancer control module.[46] Two studies analyzed the 2002-2003 HINTS database.[55-56] We rated three studies as good quality[21,46,56] and the remainder as fair.

Table 25. National studies of association between physician recommendations and CRC screening

Author, Year, Study Design, Population, Setting, Sample size, Quality	Primary Outcome of Interest for review	Independent Variables of Primary Interest	Potential Confounders	Predictors of CRC screening Identified	Results
Cairns et al., 2006[56] Cross-sectional, national HINTS, 2002-2003, 50-64 years N = 1,253 Good	FOBT within the past year (self-report)	Reasons for not being screened	Age, insurance, whether there is a usual provider, gender, race/ethnicity, annual household income, employment, rural vs. urban county, education	↓ No physician recommendation	Among uninsured, 91% who received recommendation had received a test; those without a recommendation were 98.5% less likely (95% CI, 0.003-0.083) to receive tests (*P* < 0.001).
Seeff et al., 2004[21] Cross-sectional, retrospective, national NHIS, 2000, ≥ 50 N = 14,874 Good	FOBT in past year; endoscopy in past 10 years (self-report)	Physician recommendation in past year as a reason for not having had a CRC test	Age, gender, race, ethnicity, education, marital status, insurance status, income, usual source of care, MD visits/year, personal/risk factors	↓ No physician recommendation	Of those 50-64 years, 94.1% (95% CI, 93.3-94.9%) who were not current with testing had not been recommended by physician to get a FOBT; 92.8% (95% CI, 91.9-93.7%) had not been recommended to get an endoscopy Of those ≥ 65, 95.9% (95% CI, 95.1-96.6%) had not received a physician recommendation for FOBT and had not been tested; 95.2% (95% CI, 94.4-96.1%) had not received a recommendation for an endoscopy

AOR, adjusted odds ratio; CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; HINTS, Health Information National Trends Survey; MD, medical doctor; NHIS, National Health Interview Survey; P, probability; PCP, primary care physician; US, United States.

* Arrow symbols (↓or ↑) are provided as a quick reference point of overall findings and represent the association reported between each variable and CRC screening.

Table 25. National studies of association between physician recommendations and CRC screening (continued)

Author, Year, Study Design, Population, Setting, Sample size, Quality	Primary Outcome of Interest for review	Independent Variables of Primary Interest	Potential Confounders	Predictors of CRC screening Identified	Results
Shapiro et al., 2008[46] Cross-sectional, retrospective, national NHIS, 2005, ≥ 50 N = 13,269 Good	FOBT in past year; endoscopy in past 10 years (self-report)	Reasons for not having a FOBT or endoscopy, by colorectal cancer testing history, NHIS 2005	Age, gender, race, ethnicity, education, marital status, insurance status, income, usual source of care, MD visits/year, personal/risk factors	↓ No physician recommendation	Of those who never had tests, lack of physician recommendation given as reason for not having a FOBT: 96.3% of those who never had either test (95% CI, 95.6-96.9%); 95.4% (95% CI, 94.7-96.0) for those who had test but not in recommended time. As a reason for no endoscopy; 89.7% of those who never had either test (95% CI, 88.5-90.7%); 87.9% (95% CI, 88.5-90.7%) of those who had test but not in recommended time
Berkowitz et al., 2008[55] Cross-sectional, retrospective, national HINTS, 2002-2003; 65-89 years N = 1,148 (583 not up-to-date with screening) Fair	FOBT (within past year) or, FS or colonoscopy in past 10 years (self-report)	Physician recommendation reported	Gender, race, income, education, marital status, family history of CRC, health status, regular source of care, annual MD visits, knowledge about CRC and testing, beliefs about CRC, perceived risk	↓ No physician recommendation	Reasons for not being screened: No recommendation received for 65-74 year olds: FOBT: 87.5% (95% CI, 76.7–93.7%) FS/colonoscopy: 79.1% (95% CI, 69.3-86.4%) For those 75-89 years: FOBT: 84.4% (95% CI, 70.6-92.3%); FS/colonoscopy: 75.9% (95% CI, 64.1-86.2%)
Coughlin et al., 2005[159] Cross-sectional, retrospective, national NHIS, 2000, ≥ 50 N = 11,480 Fair	Persons with no recent CRC test	Physician recommendation as a reason for not being tested	Age, gender, race, ethnicity, marital status, education, years in US, family history of CRC, general health status, income, insurance status	↓ No physician recommendation	Reasons for not being screened: Physician didn't recommend FOBT: 94.6% (95% CI, 94.0-95.2); endoscopy: 93.5% (95% CI, 92.8-94.2)

Table 25. National studies of association between physician recommendations and CRC screening (continued)

Author, Year, Study Design, Population, Setting, Sample size, Quality	Primary Outcome of Interest for review	Independent Variables of Primary Interest	Potential Confounders	Predictors of CRC screening Identified	Results
Klabunde et al., 2005[57] Cross-sectional, retrospective, national Surveys of doctors (PCPs) and patients (from NHIS), data collected 1999-2000, for patients ≥ 50 N = 1,235 PCPs N = 6,497 adults Fair	No FOBT in past year nor endoscopy in past 10 years (self-report)	Physician recommendation	Age, gender, race, ethnicity, marital status, education, income, insurance, MD visit in past year, years in US, urban/rural	↓ No physician recommendation	Among respondents who had not been tested for: FOBT: 21.6% (95% CI, 20.2–23.0) or endoscopy: 22.2% (95% CI, 20.9–23.6) had not received a MD recommendation.
Wee et al., 2005[111] Cross-sectional, retrospective, National NHIS, 2000, 50-75 years N = 11,427 Fair	FOBT in past year; FS in past 5 years; or colonoscopy in past 10 years (self-report)	Physician not recommending screening	Age, race or ethnicity, educational level, region of the country, and body weight as classified into standard BMI categories, family history of CRC, healthcare access, smoking status, and illness burden.	↓ No physician recommendation	Reasons that respondents did not have a FOBT (of 9017), 22% reported their physician did not recommend; for FS/colonoscopy, 21% reported their physician did not recommend.

The NHIS cancer control module for CRC did not change between 2000 and 2005; results from the analyses of these two surveys were similar. All five of the NHIS studies assessed the percentage of people who had not had a screening test within the recommended interval and who reported that they had not had a physician recommendation to be tested within the past year. One study also examined data on 1,235 primary care physicians from the Survey of Colorectal Cancer Screening Practices, a 1999-2000 nationally representative survey of primary care and specialty physicians and health plan medical directors.[57]

The 2002-2003 HINTS survey was a nationally representative random-digit dialing telephone survey of 6,369 noninstitutionalized civilians ages 18 and older, with over-sampling of blacks and Hispanics. Respondents who had not been screened within the recommended time interval (1 year for FOBT, 5 years for FS, and 10 years for colonoscopy) were asked an open-ended question about reasons for not being screened. The reasons were later aggregated into 12 predefined categories for analysis. Among the categories was lack of physician recommendation.[55-56] One HINTS study[56] primarily examined CRC screening in the uninsured

(ages 50 to 64 years); the other assessed CRC screening in older respondents (ages 65 to 89 years).[55]

Overview of results of national studies. For people who had not had a screening test in the recommended interval but who had a physician whom they had visited within the past 12 months, three studies agreed that from 92 percent to 94.6 percent had not received a physician recommendation for screening in that year.[21,111,159] The fourth NHIS 2000 study compared reasons for low screening rates given by NHIS participants and those given by primary care physicians from the 1999-2000 Survey of Colorectal Cancer Screening Practices.[57] Thirty-seven percent of physicians and 20 percent of NHIS participants cited failure of physician recommendation as a primary reason for low screening rates. As in the three other studies from the NHIS 2000, this study also found that among those respondents who had not been screened and who had seen a physician within the past year, about 90 percent had not received a recommendation for screening over that year.[57] The NHIS 2005 study found results almost identical to the NHIS 2000 studies.[46]

One HINTS study found that 75 percent to 85 percent had not been advised to be screened over this year.[55] The other HINTS analysis examined barriers to CRC screening among the uninsured and found that about 91 percent of uninsured people who had received a physician recommendation for screening had in fact been screened; only 13 percent of uninsured respondents who had not received a recommendation had been screened ($P < 0.001$).

Study characteristics of regional studies. Of the five regional studies, all rated as fair quality (Table 26),[107,136,142,148,153] four were telephone surveys of people in three different areas: two studies from Massachusetts;[107,153] one from Maryland; [148] one from Iowa; [136] and one from Genessee County, Michigan.[142] These studies included one that called respondents who had responded to the 1999 BRFSS,[153] and findings from either a state-based,[107,148] or county-based health survey.[142] One other study was a project that combined patient surveys and medical record reviews from family practices in rural Iowa.[136] The study from Iowa matched a 2004 mailed survey of 511 patients (53 percent response rate) with a medical record review.[136]

Table 26. Regional studies of the association of physician recommendation with CRC screening

Author, Year, Study Design, Population, Setting, Sample size, Quality	Primary Outcomes of Interest for Review	Predictors Examined	Potential Confounders Considered	Variables Associated with CRC Screening	Results (95% CI)
Brawarsky et al., 2004[153] Cohort, state Massachusetts BRFSS and a CRC call-back study, 1999, ≥ 50 N = 779 Fair	FOBT in past year, FS in past 5 years, colonoscopy in past 10 years (self-report)	Physician recommendation	Age, education, gender	No comparison group	75% had received a physician recommendation; 81% who had a recommendation adhered to testing

AOR, adjusted odds ratio; BRFSS, Behavioral Risk Factor Surveillance System; CHS, Community Health Survey; CI, confidence interval; CRC, colorectal cancer; DCBE, double contrast barium enema; FOBT, fecal occult blood test; FQHC, federally qualified health center; FS, flexible sigmoidoscopy; MD, medical doctor; N, number; SES, socioeconomic status.
*Arrow symbols (↓or ↑) are provided as a quick reference point of overall findings and represent the association reported between each variable and CRC screening.

Table 26. Regional studies of the association of physician recommendation with CRC screening (continued)

Author, Year, Study Design, Population, Setting, Sample size, Quality	Primary Outcomes	Independent Variables of Primary Interest	Potential Confounders	Predictors of CRC screening Identified	Results
Gilbert et al., 2005[148] Cross-sectional, retrospective, state Maryland Cancer Survey, 2002, 50-64 years N = 2,994 Fair	FOBT in past year; FS in past 5 years; or colonoscopy in past 10 years (self-report)	Ever had recommendation for FOBT, FS, or colonoscopy	Age, gender, race, ethnicity, SES, marital status, health status, personal and family risk factors	↑ Physician recommendation	Those who ever had physician recommendation were more likely to have completed the FOBT (AOR, 70.72; 95% CI, 66.56-77.45); FS (AOR 17.41; 95% CI, 14.9-20.25); or colonoscopy (AOR 57.32; 95% CI, 53.82- 60.75).
Janz, et al., 2003[142] Cross-sectional, retrospective, county residents in Michigan, 50-79 years N = 355 Fair	FOBT in past year and FS in past 5 years; OR colonoscopy in past 10 years (self-report)	Physician recommendation	Relevant sociodemographic and related factors (unspecified)	↑ Physician recommendation	Between 54 and 65% of respondents indicated that their physician had recommended FOBT, and over 92% of those subjects reported having had the test (no *P* values or odds ratios provided).
Levy et al., 2006[136] Cross-sectional, retrospective, practice based Iowa family physicians (n = 16), 2004, 55-80 years N = 511 Fair	Five FOBT within past 5.5 years; FS or DCBE within past 5.5 years; colonoscopy in past 10.5 years (claims)	Physician recommendation	Personal or family CRC history, recommendation, sociodemographic information (not specified)	↑ Physician recommendation	Patients who recalled physician recommendation for testing were more likely than others to have been screened (AOR, 6.4; 95% CI, 4.2-9.6).
Zapka et al., 2002[107] Cross-sectional, State CHS, 1998, Residents of Massachusetts, ≥ 50 years N = 1,002 Fair	Any test (colonoscopy or barium enema within 10 years, FS within 5 years, and FOBT in the past year) (self-report)	MD ever recommended FS	Gender, race, education, employment status, income, marital status, family history of CRC, perceived health status	↑ Physician recommendation	Persons 50-64 and ≥65 were more likely to have received a FS if MD had ever been recommended (AOR, 13.44; 95% CI, 7.22-25.02 and AOR 12.39; 95% CI, 5.68-27.06, respectively, *P* < 0.0001).

Overview of results of regional studies. All five studies found a strong association between physician recommendation and receipt of CRC screening, much like those at the national level.

Patient-Provider Communication

Study characteristics. We found five cross-sectional studies, which we rated fair quality, pertaining to the association between patient-provider communication and CRC screening (Table 27).[56,135,140,154,167] Two used HINTS data to examine the association between communication and screening among the uninsured.[56,135] Both used measures from the Consumer Assessment of Healthcare Providers and Systems (CAHPS®) to assess patient-provider communication; these address how well patients feel the provider listens to them, explains options, respects them, spends adequate time with them, and involves them in medical decision making. Another study used data from 8,488 survey respondents from the MEPS to examine the relationship between patient-provider communication and socioeconomic variables on the receipt of CRC screening;[154] patient-provider communication was assessed by measures derived from CAHPS. Another study surveyed 397 Black church members in North Carolina;[140] it assessed this factor with a "communication score" based on five patient-reported items. The final study surveyed female patients of primary care physicians in Los Angeles on their perceptions of how enthusiastically their provider recommended or discussed CRC screening with them.[167]

Table 27. Studies of the association of patient-provider communication and CRC screening

Author Year Study design Population Setting Sample size Quality	Study Aims	Primary Outcomes of Interest	Predictors Examined	Potential Confounders and Modifiers Considered	Variables Associated with CRC Screening†	Results (95% CI)
Cairns et al., 2006[56] Cross-sectional, national sample, HINTS Ages 50-64 1,253 Fair	Examine the role of communication factors and insurance, with a specific focus on the uninsured, to examine disparities in CRC screening	Ever screened for FOBT, FS, or colonoscopy (self-report)	Patient-provider interaction based on five CAHPS measures*	None. A analyses of patient-provider communication were bivariate and did not adjust for potential confounders	No differences on interaction variables	No communication measures were significantly related to CRC screening status.

AOR, adjusted odds ratio; CAHPS, Consumer Assessment of Healthcare Providers and Systems; CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; HINTS, Health Information National Trends Survey; MD, medical doctor.

*CAHPS measures: During the past 12 months, how often did doctors or other health care providers: listen carefully to you, explain things in a way you could understand, show respect for what you had to say, spend enough time with you, involve you in decisions about your health care as much as you wanted]? Would you say always, usually, sometimes, or never?
†Arrow symbols (↓or ↑) are provided as a quick reference point of overall findings and represent the association reported between each variable and CRC screening.

Table 27. Studies of the association of patient-provider communication and CRC screening (continued)

Author Year Study design Population Setting Sample size Quality	Study Aims	Primary Outcome	Measurement of Independent Variable of Primary Interest	Potential Confounders and Modifiers	Variables Associated with CRC Screening†	Results (95% CI)
Carcaise-Edinboro et al., 2008[154] Cross-sectional, national sample Medical Expenditures Panel Survey (MEPS) Age 50 years or older 8,488 Fair	Examine the relationship between patient-provider communication and socioeconomic variables on the receipt of CRC screening)	Ever screened for CRC by FOBT, colonoscopy, or FS in lifetime (self-report)	Patient-provider communication assessed by measures derived from CAHPS	Age, sex, race, education, geography, metropolitan statistical area, insurance status, family income, usual source of care, self-reported health,	↑ Enough time with provider for any test ↑ MD adequately explains information for FOBT	Those who reported that they sometimes, usually, or always have enough time with the provider were more likely to be screened by any test (AOR range, 2.61-2.99). Those who reported that their provider sometimes, usually, or always adequately explains information about FOBT were more likely to report being screened (AOR range, 3.67 to 6.42).
Fox et al., 2009[167] Cross-sectional, retrospective, local Survey of women patients of 63 PCP in Los Angeles, 50 years or older N = 904 Fair	Examine the separate contributions of patients and physicians to their communication regarding cancer screening	FOBT within past year	Level of enthusiasm provider showed in discussion about FOBT	Race, ethnicity, income, education, insurance,	↑ Low level of enthusiasm from MD for FOBT (vs. no discussion)	Patients who perceived a low level of enthusiasm from provider were more likely to complete FOBT than those who reported no discussion (AOR, 6.426; *P* < 0.0001). For those who perceived high enthusiasm, the relationship to screening was not significant.

Table 27. Studies of the association of patient-provider communication and CRC screening (continued)

Author Year Study design Population Setting Sample size Quality	Study Aims	Primary Outcome	Measurement of Independent Variable of Primary Interest	Potential Confounders and Modifiers	Variables Associated with CRC Screening†	Results (95% CI)
Katz et al., 2004[140] Cross-sectional, church-based, 1 state (North Carolina) Age 50 years or older 397 Fair	Determine the relationship between the general quality of patient-rated patient-provider communication and the completion of CRC screening	Undergoing FOBT, colonoscopy, FS within the recommended time period (self report)	Communication score used to categorize quality of communication as good, fair, or poor; based on five items (abbreviated versions here): (1) receive understandable information from doctor (2) feel rushed during visits (3) feel your doctor allows you to become involved (4) feel uncomfortable asking doctor about tests (5) feel that your doctor understands your health needs	Sex, source of health care, knowledge of CRC risk	↑ Quality of communication	Quality of communication (good vs. poor/fair communication scores) were significantly associated with improved completion of CRC screening: OR 1.95 (95% CI, 1.29-2.94).
Ling et al., 2006[135] Cross-sectional, national sample, HINTS Age 51 years or older 2,670 Fair	Assess the association between provider-patient interaction and CRC screening utilization	CRC screening up to date or not (self-report); considered up to date if FOBT in past year or FS or colonoscopy in past 10 years	Respondents were asked five CAHPS* measures.	Age, sex, race, highest education level, tobacco use, household income	No differences based on provider-patient interaction ↑ Trust in cancer information provided	The up-to-date and not up-to-date groups did not differ significantly on any patient-provider interaction item. Having trust in cancer information from the doctor was associated with being up-to-date with CRC screening: AOR 2.08 (95% CI, 1.49-2.94).

All five studies measured patient-provider communication as perceived by patients. In addition, all five used patient-reported CRC screening status as their primary outcome. One study also assessed subject's trust in cancer information from the doctor.[135]

Overview of results. The two national studies that used HINTS data reported no significant association between patient-provider communication measures (from CAHPS) and CRC screening status.[56,135] However, the MEPS-based study demonstrated that patients who reported that their provider spent enough time with them and adequately explained information were 2.6 to 6.4 times more likely to have undergone CRC screening.[154] The North Carolina study reported that better quality of patient-provider communication was significantly associated with completion of CRC screening.[140] The fifth study of women of PCP physicians in Los Angeles found that even a discussion with the provider with perceived 'low enthusiasm' for testing was significantly more likely to result in testing than no discussion about testing (AOR, 6.246; $P < 0.0001$).[167] One other study (presented in the patient level factors section) also supported a positive relationship between patient-provider communication and any CRC screening.[144]

One of the HINTS studies reported that subjects having trust in cancer information from the doctor were more likely to be up-to-date with CRC screening (OR = 2.08, 95% CI, 1.49-2.94).[135] Another study, highlighted in the patient level factors section on insurance status also reported a positive relationship between adherence to FOBT and patient's report that their provider demonstrates compassion.[128]

Periodic Health Examinations

Study characteristics. We found one study, which we rated as fair quality, that focused on the association between receipt of a periodic health examination (PHE) and CRC screening rates (Table 28).[164] It was a retrospective cohort study of 64,288 consecutive enrollees in a Washington state health plan who had attended one or more primary care visits in 2002-2003 and had been eligible for one or more cancer screening tests (for CRC, breast cancer, or prostate cancer).[164] It defined a PHE as any outpatient encounter (in 2002-2003) having either (1) an evaluation and management code indicating "initial evaluation" (codes 99386-7) or "reevaluation and management of a healthy individual" (codes 99396-7) or (2) an International Classification of Diseases, Ninth Revision, Clinical Modification, code signifying either a general medical examination (code V700 or V708-9) or a gynecologic examination (code V723). The study reported results for a combined outcome of either FOBT or invasive CRC testing (FS, colonoscopy, or barium enema).

Overview of results. A greater proportion of subjects who had had a PHE received CRC screening than subjects who had not had a PHE (unadjusted: 57.2 percent versus 17.2 percent, respectively).[164] The incidence of CRC testing was more than three times higher in patients who received PHEs than in those who did not (adjusted relative incidence, 3.47; 95% CI, 3.34-3.59; $P < 0.001$).[164]

Results from several other studies in this review supported the finding that subjects having periodic health examinations, annual physicals,[134] physicals,[171] health maintenance examinations,[136] or annual checkups[108,153,172] are more likely to have had CRC screening than people not receiving such services. We do not describe these studies in further detail or include them in the table because they were not designed to focus on this factor (PHEs); rather, they primarily examined another factor or examined multiple factors simultaneously.

Table 28. Studies of association between periodic health examination (PHE) and CRC screening

Author Year Study design Population Setting Sample size Quality	Study Aims	Primary outcome	Measurement of Independent Variable of Primary Interest	Potential Confounders and Modifiers	Association of Variables to CRC Screening*	Results
Fenton et al., 2007[164] Retrospective cohort, 1 state Enrollees in a Washington State health plan N = 64,288 Fair	Determine the association between receipt of a PHE and completion of cancer screening	Completion of either FOBT (based on automated laboratory data) or invasive testing (FS, colonoscopy, or barium enema; based on CPT codes from outpatient and inpatient encounters) in 2002-2003	PHE, from evaluation and management codes or ICD9 codes	Adjusted for age, sex, comorbidity (Charleson comorbidity index), number of outpatient visits, baseline PHE receipt, baseline number of target organ cancer tests, and significant interactions between PHE receipt and the listed covariates	↑ PHE	Of those who received a PHE, 57.2% received CRC testing vs. 17.2% of those who did not receive a PHE (AOR, 3.47; 95% CI, 3.34-3.59; *P* < 0.001)

AOR, adjusted odds ratio; CRC, colorectal cancer; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; CPT, current procedural terminology; ICD-9, International Classification of Diseases, Ninth revision; N, number; P, probability; PHE, periodic health examination.
* Arrow symbols (↓or ↑) are provided as a quick reference point of overall findings and represent the association reported between each variable and CRC screening.

System Level Factors Associated With CRC Screening

This part of KQ 2 focuses on health care system characteristics associated with CRC screening, CRC screening discussions, or the quality of CRC screening. The issue we addressed is whether the organization of health care services influences CRC screening. Thus, we searched for studies of any research design that examined the association between system characteristics and any of our three primary outcomes (measured in a valid and reliable manner): CRC screening rates, the frequency or quality of CRC discussions, or the quality of CRC screening.

By health care system characteristics, we are referring to such variables as involvement of nonclinician staff in screening, the practice's being part of a managed care organization, use of reminder or recall systems, having an organized endoscopy referral system, the size and/or type of the medical practice, and the degree of local autonomy over the structure of care delivery. We distinguish between these system characteristics and other factors, such as patient access to health care (including having health insurance or having a regular source of health care), characteristics of the patient-clinician interaction (including trust or having health maintenance visits), or receiving a clinician recommendation for screening.

Study characteristics. We found six fair-quality studies that provided some information about this question.[66,110,127,139,143,173] Three studies used large datasets (one including 155 VA primary care clinics),[110] another used Medicare claims data,[139] another used Medicare claims data plus a national physician survey,[127] while the sixth used survey data to compare patients who receive their regular care from county health centers versus those going to a private

physician office in the New York City area.[66] Two studies collected data from medical practices.[143,173] One of the latter studies focused on 22 suburban primary care practices in New Jersey and Pennsylvania,[143] and another examined a single primary care practice within a low-income urban New York City setting.[173] Five studies were cross-sectional,[66,110,127,139,143] and the sixth was a cohort study.[173]

The six studies examined a variety of system variables, including involvement of nonclinician staff in screening, reminder systems, endoscopy referral systems, local autonomy of the internal structure of care delivery, size or type of the practice, group versus solo practice, and degree of managed care activity in the area. All used the outcome of CRC screening (according to national screening guidelines), assessed either through administrative databases,[127,139,173] through direct medical record review,[110,143] or self-report via telephone surveys.[66]

Overview of results. Five of the six studies reported a positive association between some system characteristic and CRC screening (Table 29). The most positive associations were use of nonphysician staff (for either general counseling[143] or assistance with the screening process[173]). In one study, a practice's use of nonphysician staff for general lifestyle counseling was associated with a near-doubling of CRC screening (from 27.2 to 54.1 percent points);[143] in another, nonphysician "patient navigators" (along with several other administrative changes) increased the number of patients receiving colonoscopy each month from 75.7 to 119.0.[173]

Table 29. Studies of the association between system level factors and CRC screening

Author, Year, Study Design, Population, Setting, Sample Size, Quality	Primary Outcomes	Independent Variables of Primary Interest	Potential Confounders	Association of Variables to CRC Screening*	Results
Yano et al., 2007[110] Cross-sectional, retrospective, VA based Data collected 1998 and 2001 Primary care directors survey, 155 VA primary care clinics across country, 1999-2000 and 38,818 patient claims data (2001) Fair	Abstracted data on colonoscopy, FOBT, FS; overall screening rate (claims)	Centralization (authority over operations, staffing, etc.), resources (sufficiency of nonclinician staffing, space, clinical support), and complexity (facility size, academic status, managed care) of organization	Patient and clinician characteristics, health care use	↑ Centralization (i.e., autonomy), resources (i.e., clinical support), and complexity (i.e., facility size)	Autonomy over internal structure ($P < 0.04$), clinical support ($P < 0.03$), and smaller size ($P < 0.001$) were statistically significantly associated with more CRC screening.

CI, confidence interval; CRC, colorectal cancer; CTS, Community Tracking Study; DERS, Direct Endoscopic Referral System; FFS, fee-for-service; FOBT, fecal occult blood test; GI, gastrointestinal; MCA, managed care activity; N (n), number; AOR, adjusted odds ratio; PCP, primary care physician; SES, socioeconomic status; US, United States; VA, Veterans Administration; vs., versus; MCA, managed care; CHC, county health center; PPO, private physician offices.
* Arrow symbols (↓or ↑) are provided as a quick reference point of overall findings and represent the association reported between each variable and CRC screening.

Table 29. Studies of the association between system level factors and CRC screening (continued)

Author, Year, Study Design, Population, Setting, Sample Size, Quality	Primary Outcomes	Independent Variables of Primary Interest	Potential Confounders	Association of Variables to CRC Screening*	Results
Hudson et al., 2007[143] Cross-sectional study, retrospective, practice based 22 family practices, NJ and PN, 2003-2004 N = 795 Fair	Colonoscopy, FOBT, and FS; overall screening rate	Use of nursing or health educator staff to counsel patients about diet, exercise, or tobacco use Use of patient reminder systems of any type (not specifically for CRC screening)	Physician, patient, interaction, and other practice characteristics; variation in types of reminders used	↑ Counseling from non-clinician staff, use of reminder systems	CRC screening rates: Use of nonclinician staff for counseling: • Yes: 54.1% • No: 27.2% [AOR, 2.96 (95% CI, 2.21-3.96)] Reminder systems: • Yes: 39.9% • No: 19.6% [AOR, 2.57 (95% CI, 1.77-3.74)]
Koroukian et al., 2005[139] Cross-sectional study, retrospective, national Association of county-level assessment of managed care (MCA) with Medicare FFS patients, 1998-1999, ≥ 65 N = 23 million Fair	Colonoscopy, FOBT, FS (claims)	County-level assessment of MCA, based on % Medicare patients on managed care in each US county: High: > 30% Moderate: 10-29.9% Low: < 10%	Patient, physician, and interaction characteristics; practice organizational characteristics; only have county-level data on patient and physician characteristics	↑ Managed care among Medicare FFS patients	Greater level of MCA associated with CRC screening: High vs. low MCA: • FOBT: AOR, 1.10 (95% CI, 1.04-1.16) • Colonoscopy: AOR, 1.07 (95% CI, 1.03-1.10) • FS: AOR, 0.98 (95% CI, 0.93-1.03) No absolute screening rates given.
Messina, et al., 2009[66] Cross-sectional, retrospective, local Telephone survey of random samples of patients of CHC compared to those of PPO offices in the New York City area, 52- 75 years of age	FOBT within past year, FS in past 5 years, colonoscopy in past 10 years (self-report)	Type of provider (CHC or PPO)	Gender, race/ ethnicity, education, income, insurance, health status	↓ CHC patients compared to PPO patients for endoscopy screening ↑ CHC patients compared to PPO patients for FOBT	FOBT was more frequent among CHC patients; FS and colonoscopy were more frequent among PPO patients ($P < 0.001$) CHC patients less frequently cited no physician recommendation as a barrier to FOBT, but more frequently cited no

Table 29. Studies of the association between system level factors and CRC screening (continued)

Author, Year, Study Design, Population, Setting, Sample Size, Quality	Primary Outcomes	Independent Variables of Primary Interest	Potential Confounders	Association of Variables to CRC Screening*	Results
Messina, et al., 2009[66] (continued N = 1070 Fair					recommendation as a barrier to FS and colonoscopy, compared with PPO patients (p<0.02).
Nash et al., 2006[173] Retrospective cohort analysis, before and after an organizational intervention (no control group), data collected 2003-2004 Single medical center in New York City Fair	Monthly rate of screening colonoscopy, broken-appointment (appt) rate for colonoscopy (claims)	Intervention included (1) two "patient navigators" to assist patients in obtaining a colonoscopy, providing continuity between departments as patients navigated the system; (2) new DERS to allow PCP to refer patients directly for colonoscopy; and (3) GI suite enhancements to improve operational efficiency (e.g., more colonoscopies, efficient colonoscope cleaning, more nurses in procedure rooms)	Societal, independent increase in colonoscopy happening at same time; other cointerven-tions (e.g., public information at same time) also possible	↑ Patient navigation (due to reduced broken appoint-ments)	Broken colonoscopy appt rate decreased from 67.2% before intervention to 5.3% after intervention. The broken appointment rate started immediately after patient navigators hired and before DERS was in place.
Pham et al., 2005[127] Cross-sectional, retrospective, national Physician survey and Medicare claims data, 2000-2001 N = 3,660 physicians and 24,581 patients Fair	One-year rates of colonoscopy or FS, excluded FOBT because claims data not reliable	Patient characteristics (e.g., age) from Medicare file, some patient variables (e.g., income) from zip code data Physician and practice characteristics from CTS physician survey, focus on primary care physicians Practice characteristics	Patient comorbidity, individual income and other demographic and education factors; doctor-patient interaction factors; managed care practice factors	No associations found	No statistically significant association between CRC screening among patients cared for by physicians in different practice types (e.g., medium/large group vs. solo/two-person group: AOR, 1.12 [95% CI, 0.90-1.38]). Patients cared for by physicians with access to reminders were not more likely

Table 29. Studies of the association between system level factors and CRC screening (continued)

Author, Year, Study Design, Population, Setting, Sample Size, Quality	Primary Outcomes	Independent Variables of Primary Interest	Potential Confounders	Association of Variables to CRC Screening*	Results
Pham et al., 2005[127] (continued)		including use of computerized physician reminders, size and type of the practice			to have been screened: 5.8% with reminders vs. 5.9% without reminders (adjusted AOR, 0.96 [95% CI, 0.84-1.09]).

Two other studies found what appears to be moderate increases in CRC screening associated either with higher levels of managed care activity in the area[139] or with a higher level of autonomy over the internal structure of the practice.[110] Although both findings were statistically significant, determining the exact strength of the association in these studies is difficult because they did not provide absolute screening rates.

Use of patient reminders was associated with a higher level of CRC screening in one study (39.9 percent versus 19.6 percent).[143] However, the availability (rather than the use) of computerized physician reminders was not associated with a higher screening rate after adjustment for practice size and patient covariates.[127]

In addition, one study found that smaller practices (within a group of large practices) were associated with higher screening rates (although absolute rates were not given).[110] After adjusting for other patient and physician covariates, investigators on another study found no association between practice size among smaller practices (solo/two-person group practice versus larger group practice) and CRC screening (5.9 percent versus 5.8 percent 1-year screening rates).[127] The final study found higher endoscopy screening rates among patients of private physician offices compared to those receiving care in the same geographic region through county health centers ($P < 0.001$).[66] This study also found that patients of county health centers were more likely to cite no physician recommendation as a barrier to endoscopy when compared to patients of private physician offices ($P = 0.02$).[66]

Summary

We categorized studies examining factors associated with the use of CRC screening tests into five domains: 1) patient factors, 2) physician factors (including physician characteristics, physician-patient connectedness, and physician recommendations about screening), 3) patient-physician communication factors, 4) the periodic health examination, and 5) system level factors. We further categorized the patient factors into four groups: patient demographics, access to care, personal health or risk factors, and psychosocial factors.

All included studies focused on factors associated with underuse of CRC screening. None focused on factors associated with underuse of CRC discussions or on factors associated with overuse or misuse of CRC screening.

Several factors are consistently and significantly associated with reduced CRC screening (i.e., $P < 0.05$ or confidence intervals that do not overlap or include 1.0). They include:

- Low household income
- No health insurance

- Being Hispanic or Asian
- Not being acculturated into the United States
- Limited access to care (i.e., lack of a regular source of primary care and no visits in previous year to provider), and
- No physician recommendation to be screened.

Factors positively associated with CRC screening include having private insurance, being non-Hispanic white, higher education level, participating in regular screenings for other cancers, having a family history of CRC or personal history of another cancer, having regular access to care, having effective provider-patient communication, or physician recommendation. We found one study each that examined the association between screening and specific physician characteristics, physician-patient connectedness, and use of periodic health examinations. Thus, insufficient evidence exists to draw conclusions about these relationships. Studies on system level factors that might influence CRC screening did not consistently measure the same variables but seem to support counseling by nonclinicians, reminder systems, and assisting patients to keep appointments.

KQ 3: Which Strategies Are Effective In Increasing The Appropriate Use Of Colorectal Cancer Screening And Followup?

KQ 3 focuses on the evidence on effectiveness of strategies that have attempted to increase appropriate CRC screening and followup. Therefore, all included studies measured the outcome of CRC screening and/or followup rates; one also included the outcome of a discussion with a provider about screening.

We classified strategies into those that targeted the patient, the provider, the health system, and/or the community. We identified and included 15 studies that targeted the patient,[85,174-187] 2 that targeted the provider,[186,188] and 5 (six manuscripts) that targeted the health care system.[162,189-193] (Some studies had more than one focus.) We found no RCTs of either fair or good quality that tested interventions implemented within a community. Of these 21 studies in all, one focused on appropriate followup after an abnormal screening;[188] the others focused only on increasing screening rates.

We present only those studies that we rated as fair or good quality. Common reasons that we rated studies as poor quality included a combination of issues. For example, the randomization process was not explained, was difficult to determine, or was not blinded to the provider; the response rate was low (< 60 percent); the investigators used nonstandard instruments or outcome measures to assess screening or followup rates; and/or the comparison samples were dissimilar on key characteristics at baseline.

Our overall summary and strength of evidence tables for studies addressing this KQ are presented at the beginning of this section. The remainder of this section provides, first, an overview of studies of patient-level interventions. We then consider the two studies of a provider-level intervention[186,188] and the five studies of a system-level intervention.[162,189-193]

KQ 3: Overall Summary and Strength of Evidence

In the tables that follow, our overall grades of the strength of evidence appear in the far right column; grades for key domains to determine the strength of evidence are in the intermediate columns. Table 2 (Chapter 2) defined terms used to describe the strength of evidence; these definitions can also be found in the glossary for this report.

We included 21 RCTs, rated good or fair quality, of interventions designed to increase CRC screening. These included 15 studies that targeted the patient,[85,174-187] 2 that targeted the provider,[186,188] and 5 (including two manuscripts of the same study) that targeted the health care system.[162,189-193]

Following categories similar to those recently used to develop recommendations by the Task Force on Community Preventive Services (TFCPS) on CRC screening,[194] we divided the types of studies of interventions targeting patients into five categories: (1) patient reminders;[175,182-183,186] (2) small media (with[177-178,181] and without[174-176,185] decision aids); (3) group education;[184-185] (4) one-on-one interaction;[85,179-180] and (5) reducing structural barriers.[85,175,179,183,186-187] Much like recommendations for the Guide to Community Preventive Services,[194] these studies include five that have more than one type of intervention.[85,175,179,183,185] For each of these, we categorized them into more than one type of intervention in determining the strength of evidence and presenting the overall findings in the following sections. When possible, we attempted to evaluate the incremental contribution of each component separately. However, for most studies, the effect of all the components was evaluated collectively, such that findings were not presented by authors in a way that allowed us to assess the incremental impact of adding each component. Across these 15 RCTs focused on patient-level interventions, the range of increases in screening was 0 percent to more than 40 percentage points.[85,174-187]

As shown in Table 30, we found high strength of evidence that interventions that provide patient reminders lead to small to moderate increases in screening (percent increases ranged from 5.0- 15 percentage points).[175,182-183,186] We also found high strength of evidence that of small media, such as delivery of education videos or brochures to patients before being seen by a physician or in the mail through a church registry list, have little to no impact on screening rates.[174-176,185] Use of decision aids, delivered via small media, was less conclusive. Although we recognize that not all decision aids are equal, with some designed to be more interactive with patients than others, we found the evidence to be mixed in terms of how effective they are in increasing screening (rate change in percentage points from 3 percent [$P = 1.0$[181]] to 14.2 percent[177] and 23 percent[178]). For this mixed evidence, with two of three studies showing benefit, we concluded that the strength of evidence is low (because of the inconsistent results) that some types of decision aids are effective for increasing screening. We identified two studies examining the impact on CRC screening rates of group education delivered either by Native Hawaiians among Native Hawaiians[184] or by African Americans for their fellow church members on the need for testing.[185] These studies demonstrated mixed effects; one showed a negative finding on the impact of the intervention on screening[184] and another finding a borderline positive effect ($P = 0.08$),[185] we concluded that the strength of evidence is low for this intervention type. The two remaining categories of patient level interventions (one-on-one interventions and eliminating barriers) both provided high strength of evidence that they yield an increase in screening rates. The interventions designed to provide one-on-one interactions, through either a nurse, or health educator,[85,179] or on the phone,[180] hold promise in their ability to increase CRC screening, with

Table 30. Effect of patient-level interventions on CRC screening rates

Number of Studies; # of Subjects	Risk of Bias Design/ Quality	Consistency	Directness	Precision	Results	Overall Strength of Evidence
Patient Reminders						
Denberg et al., 2006[182] Myers et al., 2007[175] Church et al., 2004[183] Sequist, et al., 2009[186] 4: 25,442	Low 4 RCTs/ 1 Good, 3 Fair	Consistent	Direct	Precise	Patient reminders are effective vs. no intervention (5.0 - 15 percentage point increase in screening rates).	High
Small Media (only)						
Zapka et al., 2004[174] Myers et al., 2007[175] Costanza et al., 2007[176] Campbell, et al., 2004[185] 4: 5,245	Low 4 RCTs/ 1 Good, 3 Fair	Consistent	Direct	Precise	Small media (i.e., providing education to patients without specific decision aids) do not seem to be effective.	High
Small Media/Decision Aids						
Ruffin et al., 2007[178] Dolan and Frisina, 2002[181] Pignone et al., 2000[177] 3: 518	Low 3 RCTs/ 1 Good, 2 Fair	Inconsistency present	Direct	Imprecise	Mixed results such that 2 of 3 studies found decision aids to be beneficial versus no or limited interventions (14 - 23 percentage point increase in screening rates reported in the two positive studies).	Low
Group Education Interventions						
Braun, et al., 2005[184] Campbell, et al., 2004[185] 2: 409	Low 2 RCTs/ 2 Fair	Consistent	Direct	Imprecise	Group education interventions were not more effective than comparisons for increasing screening rates.	Low
One-on-one Interventions						
Basch et al., 2006[180] Stokamer et al., 2005[85] Tu et al., 2006[179] 3: 1,545	Low 3 RCTs/ 1 Good, 2 Fair	Consistent	Direct	Precise	One-on-one interactions were effective in increasing CRC screening rates (14.6 - 41.9 percentage point increase).	High
Eliminating Barriers						
Tu et al., 2006[179] Stokamer et al., 2005[85] Myers et al., 2007[175] Church et al., 2004[183] Potter, et al., 2009[187] 5: 4304	Low 5 RCTs/ 2 Good, 3 Fair	Consistent	Direct	Precise	Eliminating barriers for increasing CRC screening was effective vs. no intervention (14.6 - 41.9 percentage point increase in any CRC test use).	High

CRC, colorectal cancer; RCT, randomized controlled trial.

percentage point increases ranging from 14.6 percent in FOBT completion,[85] 20.9 percent of any CRC test through repeated telephone counseling, and 41.9 percent in FOBT completion through an intervention provided by a bi-lingual health educator.[179] Those designed to eliminate barriers by providing FOBT tests to use at home or providing access to individuals who can help to address barriers were also shown to be effective in increasing screening rates (rate change from 14.6- 41.9 percentage points).[85,175,179,183,187]

We also address discussions with providers as an outcome for KQ 3 and found one study that presented findings specific to increases in this outcome (Table 31).[177] These investigators reported 25.1 percent increase in discussions (Table 31), but with only one study we concluded that there is low overall strength of evidence for patient-level interventions to increase discussions with providers.

Table 31. Effect of patient-level intervention on discussions with providers

Number of Studies; # of Subjects	Risk of Bias Design/Quality	Consistency	Directness	Precision	Results	Overall Strength of Evidence
Pignone et al., 2000[177] 1: 651	Low 1 RCT/ 1 Fair	Consistency Unknown (single study)	Direct	Imprecise	One study favored use of small media with or without decision aids vs. no intervention in increasing discussions with providers (25.1 percentage point difference).	Low

RCT, randomized controlled trial.

In addition to the 15 studies of patient level interventions, we included 2 studies on provider level interventions (Table 32).[186,188] One study on provider-level interventions sent reminders to physicians who had patients in need of surveillance colonoscopies;[188] the other study used electronic reminders during patient office visits to increase ordering of the tests.[186] The first study favored providing reminders to physicians to increase surveillance colonoscopies, but the other found no difference between CRC screening rates of patients whose providers received reminders or not ($P = 0.47$).[186] We rated the strength of evidence as low because the included studies tended to indicate no benefit in provider reminders in increasing screening.

Table 32. Effect of provider-level interventions on CRC screening rates

Number of Studies; # of Subjects	Risk of Bias Design/Quality	Consistency	Directness	Precision	Results	Overall Strength of Evidence
Ayanian, et al., 2008[188] Sequist, et al., 2009[186] 2: 251 physicians: 22,630 patients	Low 2 RCTs/ 2 Good	Inconsistent	Direct	Imprecise	Mixed results such that 1 study found a slight increase in surveillance colonoscopy and another study found no difference in CRC screening among patients whose provider received reminders.	Low

RCT, randomized controlled trial; CRC, colorectal cancer.

The five studies (six articles) on system-level interventions[162,189-193] implemented changes to improve referral of patients for screening[190-192] or identified a person such as a patient navigator[189] or someone in a similar role (i.e., Prevention Care Manager or PCM)[162,193] to help patients navigate the health care system (Table 33). Their findings indicated that this intervention may provide promising effects on increasing CRC screening.

The 21 studies identified as eligible for this KQ represented a small fraction of all studies reporting on interventions designed to improve CRC screening. These other (ineligible) studies were not conducted as a RCT design, provided a limited description of the intervention, or used untested or unvalidated measures in assessing outcomes.

Table 33. Effect of system-level interventions on CRC screening rates

Number of Studies; # of Subjects	Risk of Bias Design/ Quality	Consistency	Directness	Precision	Results	Overall Strength of Evidence
Jandorf et al., 2005[189] Dietrich, et al., 2007[162] Roetzheim, et al., 2004[190] Roetzheim, et al., 2005[191] Ling, et al.., 2009[192] Dietrich, et al., 2006[193] 5: 9445	Low 5 RCTs/ 5 Fair	Consistent	Direct	Precise	System- level interventions are effective in increasing CRC screening vs. no intervention (7%-28.2% difference in screening rates).	High

RCT, randomized controlled trial; CRC, colorectal cancer.

Patient Interventions

Study characteristics. Following categories similar to those that the TFCPS used to develop CRC screening recommendations,[194] we divided the types of studies of interventions targeting patients into five categories: (1) patient reminders;[175,182-183,186] (2) small media (with[177-178,181] and without[174-176,185] decision aids); (3) group education;[184-185] (4) one-on-one interaction;[85,179-180] and (5) reducing structural barriers.[85,175,179,183,187]

Table 34 Shows which studies employed which types of interventions; following this section and overview of results, we consider each kind of intervention in turn.

Patient reminders can be in the form of written materials such as postcards, letters, or other materials used to remind or alert patients of their need for CRC screening. Reminders can also be provided through telephone contacts with patients who are due for screenings. These reminders, when used as an intervention, are provided to patients who are due for a rescreening or who have never been screened; they are not reminders of an upcoming appointment that is already scheduled. Patient reminders are thought to be a means of effectively prompting people about their need for annual screening (or for screening related to whatever period recommended for the patient); the idea is that if patients are not scheduled to see a provider, they will initiate an appointment in order to remain current on cancer screening tests.

Small media interventions focus on providing respondents with educational materials; they can include videos and printed materials such as letters, brochures, and newsletters that are provided to patients explicitly to educate them about the disease under study (i.e., colorectal cancer), their risks for being diagnosed with the disease, and screening tests that are available. These materials are termed “small media” because they rely on mail, telephone, or distribution of

Table 34. Patient-level studies by category of intervention

Included Articles with Patient-Level Interventions	Patient Reminders	Small Media to Provide Education: Education Materials and Messages	Small Media to Provide Education: Decision Aids	Group Education	One-on-one Interactions	Reducing Structural Barriers
Basch et al., 2006[180]					•	
Braun, et al., 2005[184]				•		
Campbell, et al., 2004[185]		•		•		
Church et al., 2004[183]	•					•
Costanza et al., 2007[176]		•				
Denberg et al., 2006[182]	•					
Dolan et al., 2002[181]			•			
Myers et al., 2007[175]	•	•				•
Pignone et al., 2000[177]			•			
Potter, et al., 2009[187]						•
Ruffin et al., 2007[178]			•			
Sequist, et al., 2009[186]	•					
Stokamer et al., 2004[85]					•	•
Tu et al., 2006[179]					•	•
Zapka et al., 2004[174]		•				

education materials. They are not educational media campaigns that would be provided through television advertisements and public service announcements (PSAs); neither are they national media campaigns such as the one conducted by the Centers for Disease Control and Prevention (CDC) called "Screen for Life," which uses PSAs on national TV stations to educate people about the need for cancer screening tests. Both the small media method of educating the public, as well as the large media campaigns, can be used to inform and motivate people to be screened for cancer and can be tailored to specific individuals or target general audiences.

We included in this category the three studies that tested aids in helping patients to make informed decisions (i.e., decision aids). Decision aids are mechanisms or interventions that have been developed to improve communication between health professionals and patients; their goal is to help involve patients in making decisions regarding their health care. Decision aids can include brochures, videotapes, or interactive computer programs.

Group education interventions are those conducted within a specified group setting and deliver information or motivation to encourage screening. Although these interventions often include handing out information or materials, we categorized studies that included this intervention as group education because they also provided a setting in which an individual was present to interact with the audience.

One-on-one education includes studies in which a provider (e.g., physician, nurse, health educator) works individually with patients to educate them about CRC screening and/or aid them in making decisions about which tests to complete and when to receive screening. These interventions tend to include some concentrated time with a patient to answer questions, address concerns, and help facilitate completion of screening tests. Studies included in this category provided this one-on-one education either by telephone[180] or in person.[85,179]

The final category includes studies that address reducing or eliminating structural barriers to screening. Many problems can make it difficult for people to seek screening for cancer. Barriers can include distance from screening location, limited hours of operation, no day care for

children, limited access to screening tests, and language and cultural factors. These types of interventions seek to increase screening by removing structural barriers. In this category, we included studies that tested the provision of FOBT tests through the mail, either alone[183] or in combination with an intervention that also addressed language and cultural barriers that may be barriers to screening among Japanese Americans.[179]

Overview of results. A total of 15 articles examined the impact of various interventions targeting the patient in an attempt to increase CRC screening.[85,174-187] All 15 focused on screening, not followup. All studies also partially addressed the "appropriate" use of screening by using the criteria for screening guidelines as "inclusion" or "exclusion" criteria (e.g., no FOBT in prior 12 months, no prior CRC diagnosis) in the sample. Seven studies[174-179,187] had an upper age limit (from 70 to 79 years) for their studies; eight did not.[85,180-186] This feature raises the issue of potentially inappropriate screening for older people. Three studies relied only on self-reported frequency of CRC screening,[178,183,185] which has been shown to overestimate screening rates.

Among these studies, four presented findings of an intervention to provide patient reminders, seven focused on the use of small media (e.g., video, letters) to educate patients about the need for screening and/or types of tests available or to help their decisionmaking process, two presented findings from group education interventions, and three focused on interventions that provided one-on-one interactions either by phone on in person to increase screening.

Five studies addressed barriers to screening by providing FOBTs to patients (i.e., by mail or in health clinics) who were due for screening. One of these implemented an intervention that also addressed cultural and language barriers.[179]

The impact of these interventions on CRC screening rates ranged from 0 percent to 41.9 percent when the intervention groups were compared with the control groups. Studies that examined the use of educational materials presented via small media[174-176,185] had no impact on screening rates (increase of 0 - 15.1 percentage point change [$P = 0.08$ for study with highest percentage change]); those that provided means for eliminating structural barriers, such as access to CRC screening tests or language barriers,[85,175,179,183,187] demonstrated the highest impact on screening rates overall (14.6 to 41.9 percentage point change). Those that used decision aids delivered to patients through small media had mixed results; two studies demonstrated an overall increase in CRC screening (14.2 to 23 percentage point change)[177-178] and the other demonstrated only a 3 percentage point increase in CRC screening.[181] Interventions that provided patient reminders in the mail or over the telephone had an impact on screening using any CRC test ranging from 5.4 percent to 11.7 percent and 15 percent.[175,182-183,186] Two studies tested an education intervention in a group setting and found no difference in screening rates among their samples.[184-185] Only one study measured increases in discussions between the patient and providers as an outcome of their intervention, reporting a 25.1 percent increase in discussions among patients in the intervention group compared with those in the control group.[177]

Patient reminders. *Study characteristics.* Four RCTs, one rated as good quality[186] and three rated as fair quality, [175,182-183] focused on testing reminders mailed to patients due for screening (Table 35). One study used usual care as a comparator; it involved a mailed reminder (brochure) sent to patients who had been referred for a screening colonoscopy after an appointment at a primary care practice.[182] Another study randomized subjects into one of four groups:[175] one group received a mailed standard intervention (Group 1: SI) that included an informational booklet and FOBT kit; a second group received a tailored intervention (Group 2: TI) that included the SI package plus tailored "message pages" of brief messages that addressed personal

barriers to screening; a third group (Group 3: TIP) included the TI package plus a reminder telephone call; and the fourth was a control group. All three intervention groups received either a letter or a telephone call as a reminder to complete the FOBT. The intervention groups then varied on the type of additional education materials they received or the type of contact that was made, such that G3 is the only group that received phone calls. These three groups were compared with a sample of patients who received usual care.

Table 35. Studies of patient reminders on increasing colorectal cancer screening rates

Author, Year **Study Design** **Population** **Setting** **Sample Size** **Quality**	**Study Aims**	**Study Groups**	**Results (95% CI)**
Sequist et al., 2009[186] RCT, 15-month followup 11 Ambulatory Health Care Centers in Massachusetts N= 110 physicians, 21,860 patients Good	Compare the individual and joint impact of personalized mailings to patients and electronic reminders to primary care physicians to promote colorectal cancer screening within a multisite group practice	G1: Patients were mailed a package to remind them of need for CRC screening that included a FOBT kit, letter and pamphlet, and a telephone number they could call to make an appointment for endoscopy (n=10,930) G2: Usual care for patients (n=10,930) G3: Providers were given electronic reminders during office visits that patients were overdue for screening (n=55 or 10,912 patients) G4: Usual care such that providers received no reminders (n=55 or 10,948)	G1: 25.4% FOBT completion; 44% completed any CRC test G2: 20.4% FOBT completion (*P* < 0.001); 38.1% completed any CRC test (*P*< 0.001) G3: 41.9% completed any CRC test G4: 40.2% completed any CRC test (*P*=0.47) Interaction effect between the patient and provider interventions was small and not statistically significant (-0.6%; 95% CI, -1.2%- 0.1%; *P* = 0.08)
Church et al., 2004[183] RCT, 1 year Residents, 50 years of age or older, of Wright County, Minnesota N = 1,255 Fair	Test direct mailing of FOBT kits with and without reminders to general population	G1: (no reminders) Questionnaire mailed plus FOBT kit and instructional brochure (n = 434) G2: (reminders) Same package as G1, plus telephone reminders (n = 404) G3: Questionnaire only (n = 417)	G1: 16.9% FOBT completion rate (95% CI, 11.5-22.3%); 13.2% for any CRC test (95% CI, 8.4-18.2%) G2: 23.2% FOBT completion rate (95% CI, 17.2-29.3%); 14.1% for any CRC test (95% CI, 9.1-19.1%) G3: 1.5% FOBT completion rate (95% CI, -2.9-5.9%); 7.8% for any CRC test (95% CI, 3.2-12.0%)
Denberg et al., 2006[182] RCT, 4 months Primary care practices is there a city/state? N = 781 Fair	Test whether a mailed brochure after referral for screening colonoscopy will increase colonoscopy completion	G1: Follow-up mailing of educational brochure within 10 days after a primary care visit where a screening colonoscopy was recommended (n = 386) G2: Usual care (n = 395)	G1: 70.7% colonoscopy completion rate G2: 59% colonoscopy completion rate (11.7 percent point difference; 95% CI, 5.1-18.4%; *P* = 0.001)

CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; G, group; N, sample size; NR, not reported; AOR, adjusted odds ratio; *P*, significance/probability of finding; RCT, randomized controlled trial.

Table 35. Studies of patient reminders on increasing colorectal cancer screening rates (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Study Groups	Results (95% CI)
Myers et al., 2007[175] RCT, 2 years Primary practice patients in Philadelphia, Pennsylvania N = 1,546 Fair	Test whether targeted and tailored message delivery, both by mail and via phone outreach, will improve CRC screening rates	G1: "Standard Intervention" (SI) of mailed letter, information booklet, FOBT kit, and reminder letter (n = 387) G2: Standard intervention package plus 2 "tailored message pages" (TI) (n=386) G3: SI plus TI, and a reminder phone call (TIP) by an educator (n=386) G4: (control) Usual care (n = 387)	G1: 46% completion rate for any test (AOR, 1.7; 95% CI, 1.2-2.5) G2: 44% (AOR, 1.6; 95% CI, 1.2-2.1) G3: 48% (AOR, 1.9; 9.5% CI, 1.4-2.6) G4: 33% (*P* NR)

Another study mailed packages of a letter, pamphlet, and FOBT kit to patients of an ambulatory health care center who were due for CRC screening and compared these patients with others who received usual care.[186] The fourth study randomized residents in a local community to mailed FOBT kits without reminders (G1), mailed FOBT kits with telephone reminders (G2), or a questionnaire about CRC (G3: control group).[183] Because both G1 and G2 of this study provided mailed FOBT kits to a random sample of local residents, the differences between these two groups reflects the impact from telephone reminders to complete the FOBT.

Three studies focused on patients 50 years of age or older; one study limited its intervention to persons 50 to 80 years.[186] The times for followup varied: within 4 months of the initial referral for colonoscopy screening;[182] 6 months of the original mailing and 1 year to measure completion rates;[183] 15 months after the initial mailing;[186] or 24 months after the initial visit to their provider.[175] The three studies focusing on populations recruited through a provider setting measured their outcomes through medical chart review;[175,182,186] the fourth study with a randomized sample of residents relied on self-reported screening for their outcomes.[183]

Overview of results. All four studies found statistically significant increases in CRC screening rates, with absolute increases in screening from about 5.9 percentage points to about 15 percentage points. The colonoscopy study found an increase in completed colonoscopy from 59.0 percent in the control group to 70.7 percent in the intervention group (difference: 11.7 percentage points; 95% CI, 5.1 -18.4 percentage points).[182] The tailored intervention study found an increase in any CRC screening for all three intervention groups compared with controls (33 percent control versus 46 percent, 44 percent, and 48 percent; OR, 1.7; 95% CI, 1.3-2.5; OR, 1.6; 95% CI, 1.2-2.1; OR, 1.9; 95% CI, 1.4-2.6), but no difference among the interventions.[175] In the TIP group, 28 percent did not receive a telephone call. The study providing FOBT kits to patients of ambulatory care centers found that those who received mailings were more likely to obtain screening than those who did not (44.0 percent versus 38.1 percent, respectively, $P < 0.001$).[186] The population-based study that mailed FOBT kits to the intervention groups and followed them either with or without reminders reported an increase in completion of any CRC screening of 7.8 percent (95% CI, 3.2-12.0 percent) for the control group, 13.2 percent (8.4-18.2 percent) for the FOBT without reminders group, and 14.1 percent (9.1-19.1 percent) for the FOBT with reminders group.[183] The difference between FOBT with reminders and controls was statistically

significant. Overall baseline adherence to any CRC screening was 55.8 percent; the final adherence rate for any CRC screening was above 60 percent for the intervention groups, although these rates were self-reported. The primary care and population-based studies showed little increase in screening with increased intensity of intervention.[175,183]

Detailed results. The one study using only mailed patient reminders provided a brochure about CRC tests for patients who had been referred for a screening colonoscopy.[182] Patients in the intervention group were mailed the information brochure within 10 days of referral for the colonoscopy. Each brochure included the primary care physician's name, encouraged patients to schedule the procedure, and explained CRC and polyps, the risks of being diagnosed with CRC, the nature of bowel preparation, alternative screening tests, and the complication risks of colonoscopy. Those patients assigned to the control group had been referred for screening colonoscopy as well but received no reminder. The findings indicated that patients receiving the reminders were more likely to complete the test (within the 4-month follow-up period) than those who did not (11.7 percentage point difference; 95% CI, 5.1-18.4 percentage points; $P = 0.001$).

The second study examined three different types of interventions, all with varying intensity, and compared them with a control group that received usual care and none of the study intervention contacts.[175] In the standard intervention (G1), patients were mailed a package that included a CRC screening invitation letter, information booklet, FOBT kit, and reminder letter. The package also included instructions for completing a home FOBT and on arranging for a flexible sigmoidoscopy (FS). The TI patients (G2) received the SI package and two tailored message pages, which addressed personal barriers to FOBT and FS that were identified through analysis of baseline survey data collection. TIP patients (G3) received the SI and TI information and a telephone reminder to conduct the FOBT. During these telephone calls, a trained health educator reviewed the mailed materials and encouraged participants to consider screening. Although the investigators did find that groups that received some form of reminder were more likely to complete screening than those who received usual care ($P = 0.001$ or 0.002), they did not find differences among the intervention groups to indicate whether patients who received mail or telephone reminders (SI: AOR, 1.7; 95% CI, 1.3-2.5; TI: AOR, 1.6; 95% CI, 1.2-2.1), or a combination of the two (TIP: OR, 1.9; 95% CI, 1.4-2.6) were any more likely than any other to be screened.

The third study conducted in a clinic setting identified patients through their medical record system who were overdue for CRC screening (N = 21,860).[186] Patients ages 50 to 80 years were randomly selected to receive a package that included (1) a letter from the chief medical officer explaining that the patient is overdue for screening; (2) an educational pamphlet explaining the screening test options; (3) FOBT kit with instructions; and (4) a telephone line dedicated to having patients call to make endoscopy appointments. A second mailing was sent to nonrespondents at 6 months. Patients who received the mailing were more likely than the control group to complete a FOBT (25.4 percent versus 20.4 percent, respectively; $P < 0.001$) or any CRC test (44.0 percent versus 39.1 percent, respectively; $P < 0.001$).

The fourth study tested receipt of reminders versus no reminders and compared both with a control group.[183] The study identified a random sample of residents in Wright County, Minnesota, who were determined to be 50 years of age or older based on records from the Minnesota State Driver's License and Identification Card database. The sample was divided into three groups: the control group (Group 3) and two intervention groups that both received informational packages but differed in terms of whether they received telephone reminders for testing (Group 2) or not (Group 1). All three groups were mailed an initial survey on CRC and

then either received no additional information until the follow-up survey in 1 year (Group 3) or received a package of information approximately 2 months after the questionnaire that included an FOBT kit with instructions and educational material about CRC and screening test. Group 2 individual who did not return FOBT kits were mailed reminder letters 1 month later that included another FOBT kit and then, if they had still not returned an FOBT, they received a telephone call 1 month later. Of those in the "no reminder" group (Group 1), 49.6 percent of the participants accidentally received the first reminder letter with no further contact. They did not receive any of the subsequent reminders (i.e., two more mailings and telephone calls). The authors did not report the number of respondents in Group 2 who had been called Although the study did report self-reported completion of any CRC test, the findings specific to reminders demonstrated an overall increase of 6.3 percent in completion of FOBT for Group 2 received telephone reminders (received reminders: 23.2 percent FOBT completion rate; 95% CI, 17.2-29.3 percent) and Group 2 (no reminders: 16.9 percent FOBT completion rate; 95% CI, 11.5-22.3 percent).

Small media interventions. Seven RCTs were patient-directed small media interventions; that is, these studies that used various tools such as print materials or telephone calls to provide education to a targeted sample. We divided this set of studies into two categories: (1) four studies that focused on small media interventions that were not decision aids[174-176,185] and (2) three studies of decision aids.[177-178,181]

Small media: educational materials and messages. *Study characteristics*. As shown in

Table 36, one study in this category was rated as good quality[174] and three were rated as fair quality.[175-176,185] The populations targeted for all four studies were at average risk for CRC and met recommendations for screening tests. All four studies focused on those 50 years or older.[174-176,185] The populations in three studies were recruited from primary care practices, and patients in each of the control groups were receiving usual care. Because these were patients already receiving care from a physician, "usual care" was defined as people who received none of the interventions.[175-176] The fourth study recruited church members from predominantly African-American churches located in rural areas of one state and compared their intervention with those in churches whose members received education on unrelated health topics.[185] Participants of two of the studies were predominantly non-Hispanic white;[174,176] the third primary care study included 39 percent multiracial (race unspecified) participants from an urban center,[175] and the fourth study included only African Americans.[185] Two interventions focused on mailing educational materials, followed by telephone contact;[175-176] the third intervention consisted of a mailed 15-minute videotape,[174] and the fourth intervention included a combination of print and video materials that were mailed at 2-month intervals over the 9-month intervention period.[185] The timing for measuring outcomes ranged from 6 months[174] to 24 months.[175] Three studies measured their outcome of receiving any CRC test by reviewing medical charts;[174-176] the fourth measured CRC screening through self-reported responses.[185]

Overview of results. The four studies that did not deal with decision aids demonstrated consistent findings with regard to education materials and information provided to patients via small media: such interventions had no influence on CRC screening rates that was found to be statistically significant (0 percent to 15.1 percentage point differences in rates among intervention and control groups across studies).

Table 36. Studies of small media: Educational materials and messages on increasing colorectal cancer screening rates

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Study Groups	Results
Zapka et al., 2004[174] RCT, 6 months Primary care practices in central Massachusetts N = 938 Good	Test the effect on CRC screening of an educational video mailed to patients' homes before a physical examination	G1: Patients scheduled for an upcoming physical examination received a video in the mail prior to appointment (n = 450) G2: Usual care (n = 488)	G1: 55% overall screening rate G2: 55% screening rate
Campbell et al., 2004[185] RCT, 1 year follow-up African-American churches in rural North Carolina N = 287 (50 years or older) Fair	To test an intervention to improve multiple health behaviors among rural African American church members	G1: TPV materials distributed to church members via mail (n= 76) G2: LHA trained within experimental churches to provide CRC information through existing networks (n=51) G3: Combination of TPV and LHA (n=87) G4: Speakers came to churches and offered educational workshops on a variety of topics (e.g., HIV/AID); provided members education materials (n=69)	G1: 36.8% received FOBT test; 21.1% received another CRC test G2: 33.3% received FOBT test; 25.5% received another CRC test G3: 31.0% received FOBT test; 14.9% received another CRC test G4: 21.7% received FOBT test; 27.5% received another CRC test Differences in group are not statistically significant (p=0.08 for FOBT, NR for 'other' tests; only 'ns' noted).
Costanza et al., 2007[176] RCT, 17-22 months Primary care practice in Massachusetts N = 2,448 Fair	Test stage-based computer-assisted tailored telephone counseling to promote CRC screening in a primary care population.	G1: Mailed brochure followed by computer-assisted stage-based telephone counseling (n = 1,187) G2: Usual care (n = 1,261)	G1: 25% completed any CRC test G2: 24% completed any CRC test (*P* = 0.68)
Myers, et al., 2007[175] RCT, 2 years Primary practice patients in Philadelphia, Pennsylvania N = 1,546 Fair	Test targeted and tailored message delivery, both by mail and via phone outreach	G1: "Standard Intervention" (SI) of mailed letter, information booklet, FOBT kit, and reminder letter (n = 387) G2: Standard intervention package plus 2 "tailored message pages" (TI) G3: SI plus TI, and a reminder phone call (TIP) by an educator G4: (control) Usual care (n = 387)	G1: 46% screening rate (AOR, 1.7; 95% CI, 1.2-2.5) G2: 44% (AOR, 1.6; 95% CI, 1.2-2.1) G3: 48% (AOR, 1.9; 95% CI, 1.4-2.6) G4: 33% (*P* NR)

AOR, adjusted odds ratio; CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; G, group; HIV/AIDs, human immunodeficiency virus/acquired immune deficiency syndrome LHA, lay health advisor; FOBT, fecal occult blood test; N, sample size; NR, not reported; ns, not significant; RCT, randomized controlled trial; SI, standard intervention; TI, tailored intervention; TPV, tailored print and video.

For one study, determining the increase in screening specific to the educational materials was somewhat challenging.[175] It included multiple strategies; the primary difference between the control group and the three intervention groups was that all the intervention groups received both an FOBT kit and some type of reminder to complete the test (either by letter or by letter and telephone). The differences between the three intervention groups are in the type of small media used to influence completion of CRC testing. These three groups did not differ in terms of completion of CRC screening for patients who received print material only compared with those who got print materials plus telephone reminders (2 percentage point difference in screening rates).[175]

The other two studies also had no effect on screening rates (0-1 percentage point difference in control and intervention groups).[174,176]

Detailed results. One good-quality study explored the effect of mailing an educational video to patients' homes just before they had an appointment for a physical examination.[174] The research team mailed a letter to potential participants who were 50 to 74 years of age and had an appointment with their primary care provider in the next 3 weeks. After conducting a baseline interview with all interested patients, they randomly assigned patients to receive an educational video through the mail or to usual care (i.e., no video). The 15-minute video included information to encourage discussion with their provider about CRC screening and increase the use of screening, particularly by FS. The mailed package with the video also included a letter encouraging the patient to view the video. After the video was mailed, the patients were interviewed by telephone between 4 and 6 months after the primary care appointment to determine whether they had obtained screening. This study reported no difference in screening rates among the intervention and control group participants (55 percent for both groups).

Another study involved rural churches in North Carolina with high proportions of African-American members.[185] The study aims included improving nutrition and physical activity, but those participating who were age 50 years or older were also encouraged to obtain CRC screening. The intervention included two components: a tailored communication to select church members randomly and another that involved group education provided by a lay health advisor. We categorized this study into both small media and group education interventions.

For the small media component of the intervention, individual computerized materials were developed based on information obtained through a baseline survey administered to all participants. The tailored package of information included newsletters along with four targeted videotapes mailed to participants' homes. These packages were mailed bi-monthly during months 2, 4, and 6 of the intervention; the fourth mailing occurred during month 9. The videotapes included testimonials from community members and pastors on each of the targeted behaviors of the intervention. Participants in this group were compared with those attending churches in the control group, each of which were offered health education sessions and speakers on topics of their choice not directly related to the study objectives. The second component of group education by lay health educators is described under that intervention type. Members of control churches were no more likely to obtain CRC screening than those who received tailored education ($P = 0.08$).

A fair-quality study used telephone counseling to attempt to increase CRC screening; the investigators initiated contact with patients by first mailing a baseline survey to potential participants who were active patients of primary care practices (i.e., documented visit in the prior 2 years).[176] Upon receiving the baseline survey from patients, the investigators randomized respondents to the control group to receive usual care or to the intervention group. For the

intervention group, the researchers mailed a print brochure 2 months after receipt of the baseline survey; it provided basic CRC information and screening. Three months after receiving their brochure, participants received tailored computer-assisted telephone counseling; for this, a computer generated an interview protocol based on patients' initial responses about their knowledge of CRC and screening tests. Trained interviewers administered the protocol to provide basic education (approximately 4 minutes) and motivational counseling (approximately 6 minutes) to obtain screening. Approximately 17 to 24 months after receipt of the telephone counseling, the investigators reviewed participants' charts to determine whether CRC tests had been completed. This study found no difference in overall screening rates between the intervention and control groups (25 percent versus 24 percent; $P = 0.68$).

Although the third study, described previously under patient reminders, found that groups that received some form of reminder were more likely to complete screening than those who received usual care ($P = 0.001$ or 0.002), the researchers did not find differences among the intervention groups to indicate whether patients who receive various types of small media interventions (i.e., print or telephone) were more (or less) likely to complete CRC screening.

Small media: decision aids. *Study characteristics*. As shown in Table 37, three RCTs, one rated as good quality[178] and the other two as fair,[177,181] used decision aids to help patients make informed decisions about CRC testing and the type of test to request. All three studies focused on patients 50 years of age or older; they either were attending appointments at an internal medicine practice[181] or a primary care practice[177] or were selected through a random sample of local residents living in urban, suburban, or rural communities.[178]

One primary care study compared an intervention group viewing an 11-minute CRC screening video decision aid followed by a brochure for the patient and a colored chart marker for the physician with a control group viewing an automobile safety video with no colored chart marker placed in the record.[177] The other primary care study randomized participants to either an interviewer-administered printed decision aid (modeled on the analytic hierarchy process) or to printed CRC screening educational materials.[181] The third study, which included only participants familiar with computers, compared a computerized, interactive decision aid with a standard informational, noninteractive website concerning CRC.[178]

All three studies had control groups comprising patients who got some type of exposure to a CRC-related website,[178] to an unrelated topic,[177] or to basic information about CRC.[181] Two of the three studies had comparison or control groups that received some form of CRC education.[178,181] Time to followup among the studies ranged from 2 to 3 months[177,181] to 24 weeks.[178] Two studies assessed the outcome of completed screening of any test through medical chart review;[177,181] the third used follow-up telephone interviews.[178]

Overview of results. Results from the three decision aids studies are mixed. One study demonstrated a statistically significant increase in CRC test completion[178] (23 percent difference; OR, 3.23; 95% CI, 2.73-3.50; $P = 0.035$). Another showed an increase in completion of CRC testing in the intervention group compared with the control group (14.2 percentage point difference; 95% CI, 3.0-25.4 percentage points).[177] This same study demonstrated that a higher proportion of patients in the intervention group than the control group reported discussing CRC screening with their provider during their appointment (68.5 percent and 43.4 percent, respectively; 25.1 percentage point difference; 95% CI, 12.7-37.6 percentage points). By contrast, the third study reported no significant difference in CRC test completion between the intervention and control groups.[181]

Table 37. Studies of small media: Decision aids on increasing colorectal cancer screening rates

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Study Groups	Results
Ruffin et al., 2007[178] RCT, 24 weeks Residents in Michigan N = 174 Good	Test interactive website, Colorectal Web, to aid in decision-making of types of test to complete	G1: Participants completed baseline assessments and then were given a laptop to access interactive website, with posttest then administered (n = 87) G2: Same as G1 except asked to access a standard, noninteractive format website (n = 87)	G1: 56% completed any CRC test (23 percentage point difference; AOR, 3.23; 95% CI, 2.73-3.50; *P* = 0.035) G2: 33% completed any CRC test
Dolan and Frisina, 2002[181] RCT, 2 to 3 months Internal medicine practice in New York N = 95 Fair	Test a decision aid designed to help patients choose among currently recommended CRC tests	G1: Detailed written materials given to patients to explain the different CRC screening options (n = 49) G2: standardized interview consisting of a brief description of CRC (n = 46)	G1: 49% completed any CRC screening G2: 52% completed any CRC screening (*P* = 1.0)
Pignone et al., 2000[177] RCT, 3 months Three community primary care providers in North Carolina N = 249 Fair	Test whether a decision aid consisting of an educational video, targeted brochure, and chart marker increased CRC screening	G1: Video about CRC screening options, and a brochure about CRC screening (n = 125) G2 (control): Video about traffic safety (n = 124)	G1: 68.5% reported conversations with provider about CRC screening; 36.8% completed any CRC test G2: 43.4% reported conversations (25.1 percentage point difference; 95% CI, 12.7-37.6%); 22.6% completed any CRC test (14.2 percentage point difference; 95% CI, 3.0-25.4%) (*P* NR)

AOR, adjusted odds ratio; CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; G, group; N, sample size; NR, not reported; RCT, randomized controlled trial.

Detailed results. The good-quality study obtained a random sample of residents 50 years of age or older who live in urban, suburban, or rural communities in Michigan.[178] The investigators first contacted potential participants by telephone and screened for their computer knowledge to ensure that participants could adequately search the websites in the study and meet other eligibility criteria. Participants were then scheduled for an appointment at a local community site for review of the websites. Participants were randomly assigned to view and explore one of two sites: (1) an interactive password-protected website, Colorectal Web (http://colorectalweb.org), which was designed to aid in their decision of types of CRC tests to obtain or (2) a standard, noninteractive informational website (control group) with similar content as the intervention website. During the computer sessions, participants were asked to review as much of the website as they desired. At the end of the session, participants completed a questionnaire specific to their preference for testing and decision phase of choosing to get screening. All participants were interviewed by telephone 2, 8, and 24 weeks after review of the websites to determine their intention to get screened and whether they had received any CRC test. Participants in the

intervention group were more likely to have completed any CRC test within 24 weeks (56 percent) than the control group (33 percent) (AOR, 3.23; 95% CI, 2.73-3.50; $P = 0.035$).

The remaining two studies, rated fair quality, also tested different types of small media in aiding patient decisionmaking.[177,181] One study provided written materials to patients assigned to the intervention arm who were at an appointment at an internal medicine practice in New York.[181] Within a few days before a scheduled appointment with a provider, the consenting patients in the intervention group received short descriptions of CRC and the five types of screening tests available to them and completed a baseline survey. Trained interviewers also guided this group through an analytic hierarchy process specifically designed to help them make decisions that require integration of quantitative data with less tangible, qualitative considerations such as values and preferences. The control group was first interviewed face-to-face at the time of their appointment where the interviewer provided them with a brief description of CRC and asked them to complete the same survey as the intervention group. All patients were then urged to discuss CRC screening with their provider. After their visit, all patients were asked whether they discussed the screening with their provider and whether a decision had been made. A majority of all patients (88 total or 93 percent) indicated that they had discussed CRC screening with their provider, but the intervention group was no more likely than the control group to have completed any CRC test.

The study testing whether a video decision aid given to patients at the time of a primary care appointment in North Carolina would increase screening rates reported similar findings.[177] Three primary care practices with a total of nine physicians agreed to participate in the study. For study recruitment, patients were contacted by phone before a scheduled appointment and asked to participate. The intervention group for this study was asked to watch an 11-minute video on CRC that included information about susceptibility to CRC and availability of screening tests, specifically the FOBT and FS. The video included vignettes of patients who discussed their experiences with CRC screening. At the conclusion of the video, the patients were asked about their intent to request screening and then provided one of three color-coded brochures that were designed to provide information based on a person's intention to obtain screening. The researchers placed a laminated card with the same color as a patient's brochure in the patient's chart before he or she was seen by the provider. Patients in the controls watched a video of similar length on car safety and received a related brochure. No cards were attached to their charts. During the appointment, patients were asked to complete three surveys: one at baseline before seeing a video; one after viewing the video; and one after seeing the provider to assess whether a conversation about CRC occurred. The investigators completed medical record reviews within 3 months of the visits to determine whether CRC tests had been completed. The outcome reported related to discussions was whether a test was ordered. In the intervention group, 68.5 percent of patients and 43.4 percent of control group patients reported some conversation with their provider about CRC screening (25.1 percentage point difference; 95% CI, 12.7-37.6 percentage points). Screening tests were completed by 36.8 percent in the intervention group and 22.6 percent of the control group (14.2 percentage point difference; 95% CI, 3.0-25.4 percentage points).

Group education interventions. *Study characteristics*. Two RCTs tested an intervention to educate Native Hawaiians who are members in local civic clubs about the importance of CRC screening[184] or were trained to educate their fellow church members in rural predominantly African-American churches[185] (Table 38). In one study, civic clubs were randomly selected for the intervention and either a Native Hawaiian physician and cancer survivor or a non-Native

Table 38. Studies of group education on increasing CRC screening rates

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Study Groups	Results
Braun et al., 2005[184] RCT, 16 week follow-up Civic clubs in Hawaii N=121 Fair	Test an intervention to improve CRC screening among Native Hawaiians	G1: Educational workshop delivered by Native Hawaiian physician and cancer survivor, FOBT kits provided, and follow-up reminder calls to submit test (n=69) G2: Educational workshop by non-Native Hawaiian nurse, FOBT test, 1 reminder call to submit test (n=52)	G1: 23 (33%) completed FOBT (41 were already up-to-date for CRC screening at baseline so n=28 eligible for screening) G2: 21 (40%) completed FOBT (36 were up-to-date at baseline so n=16 eligible to screen which means more were screened than needed to be) People in G1 were less likely to be screened than people in control group (AOR, 0.36; 95% CI, 0.14-0.97)
Campbell et al., 2004[185] RCT, 1 year follow-up African American churches in rural North Carolina N= 287 (50 years or older) Fair	Test an intervention to improve multiple health behaviors among rural African American church members	G1: TPV materials distributed to church members via mail (n= 76) G2: LHA trained within experimental churches to provide CRC information through existing networks (n=51) G3: Combination of TPV and LHA (n=87) G4: Speakers came to churches and offered educational workshops on a variety of topics (e.g., HIV/AID); provided members education materials (n=69)	G1: 36.8% received FOBT test; 21.1% received another CRC test G2: 33.3% received FOBT test; 25.5% received another CRC test G3: 31.0% received FOBT test; 14.9% received another CRC test G4: 21.7% received FOBT test; 27.5% received another CRC test Differences in group are not statistically significant (p=0.08 for FOBT).

AOR, adjusted odds ratio; CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; LHA, lay health advisor; G, group; N, sample size; NR, not reported; RCT, randomized controlled trial; TPV, tailored print and video.

Hawaiian nurse provided an education session on the need for screening and provided participants with FOBT kits.[184] Any participants ages 50 or older were included in the intervention. The study followed participants over a 16-week period and used reports from the laboratory that received completed FOBTs to determine whether they had completed a FOBT kit. The second study targeted African-American churches in rural North Carolina with the aim of improving nutrition, exercise, and CRC screening.[185] Any church members within an intervention site could participate, but only those 50 years or older were targeted for CRC screening. The group education consisted of training volunteers to serve as lay health advisors, who then agreed to conduct group education sessions within their church over the 1-year study period. Outcomes for both studies were assessed through self-reported screening rates, with both focusing on FOBT completion rates as their primary outcome.

Overview of results. One study demonstrated a negative finding: those in the control group were statistically significant more likely to have completed a FOBT over the 16-week study period than those in the intervention group (AOR, 0.36; 95% CI, 0.14-0.97).[184] The second study found no difference between those who received group education and those in control churches (P = 0.08).[185]

Detailed results. The study based in Hawaii involved members of local civic clubs who were provided with an educational session specific to CRC screening at one of their regularly scheduled meetings.[184] The control group received the education from a non-Native nurse who addressed topics specific to CRC screening and the importance of screening among Native Hawaiians. She then distributed a FOBT kit along with basic instructions on completing the test, and a phone number of local providers they could contact for assistance. Within a month of the presentation, if a completed FOBT kit had not been received from participants, one reminder call was made to each and a replacement FOBT kit was mailed upon request. The intervention group differed in that the presenter at the workshop included a physician and survivor who were both Native Hawaiian. Participants in this group were also provided a FOBT and a demonstration on how to complete the test was also presented by the physician. Between 4 and 16 weeks after the presentation, multiple telephone calls were made to those who had not completed the FOBT kit and replacement kits were provided upon request. Information on the frequency and intensity of these reminder calls is not provided by the authors so this study is not categorized as one providing patient reminders since we were unable to determine the extent to which the control and intervention groups differed on this aspect of the intervention. The outcomes for the study were determined through copies of the FOBT results received from the laboratory that tested them. Overall, the authors reported that people in the intervention group were less likely to complete a FOBT than people in the control group (33 percent compared to 40 percent, respectively).

The study based in rural churches in North Carolina included two components of interventions, one that involved small media which is described elsewhere and a second that included training church members to serve as lay health advisors and conduct group education sessions with their peers.[185] Church members were asked to recommend people to serve as lay health advisors, who were then invited to attend a series of trainings. A total of 62 such advisors (47 women, 15 men) from six churches were trained through six sessions. The training included information specific to CRC screening, available tests, and a detailed training manual was provided to each participant. In addition to providing information to peers through existing social networks, the lay health advisors were expected to organize and conduct at least three church-wide activities focused on spreading information about nutrition, exercise, and/or CRC screening. Findings indicated that churches where these advisors were present were no more likely to have members who received FOBT or any CRC test than control churches. In addition, some churches included both tailored or small media education combined with lay advisors, but this combination produced no effect compared with a control group.

One-on-one interactions. *Study characteristics.* Three RCTs, two rated as good quality[179-180] and the other as fair quality,[85] tested one-on-one interactions with patients as a way to increase screening rates (Table 39). Interactions involved a nurse who conducted[85] a series of telephone calls to participants of a health plan,[180] and a health educator.[179] Two studies were conducted within a primary care or community clinic setting and relied on medical chart review for screening outcomes;[85,179] the third worked with a random sample of participants in a health benefit fund.[180] Two studies included patients who had not yet agreed to screening;[179-180] the other involved patients who had agreed to FOBT screening.[85] In two studies populations included those 50 years of age or older determined to be in need of screening based on national guidelines;[85,179] the third study focused on those 52 years of age and older who were self-reported as not current on their CRC screening (i.e., no FOBT in past 2 years, no FS in past 5

years, or no colonoscopy or barium enema in past 10 years).[180] All three studies were in urban settings; one had about two-thirds African-American participants,[180] another had about one- third

Table 39. Studies of one-on-one interactions on increasing colorectal cancer screening rates

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Study Groups	Results
Basch et al., 2006[180] RCT, 6 months Members of a New York health benefit fund that includes CRC screening coverage N = 456 Good	Test the effectiveness of a telephone outreach approach versus a direct mail approach in a predominantly African-American population	G1: Tailored telephone outreach by a health educator through repeated calls (median = 5) to educate patients on the need for screening and build their self-efficacy in obtaining screening (n = 226) G2: Mailed package that included a letter and brochure about CRC screening (n = 230)	G1: 27% received any CRC test (n = 61) G2: 6.1% (n = 14) Rate difference = 20.9 percentage points; 95% CI, 14.34-27.46 RR 4.4 (2.6-7.7) (*P* NR)
Tu et al., 2006[179] RCT, 6 months Community clinic in Seattle, Washington N = 210 Good	Test a clinic-based, culturally and linguistically appropriate intervention promoting FOBT screening	G1: Bilingual materials including motivational video on CRC screening, pamphlet, FOBT instruction sheet, CRC informational pamphlet, CRC screening education from a health educator, and FOBT kit with instructions in Chinese and English (n = 105) G2: Usual care (n = 105)	G1: 69.5% received FOBT screening G2: 27.6% received FOBT screening (AOR, 6.38; 95% CI, 3.44-11.85) (*P* NR)
Stokamer et al., 2004[85] RCT, 6 months Primary care clinic at a VA in NYC N = 788 Fair	Test whether intensive patient education increases FOBT card return rates	G1: Educational session of 10 to 15 minutes with nurse, FOBT kit (n = 396) G2: Usual care (includes FOBT kit) (n = 392)	G1: 65.9% returned FOBT cards G2: 51.3% returned FOBT cards (*P*<0.001)

AOR, adjusted odds ratio; CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; G, group; N, sample size; NR, not reported; NYC, New York City; *P*, significance/probability of finding; RCT, randomized controlled trial; RR, relative risk; VA, veterans administration.

African-American participants,[85] and the third comprised almost entirely Chinese participants.[179] The time periods of each study varied: the one involving nurses[85] and the one targeting the health benefit fund followed patients for 6 months, [180] and the one with a culturally and linguistically sensitive health educator spanned a 14-month period from the initial interaction with patients.[179] The two studies based in a clinic included control groups that received usual care,[85,179] while the control group for the study of health benefit fund participants received print materials in the mail, which included a brochure about CRC and available screening tests.[180] All three studies relied on medical records review for measuring the outcome of completion of CRC screening, with one study first collecting self-reported data that was then compared with claims data in the health benefit fund database.[180]

Overview of results. All studies found statistically significant positive effects of their interventions. In the study of patients who had agreed to FOBT screening, 65.9 percent of intervention patients and 51.3 percent of the usual care group ($P < 0.001$) returned the FOBT cards; the median time to return the cards was shorter in the intervention group (36 versus 143 days, $P < 0.001$).[85] In the study of Chinese patients considering CRC screening, 69.5 percent of intervention versus 27.6 percent of control patients had completed FOBT screening (AOR, 6.38; 95% CI, 3.44-11.85).[179] The third study, which provided intensive telephone counseling to participants of a health benefit fund, also demonstrated statistically significant differences in completion of any CRC test (rate difference = 20.9 percentage points; 95% CI, 14.34-27.46 percentage points).[180]

Detailed results. The good-quality study of telephone outreach compared these participants to a group of patients who received only a mailed brochure with information about CRC and available screening tests.[180] The sampling frame for the study included persons 52 years of age or older who were members of a health benefit fund that included CRC screening as a benefit. Potential participants were first contacted by telephone to assess their interest in the study and then randomly assigned to receive telephone education or print education. The control group was mailed a letter along with a print brochure that included information about CRC, how it can be prevented, and descriptions of screening tests. The participants were instructed to talk with their providers to seek screening. The intervention group received tailored telephone outreach that began within 2 weeks of randomization. A series of semistructured telephone calls were then conducted with the participant to discuss CRC screening and provide positive reinforcement for obtaining a screening test. The frequency and duration of calls varied, with a median of 5 calls to each participant and a median of 23.5 minutes with each participant. The topics of these calls included establishing a trusting rapport with participants, reinforcing accurate knowledge about CRC and screening, correcting misconceptions, and bolstering motivation to obtain CRC screening. All participants were contacted 6 months after randomization by telephone to obtain information about whether they had obtained any CRC screening test (i.e., single office FOBT, home FOBT, FS, or colonoscopy). This self-reported information was verified either through medical records from each participant's provider or through the health benefit fund's billing system. Patients who received tailored outreach were more likely to be screened than those that received only the mailed brochure (27 percent and 6.1 percent, respectively; RR, 4.4; 95% CI, 2.6-7.7).

The study that explored the role of nurses in encouraging completion of FOBT provided patients in the intervention arm with 10- to 15-minute educational sessions conducted by a nurse specifically trained for this intervention.[85] All patients had been referred by their physician to primary care nursing for education and distribution of FOBT kits. The intensive session included providing patients with a two-page informational handout on FOBT and CRC. The session also provided verbal instructions on how to perform an FOBT and explanation of the meaning of different results. The nurse answered questions and instructed the patients to return the FOBT cards within 2 weeks and/or call with any questions. Patients randomly assigned to the control group received usual care, which consisted of receipt of FOBT kit that included written instructions and no individual session with a nurse. The outcomes for the study were assessed through medical record review 6 months after the patient's appointment to determine whether the patients had returned FOBT cards. The intervention group was more likely to return FOBT cards than the control group (65.9 percent and 51.3 percent, respectively, $P < 0.001$).

In another study, predominately Chinese patients who had not yet agreed to screening attended an intensive education session with health educators who provided culturally and linguistically appropriate (78 percent of participants spoke Cantonese and 21 percent spoke Mandarin) education about CRC screening, including a motivational video, printed material, and FOBT kit.[179] Patients were randomly selected for participation through the electronic medical database and mailed bilingual letters signed by the medical director of the two participating clinics to invite them to participate. The health educator then tracked appointments through the clinic electronic scheduling system and met face-to-face with prospective participants during their visit. Patients who agreed to participate either received usual care (no CRC information) or were asked to meet with the health educator who distributed the educational materials. Those patients assigned to the intervention group were able to watch the video at the clinic office or take it home. The control group received usual care but the study did not specify whether usual care included provision of an FOBT kit with bilingual instructions. The investigators assessed return of FOBT cards within 6 months of randomization through electronic medical records; this outcome was increased in the intervention group when compared with the control group (69.5 percent and 27.6 percent, respectively; OR, 6.38; 95% CI, 3.44-11.85).

Eliminating structural barriers. *Study characteristics.* This category includes five studies (Table 40); two were described under patient reminders;[85,175,179,183] two under one-on-one interactions;[85,175,179,183] and is described here in detail.[187] All provided FOBT kits as a means to improve access to screening tests. One study also attempted to address cultural and linguistic barriers among an Asian population of patients.[179] We rated two studies as good quality[179,187] and others as fair.[85,175,183] All five studies included people 50 years of age or older in their samples; one study specified an upper range of 79 years for study participants.[187]

Table 40. Studies of interventions to eliminate structural barriers on increasing colorectal cancer screening rates

Author, Year **Study Design** **Population** **Setting** **Sample Size** **Quality**	**Study Aims**	**Study Groups**	**Results**
Potter et al., 2009[187] RCT, 6 month follow-up Family health center in San Francisco, California N= 514 Good	Determine whether providing FOBT kits during influenza season can contribute to higher CRC screening rates.	All patients were mailed multi-lingual flu shot information G1: Patients received a FOBT kit and instruction sheet at the time they obtained a flu shot (n=268; only 143 received FOBT kit since rest were ineligible due to being up-to-date for screening) G2: Patient received flu shot only (n=246)	G1: 83 (68.0%) became up-to-date with any CRC screening at follow-up (29.8 percentage point change from baseline; 95% CI, 23.7- 36.0) G2: 24 (20.7%) became up-to-date with any CRC test (4.4 percentage point change; 95% CI, -0.7- 9.7) *P* < 0.001
Tu et al., 2006[179] RCT, 6 months Community clinic in Seattle, Washington N = 210 Good	Test a clinic-based, culturally and linguistically appropriate intervention promoting FOBT screening	G1: Bilingual materials including motivational video on CRC screening, pamphlet, FOBT instruction sheet, CRC informational pamphlet, CRC screening education from a health educator, and FOBT kit with instructions in Chinese and English (n = 105) G2: Usual care (n = 105)	G1: 69.5% received FOBT screening (AOR, 6.38; 95% CI, 3.44-11.85) G2: 27.6% received FOBT screening (*P* NR)

CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; G, group; N, sample size; NR, not reported; NYC, New York City; AOR, adjusted odds ratio; RCT, randomized controlled trial; VA, veterans administration.

Table 40. Studies of interventions to eliminate structural barriers on increasing colorectal cancer screening rates (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Study Groups	Results
Church et al., 2004[183] RCT, 1 year Residents, 50 years of age or older, of Wright County, Minnesota N = 1,255 Fair	Test direct mailing of FOBT kits with and without reminders to general population	G1: (no reminders) Questionnaire mailed plus FOBT kit and instructional brochure (n = 434) G2: (reminders) Same package as G1, plus telephone reminders (n = 404) G3: Questionnaire only (n = 417)	G1: 16.9% FOBT completion rate (95% CI, 11.5-22.3%) G2: 23.2% FOBT completion rate (95% CI, 17.2-29.3%) G3: 1.5% FOBT completion rate (95% CI, -2.9-5.9%) (*P* NR)
Myers et al., 2007[175] RCT Primary practice patients in Philadelphia, Pennsylvania N = 1,546 Fair	Test targeted and tailored message delivery, both by mail and via phone outreach	G1: "Standard Intervention" (SI) of mailed letter, information booklet, FOBT kit, and reminder letter (n = 387) G2: Standard intervention package plus 2 "tailored message pages" (TI) (n = 386) G3: SI plus TI, and a reminder phone call (TIP) by an educator (n = 386) G4: (control) Usual care (n = 387)	G1: 46% screening rate (AOR, 1.7; 95% CI, 1.2-2.5) G2: 44% (AOR, 1.6; 95% CI, 1.2-2.1) G3: 48% (AOR, 1.9; 9.5% CI, 1.4-2.6) G4: 33% (P NR)
Stokamer et al., 2004[85] RCT, 6 months Primary care clinic at a VA in NYC N = 788 Fair	Test whether intensive patient education increases FOBT card return rates	G1: Educational session of 10 15 minutes with nurse with FOBT kit provided with verbal instructions (n = 396) G2: Usual care, including FOBT kit provided with written instructions (n = 392)	G1: 65.9% returned FOBT cards G2: 51.3% returned FOBT cards (*P*<0.001)

Four of these studies took place in primary care settings or clinics.[85,175,179,187] All four used control groups that received usual care, and all assessed their outcomes through medical record review. The timing of followup of these four studies in this category was 6 months,[85] 9 months,[187] 14 months,[179] and 24 months.[175] One good-quality study provided primarily Chinese-Americans patients from a primary care clinic with access to a health educator and culturally and linguistically appropriate education materials, including bilingual instructions for FOBT.[179] Another good-quality study provided patients obtaining annual flu shots in a family health clinic with a FOBT kit.[187] One fair-quality study used a nurse to provide intensive counseling to patients who had agreed to FOBT.[85] The final study divided patients into three groups that received varying levels of tailored materials to encourage screening.[175]

The fifth study provided a random sample of residents in an urban area with a letter that included a questionnaire about CRC and screening tests.[183] These investigators then gave FOBT kits to two intervention groups with through the mail; one group received reminders to complete the FOBT and the other received no reminders. The investigators assessed screening rates through self-reported information obtained on a follow-up survey mailed to all participants 1 year after the start of the study.

Overview of results. In all five studies completion of screening by FOBT rose as a result of the interventions (14.6 to 41.9 percentage point increases in screening by FOBT). The study that used a culturally and linguistic appropriate intervention demonstrated the largest increase in screening among the studies in this section (41.9 percent). Findings from four studies demonstrated that interventions to eliminate barriers were effective in increasing CRC screening by FOBT;[85,179,183,187] the fifth did not present findings specific to FOBT completion but rather demonstrated an increase in overall CRC screening rates.[175]

Detailed results. Four of the five studies in this category were described above. One good-quality study exposed patients of Asian origin to a culturally and linguistically sensitive educator.[179] Predominately Chinese patients who had not yet agreed to screening attended an intensive education session with health educators who provided culturally and linguistically appropriate education about CRC screening, along with a FOBT kit. The difference in return rates of FOBT cards between the intervention and control groups was statistically significant (AOR, 6.38; 95% CI, 3.44-11.85).

The second study compared groups getting an FOBT both with and without telephone reminders with a control group.[183] FOBT-specific findings demonstrated a statistically significant difference between the control group (1.5 percent; 95% CI, -2.9 - 5.9 percent) and both intervention groups (respectively 23.2 percent [95% CI, 17.2-29.3 percent] and 16.9 percent [95% CI, 11.5-22.3 percent]), for an overall difference in FOBT completion rates as high as 21.7 percentage points.

The third study compared groups getting three different types of interventions of varying intensity with a usual-care control group.[175] All three intervention groups received FOBT kits. The control group had a 33 percent completion rate of any CRC screening test; the three intervention groups had the completion between 44 percent and 48 percent (G1: AOR, 1.7; [95% CI, 1.2-2.5]; G2: AOR, 1.6 [95% CI, 1.2-2.1]; G3: AOR, 1.9 [95% CI, 1.4-2.6]) (*P*-values were not reported).

The nurse-based study provided patients in the intervention arm with 10- to 15-minute educational sessions conducted by a nurse specifically trained for this intervention.[85] The percentage of individuals returning FOBT cards was higher in the intervention group than the control group (65.9 percent versus 51.3 percent; $P < 0.001$).

The fifth study was conducted in a family health center in San Francisco, California.[187] Patients of the clinic (ages 50-79) were mailed multilingual flu shot campaign information and were given dates for obtaining flu shots. Half of the days were randomly selected in blocks of 2 or 3 for provision of flu shots only (control group) or flu shots with FOBT kits (intervention group). Before each flu shot clinic, investigators gave clinic staff a list of patients with appointments who were eligible for a FOBT. Patients were given a handout at the clinic to explain the need for regular CRC testing and then a FOBT kit after their flu shot (along with instructions in several languages). Patients were telephoned if they had not returned a completed kit at 3 weeks and again (if needed) at 6 weeks. FOBT screening rates in the control group increased by 4.4 percentage points from 52.9 percent at baseline to 57.3 percent ($P = 0.07$) they

rose in the intervention group by 29.8 percentage points from 54.5 percent to 84.3 percent ($P < 0.001$); this yielded a 25.4 percentage point difference between groups ($P < 0.001$).

Provider-level interventions. *Study characteristics.* Two RCTs, both rated good quality, addressed reminder interventions targeted at provider behaviors or practices (Table 41).[186,188] In

Table 41. Study of an intervention to target provider behavior for increasing colorectal cancer screening or followup rates

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Study Groups	Results
Ayanian et al., (2008)[188] RCT, 6 months N = 141 physicians and 717 patients Primary care practice in Massachusetts Good	Determine whether surveillance colonoscopy can be increased among overdue patients by reminders to their primary physicians	G1: Letters to physicians to notify them of potential need for colonoscopy (n = 358) G2: Usual care (n = 359)	G1: 9.2% completion rate for colonoscopy within 6 months G2: 4.5% completion rate ($P = 0.009$)
Sequist et al., 2009[186] RCT, 15 month follow-up 11 Ambulatory Health Care Centers in Massachusetts N= 110 physicians, 21,860 patients Good	Test an intervention that provided both patient and provider reminders for screening.	G1: Patients were mailed a package to remind them of need for CRC screening that included a FOBT kit, letter and pamphlet, and a telephone number they could call to make an appointment for endoscopy (n=10,930) G2: Usual care for patients (n=10,930) G3: Providers were given electronic reminders during office visits that patients were overdue for screening (n=10,912 patients) G4: Usual care such that providers received no reminders (n=10,948)	G1: 25.4% FOBT completion; 44% completed any CRC test G2: 20.4% FOBT completion ($P < 0.001$); 38.1% completed any CRC test ($P < 0.001$) G3: 41.9% completed any CRC test G4: 40.2% completed any CRC test ($P = 0.47$) Interaction effect between the patient and provider interventions was small and not statistically significant (-0.6%; 95% CI, -1.2%- 0.1%; $P = 0.08$)

G, group; N, sample size; *P*, probability/significance of findings; RCT, randomized controlled trial.

one case providers were reminded during an office visit that a patient was overdue for CRC screening;[186] in the other, reminder cards informed primary care physicians when a patient scheduled for an appointment (identified through medical record review) might need CRC followup.[188] The outcome of obtaining CRC screening or adherence to repeat colonoscopy was assessed through electronic medical record review within 6 months of mailing the initial letter to physicians for one study or 15 months after the study was initiated.[186] Both studies compared patients whose physicians received specific reminders with those who received usual care.

Overview of results. One study demonstrated only minimal increase in CRC screening among patients with providers who received reminders compared with those who did not (41.9 percent

versus 40.2 percent; $P = 0.47$).[186] The other study reported a small increase in completion of colonoscopy within 6 months among patients whose physicians received the reminders (9.2 percent versus 4.5 percent; $P = 0.009$).[188]

Detailed results. One study focused on patients who may need surveillance colonoscopy and had received a prior colonoscopy with one or more adenomas detected but did not have a subsequent colonoscopy within 5 years.[188] The researchers sent physicians (n = 141) in two networks letters via interoffice mail to notify them of the potential need of a surveillance colonoscopy for the patients randomized to the intervention arm (n = 358). The investigators did not report the number of physicians who mailed letters to the patients in the intervention arm; 6 months after the letters were initially sent to the physician, the researchers reviewed medical records to determine whether colonoscopies had been completed. At the same time, they also sent letters to physicians of patients in the control group to ensure that physicians were aware of the potential need for colonoscopy if clinically appropriate. Completion of colonoscopy was higher among patients whose physicians received reminders related to surveillance than among those in the control group (9.2 percent versus 4.5 percent; $P = 0.009$). The authors did not report whether the letter to the physicians, the follow-up letter to patients if it were mailed, or a combination of both was the factor that actually raised surveillance rates.

The second provider-level patient reminder study involved 11 ambulatory health care centers in Massachusetts and targeted patients overdue for CRC screening.[186] The investigators paired physicians with similar patterns of screening rates and referrals and then randomized one to receive the intervention. Throughout the 15-month study period, physicians in the centers received electronic reminders during office visits with patients overdue for screening. Before the intervention, the investigators educated physicians in both the intervention and control group on the use of the reminder system. Physicians could view the passive alert at any point during an office visit; those who received active alerts were required to acknowledge it before making any electronic orders. These active alerts provided current information about prior CRC screening for the patients and provided a “1 click” option for ordering tests. Screening rates were similar among patients of physicians receiving the electronic reminders compared to the control group (41.9 percent versus 40.2 percent; $P = 0.47$).

System-level interventions. *Study characteristics.* Five RCTs, all rated fair quality, were classified as a system-level intervention because they explored the impact of various interventions that had been implemented within an office or health care setting with the direct aim of changing the system of care (Table 42). Three studies used a patient navigator to guide the process of obtaining a screening colonoscopy[189] or a Prevention Care Manager (PCM), similar to a patient navigator) to assist patients in addressing barriers to obtain any CRC screening;[162,193] two studies enhanced their systems of managing patients as they obtained other types of care.[190-192] All studies focused on patients 50 years of age or older; one limited the age range of patients to those no older than 79 years.[192] Three included only women.[162,190-191,193] All included patients of health clinics or primary care practices. One study compared women in their intervention group to women who received an intervention to increase mammography use;[162] the remaining four studies used patients receiving usual care as their control groups. Usual care included patients who were in the clinic for an office visit and did not receive exposure to the system level intervention. All but one study[192] specifically included patients from low-income areas to increase CRC screening rates among populations with generally low rates. The outcome of interest in one study was whether a patient completed FOBT within the 6-month follow-up period and/or got endoscopic screening if they met national guidelines for these tests;[189]another

focused on whether patients received an endoscopic screening procedure during the 1-year study.[192] The remaining studies assessed whether patients obtained any CRC test during the study period with the time for followup ranging from 11 months[162] to 24 months.[191] All outcomes were assessed through medical chart review.

Table 42. Studies of interventions to target the system level for increasing colorectal cancer screening rates

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Study Groups	Results
Dietrich et al., 2006[193] RCT, 21-month followup 11 community and migrant health centers in New York City N= 1,413 women overdue for screening Fair	Evaluate the effect of a telephone support intervention to increase rates of breast, cervical, and CRC cancer screening among minority and low-income women.	G1: PCM worked with patients to address barriers, including providing motivational intervention. Physician recommendations were provided to all patients via letter or in the office. Mailing of FOBT was done but data NR. (n = 706) G2: Usual care which included one single call to answer questions and advise of need for screening. (n = 707)	G1: 63% obtained any CRC test in follow-up period (0.24 point change from baseline) G2: 50% obtained any CRC test (0.11 point change from baseline) 0.13 point difference between G1 and G2 (95% CI, 0.07-0.19) (*P*<0.001)
Dietrich et al., 2007[162] RCT, 11-month followup Medicaid Managed Care Organization (MMCO) in New York City N= 626 women (50 years or older) Fair	Test a "prevention care management" approach to improve breast, cervical, and colorectal screening rates among enrolled women in a MMCO.	All received an intervention to receive reminder calls for a mammogram. In addition: G1: Prevention Care Manager (PCM) worked with patients to overcome barriers and schedule appointments (n = 317) G2: Affinity Mammogram Outreach Program (AMOP) followed up with all patients to provide additional educational materials on all cancer screenings and a follow-up telephone call to remind them of need for screening (n = 309)	G1: 32% up-to-date for any CRC test at follow-up G2: 25% up-to-date for any CRC test at follow-up (AOR, 1.69; 95% CI, 1.03-2.77) *P* = 0.04
Jandorf et al., 2005[189] RCT, 6 months Primary care provider in New York City N = 78 Fair	Test the effectiveness of a patient navigator in increasing screening colonoscopy.	G1: Patient navigator plus placement of FOBT card in chart (n = 38) G2: FOBT card placed in chart; physicians were asked to recommend screening to patients (n = 40)	G1: 23.7% completion rate for endoscopy; 42.1% for FOBT G2: 5% completion rate for endoscopy (*P* = 0.019); 25.0% for FOBT (*P* = 0.086)
Ling et al., 2009[192] RCT, 1 year follow-up N= 10 primary care group practices, 599 patients, Pittsburg, Pennsylvania N = 599 Fair	Evaluate methods to promote endoscopic screening in primary care practice.	G1: Enhanced management practices (including training of physicians and office staff; implement office protocols; motivational interviews to counsel patients; assist patient in overcoming barriers) with a tailored letter to patients (n = 152) G2: Enhanced management practices with no tailored letter to patient (n = 190) G3: Nonenhanced management practices (includes training of physicians and office staff,	G1: 81 (53.3%; 95% CI, 45.4-61.2) completed endoscopic CRC screening G2: 103 (54.2%; 95% CI, 47.1-61.3) completed endoscopic test G3: 58 (43.6%; 95% CI, 35.2-52.0) completed endoscopic test G4: 47 (37.9%; 95% CI, 29.4-46.4) completed endoscopic test Enhanced management practices yielded 1.63-fold increase (95% CI, 1.11- 2.41; *P* = 0.01)

CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; G, group; MMOC, Medicaid Managed Care Organization; N, sample size; NR, not reported; *P*, probability; PCP, primary care provider; RCT, randomized controlled trial.

Table 42. Studies of interventions to target the system level for increasing colorectal cancer screening rates (continued)

Author, Year Study Design Population Setting Sample Size Quality	Study Aims	Study Groups	Results
Ling et al., 2009[192] (continued)		writing of office protocols) with tailored letter to patients (n=133) G4: Nonenhanced management practices with no tailored letter (control group) (n=124)	
Roetzheim et al., 2004;[190] Roetzheim, et al., 2005[191] RCT (cluster randomized at clinic level), 12-month followup[190] and 24-month followup)[191] 8 county-funded clinics in Florida N= 1,196 at baseline; 1,237 at 12-month followup; 1,296 at 24-month followup Fair	Assess the efficacy of the Cancer Screening Office Systems (Cancer SOS) to increase cancer screening in primary care settings serving disadvantaged populations.	G1: Patients were asked to complete a cancer screening checklist to indicate which tests they were due to receive; stickers were then placed on charts to flag providers of need for screening; staff trained and unannounced audits done; formal feedback of screening rates given to practices at 6 and 12 months (each time point at different independent random samples drawn from medical records) (n=600) G2: Usual care (n=596)	G1: 40.1% FOBT completion rate G2: 11.9% FOBT completion rate AOR 2.56 for FOBT completion rate; 95% CI, 1.65-4.01 (*P*< 0.0001) at 12 months No effect on FOBT completion at 24 months (AOR 1.17; 95% CI, 0.92-1.48; *P*= 0.19)

Overview of results. All five studies found statistically significant increases in CRC screening rates for their tests of interest; absolute increases in screening ranged from about 5 percentage points to 28.2 percentage points. The screening colonoscopy study found a statistically significant increase in completed endoscopy at 6 months (23.7 percent versus 5.0 percent; $P = 0.019$).[189] The two studies that included a PCM providing assistance in addressing barriers to screening demonstrated similar findings: women in a Medicaid managed care organization had a 14 percent increase in screening rates when the PCM worked with them compared with a 9 percent increase in the control group ($P = 0.04$);[162] among women in community and migrant health care clinics in New York City receiving the intervention had a 13 percentage point difference in screening rates compared with the control group (AOR, 0.13; 95% CI, 0.07-0.19).[193] In the study of primary care practice patients who received enhanced office and patient management practices at randomly selected practices, the investigators reported a 1.63-fold increase in CRC screening among patients in the intervention clinics compared with those in control clinics (95% CI, 1.11-2.41; $P = 0.01$).[192] In the study that randomized patients at the clinic level to complete cancer screening checklists placed in their medical charts at the time of an office visit, along with a sticker flagging the provider for the need for screening, demonstrated that patients in the intervention group were 2.56 times more likely to obtain an FOBT at the 12-month followup than the control group (AOR, 2.56; 95% CI, 1.65-4.01; $P < 0.0001$),[190] but this effect was diminished at 24 months (AOR, 1.17; 95% CI, 0.92-1.48; $P = 0.19$).[191]

Detailed results. The studies using PCM staff to help patients obtain CRC screening were each conducted in New York City clinics: one in a Medicaid managed care organization (MMCO)[162] and the other in 11 community and migrant health care clinics.[193] Neither study provided racial or ethnic statistics of the women in their samples. The MMCO study involved women who were receiving an intervention of patient reminders to obtain mammography screening; it randomly assigned women to receive PCM assistance in obtaining CRC screening. The PCM assistance included a detailed script read to patients to explain the importance of CRC screening and types of available tests and assistance overcoming any barriers to screening, including making appointments for patients to receive tests.[162] Those in the comparison group received educational materials about CRC screening and one telephone call to recommend that they obtain CRC screening. At the 11-month followup, those in the group receiving PCM assistance were more likely than the women in the comparison group to be up to date with any CRC screening ($P = 0.04$). The other study (by many of the same authors) applied a similar intervention to a different setting.[193] In this study, PCMs received 7 hours of training for their role, worked with patients to overcome barriers, and provided motivational counseling during the study. For two of 11 centers, the PCM could also mail FOBT kits to patients; differences related to this aspect of the intervention were not reported. Those in the comparison group received usual care, which in the participating clinics included a single call to patients to answer any questions about CRC screening and advise them about the need to be screened. Those receiving PCM assistance were more likely than the control group to obtain CRC testing (0.13 difference in screening rates; 95% CI, 0.07-0.19).

For the study in which a patient navigator helped patients obtain screening colonoscopy, patients eligible for the study had been referred for CRC screening after an appointment with a primary care provider.[189] Patients were "navigated" in an effort to improve compliance with referrals to screening colonoscopy. Patients, from a federally qualified health center in New York City serving predominantly minority and low-income patients, were 50 years of age or older and eligible for CRC screening. More than 70 percent were female, about 80 percent were Hispanic, and less than half of the participants spoke English. Those patients randomly assigned to the intervention received patient navigation; those assigned to the control group received usual care, which included placement of an FOBT card in the patient's chart to remind his/her physician of the need for screening. The patient navigator contacted patients in the intervention group 2 to 3 weeks after the patient agreed to participate and provided education about CRC screening by telephone. The patient navigator continued to provide written reminders, further telephone calls, and scheduling assistance to the intervention group. Using completion of an endoscopic examination as a key outcome, the authors reported that patient navigation improved completion of these tests within 6 months of physician recommendation (15.8 percent compliance in the navigated group versus 5 percent in the nonnavigated group; $P = 0.019$).[189]

Another study focused on several aspects of providing enhanced office and patient management among 10 primary care practices in Pennsylvania to increase endoscopy screening.[192] All patients determined to be eligible for the study were mailed letters from their physicians recommending endoscopic CRC screening and asked patients to phone for an appointment. These letters were either tailored or nontailored; findings specific to this aspect of the intervention were discussed earlier in the "small media" category. Patients in the control group had office visits in practices that had received educational workshops for their physicians and office staff on improving CRC screening and written protocols on systematically implementing screening. Clinics randomly assigned to the intervention received this information

and assistance in implementing the office protocols and tracking patient acceptance of referral for endoscopic screening. The research team then conducted motivational interviewing with patients who had not obtained screening within 3 months after receiving a physician recommendation (by mail) to do so. During these interviews, staff worked with the patients to address any barriers to obtaining screening (e.g., scheduling appointments, obtaining transportation, addressing insurance needs). Medical records were reviewed within a year after the initial letter was mailed to assess screening rates. The study demonstrated a 1.63-fold increased odds of completing a colonoscopy or FS among patients in the intervention (95% CI, 1.11-2.41; $P = 0.01$).[192]

The results of the final study in this category were published in two articles; one presented 12-month findings[190] and the 24-month results.[191] In this study, the investigators randomized eight county-funded clinics in Florida as control or intervention sites. Patients receiving care at the control sites received usual care specific to CRC screening. Those receiving care at the intervention sites were asked to complete a cancer screening checklist at the time of an office visit. The checklist indicated the tests they had previously received and when each was obtained. Based on these responses, medical charts were flagged with stickers to indicate to the provider whether a patient was due for CRC screening. Before implementing this process, the research team also trained staff about the need for CRC screening. Throughout the 12-month study, the team also made unannounced visits to the clinics to conduct chart audits and then gave formal feedback to staff of their screening rates. They also abstracted data from medical records of independent random samples of patients at baseline and at each of the two follow-up periods to determine the extent to which patients had obtained CRC screening. At 12 months, the study demonstrated a 28.2 percentage point increase among patients receiving care at the intervention sites compared to the control sites (40.1 percent versus 11.9 percent; $P < 0.0001$).[190] At 24 months, the difference in screening rates across sites was smaller (28.2 percent versus 12.6 percent; $P = 0.19$).[190]

KQ 4: Current and Projected Capacity to Deliver Colorectal Cancer Screening and Followup

If efforts to increase screening rates for CRC are successfully implemented, providers and health care systems must be able to handle the resultant increased demand for services, particularly for endoscopic procedures, that will be needed both for primary screening and for follow-up of abnormal screening results from noninvasive screening strategies. Note that to avoid confusion over the use of the word ‘surveillance’, we refer to monitoring of patients after receipt of abnormal results as ‘followup’. As shown in the analytic framework (Figure 1, Chapter 2), capacity to deliver CRC screening is an important variable in determining the population-level benefit from screening. This key question (KQ) addresses the current and projected capacity of the health care system to deliver CRC screening and followup for the US population.

In this section we have defined key terms as follows:

- Current capacity (or current potential volume): the sum of current volume and additional available capacity, where:
  - Current volume is the estimate of the current number of FS or colonoscopy procedures conducted in the present year; and
  - Additional available capacity is the number of additional FS or colonoscopy procedures that could be conducted in the current year;

- Projected capacity: future capacity to conduct FS or colonoscopy under various scenarios such as changes in workforce or changes in the number of facilities that provide procedures;
- Ability to meet projected demand: the ability of current capacity (or projected capacity if known) to meet the projected demand under various demand scenarios, such as screening the entire eligible US population with a specific test.

Although this KQ gave priority to projected capacity of FS or colonoscopy, we found no studies that examined this topic. Most common were studies that provided estimates of current volume of FS or colonoscopy and compared those estimates with a projected demand. In this section, not only do we compile the varying estimates of current capacity and projected demand across studies and evaluate the strength of evidence of these estimates, but we also compare the estimate of current capacity based on multiple studies with that of projected demand, based on multiple studies. This approach enables us to answer better than heretofore the question of the nation's ability to meet projected demand.

In addition to the concepts defined above, we found data on current volume by provider type and geographic variation in current volume and additional available capacity.[61,195-197] Because these measures are related to our outcomes of current volume and additional available capacity, we have completed summary tables and text for these and included them as Appendix G.[§§] We also found four studies that report on current volume and additional available capacity in individual states.[61,195-196,198] Because results from these studies did not change our conclusions from the national data, we have included them as part of Appendix G rather than in the main text.

We present our overall summary and strength of evidence tables for studies addressing this KQ at the beginning of this section. The remainder of this section provides a more detailed assessment of the individual studies that informed our conclusions and our assessment of the strength of evidence.

KQ 4: Overall Summary and Strength of Evidence

In Table 43, our overall grades of the strength of evidence appear in the far right column; grades for key domains to determine the strength of evidence (risk of bias, consistency, directness, and precision) are in the intermediate columns. In assessing research specific to KQ 4 about capacity for increasing CRC screening, we ultimately had grades of only low strength of evidence. Low means that we have only low confidence that the evidence reflects the true effect; further research is likely to change the confidence in the estimate of effect and is likely to change the estimate.[31]

Overall, evidence suggests that FS current volume is not sufficient to meet projected demand if a significant proportion of the population is screened by either FS or FOBT/FS. Current volume of colonoscopy is likely to be sufficient to meet projected demand if a significant proportion of the US population is screened by FOBT or FS but not by colonoscopy. Based on one study's estimates of additional available capacity, current capacity for FS is sufficient for a screening program by FOBT/FS or FS alone, and current capacity for colonoscopy may be

[§§] Appendixes and Evidence Tables for this report are provides electronically at http://www.ahrq.gov/downloads/pub/evidence/pdf/crcuse/crcuse.pdf.

sufficient for a screening program by colonoscopy alone. All these estimates represent steady-state scenarios.

Table 43. Strength of evidence for the current and projected capacity to deliver CRC screening

Number of studies	Risk of Bias	Consistency	Directness	Precision	Results	Overall strength of evidence
Current capacity: FS						
Brown et al., 2003[195] Seeff et al., 2004[196]	Moderate 2 cross-sectional/1 Good, 1 Fair	Inconsistency present	Direct	NR	Current volume: 2.8-4.9 million FS Additional available capacity: 6.7 million FS	Low
Current capacity: COLON						
Brown et al., 2003[195] Hur et al., 2004[199] Seeff et al., 2004[196] Vijan et al., 2004[200]	Moderate 4 Cross sectional/1 Good, 3 Fair	Inconsistency present	Direct	NR	Current volume:1.6-6.6 million colonoscopies Additional available capacity: 8.2 million colonoscopies	Low
Ability to meet projected demand: FOBT Demand scenario						
Ladabaum and Song, 2005[201] Brown et al., 2003[195] Hur et al., 2004[199] Seeff et al., 2004[196] Vijan et al., 2004[200]	Moderate Capacity: 4 Cross sectional/1 Good, 3 Fair Demand: 1 Modeling/1 Good	Capacity: Inconsistent Demand: Consistency unknown (single study)	Indirect	NR	Current capacity: 9.8-14.8 million colonoscopies Demand: 3.8 million colonoscopies	Low
Ability to meet projected demand: FS Demand scenario						
Ladabaum and Song, 2005[201] Brown et al., 2003[195] Seeff et al., 2004[196]	Moderate Capacity: 2 Cross sectional/1 Good, 1 Fair Demand: 2 Modeling/1 Good, 1 Fair	Capacity: Inconsistency present Demand: No Inconsistency	Indirect	NR	Current capacity: 9.5-11.6 million FS Demand: 10 million FS	Low
Ladabaum and Song, 2005[201] Brown et al., 2003[195] Hur et al., 2004[199] Seeff et al., 2004[196] Vijan et al., 2004[200]	Moderate Capacity: 4 Cross sectional/1 Good, 3 Fair Demand: 1 Modeling/1 Good	Capacity: Inconsistency present Demand: Consistency unknown (single study)	Indirect	NR	Current capacity: 9.8-14.8 million colonoscopies Demand: 2.7 million colonoscopies	Low

Current capacity, current volume + additional available capacity.
COLON, colonoscopy; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy. NR, not reported

Table 43. Strength of evidence for the current and projected capacity to deliver CRC screening (continued)

Number of studies	Risk of Bias	Consistency	Directness	Precision	Results	Overall strength of evidence
Ability to meet projected demand: FOBT/FS Demand scenario						
Ladabaum and Song, 2005[201] Brown et al., 2003[195] Seeff et al., 2004[196]	Moderate Capacity: 2 Cross sectional/1 Good, 1 Fair Demand: 1 Modeling/1 Good	Capacity: Inconsistency present Demand: Consistency unknown (single study)	Indirect	NR	Current capacity: 9.5-11.6 million FS Demand: 6.9 million FS	Low
Ladabaum and Song, 2005[201] Hur et al., 2004[199] Seeff et al., 2004[196] Vijan et al., 2004[200]	Moderate Capacity: 4 Cross sectional/1 Good, 3 Fair Demand: 2 Modeling/1 Good, 1 Fair	Capacity: Inconsistency present Demand: Inconsistency present	Indirect	NR	Current capacity: 9.8-14.8 million colonoscopies Demand: 2.9-4.7 million colonoscopies	Low
Ability to meet projected demand: Colonoscopy Demand scenario						
Brown et al., 2003[195] Seeff et al., 2004[196] Vijan et al., 2004[200]	Moderate Capacity: 4 Cross sectional/1 Good, 3 Fair Demand: 3 Modeling/2 Good, 1 Fair	Capacity: Inconsistency present Demand: Inconsistency present	Indirect	NR	Current capacity: 9.8-14.8 million colonoscopies Demand: 4.8-8.1 million colonoscopies	Low
Ability to meet projected demand: Screening the unscreened using additional available capacity						
Seeff, et al., 2004[202]	Moderate 1 Cross sectional/1 Good	Consistency unknown (single study)	Direct	NR	Using 100 percent of additional available capacity, it would take 5 years to screen the unscreened population with colonoscopy	Low

If the US were to adopt a colonoscopy-only approach to CRC screening, either colonoscopy capacity would need to be substantially increased or at least 5 years would be required to do the "catch-up" screening required to screen people who have not been screened.

Overall capacity study characteristics. We found six studies (seven articles) of good or fair quality that reported national estimates of current capacity (current volume and/or available capacity), projected demand, and ability of current capacity to meet projected demand.[195-196,199-203] We rated one additional study as poor quality and did not include it because it did not

incorporate increased demand for surveillance colonoscopy following use of FOBT in its demand estimates.[204]

All six included studies reported on current volume or additional available capacity for one or more of the following screening procedures: FS, colonoscopy, or CT colonography. No study reported on these outcomes for FOBT, although FOBT screening is included in the various demand scenarios that are examined. Five of the studies (five articles) included estimates of both current and projected demand.[195,199-200,202-203] One article reported only estimates of current capacity (current volume as well as additional available capacity).[196] One study modeled only projected demand under different demand scenarios.[201] Among the five studies that reported on both capacity and demand, a single study can have different quality ratings for these two separate parts of the study.

Of the five studies (six articles) that report on current capacity, two studies obtained the data through national surveys, either of endoscopic facilities[196,202] or of endoscopic providers[195]; both sets of respondents reported on the number of FSs or colonoscopies they perform per week or month. These studies both reported on volume of both FS and colonoscopy, and one of the two reported on additional available capacity of FS and colonoscopy as well. Two studies,[199-200] which reported only on current volume of colonoscopy, conducted secondary analyses of a database from the Clinical Outcomes Research Initiative (CORI), a voluntary consortium of 400 endoscopists at 42 sites in 22 states. The final study, which reported on current volume of CT colonography, used secondary data on CT scanners in the United States for its estimates.[203]

Six studies that reported projected demand used a variety of mathematical models to do so. For their modeling, investigators used various refinements of population estimates, e.g., population growth, percentage of population that are at high risk because of family history or inflammatory bowel disease, and the percentage of the population ineligible for screening because of comorbid conditions. Also, a critical assumption in the modeling of demand that varied across these studies was the percentage of persons participating in screening overall; this figure ranged from 40 percent to 100 percent. A subset of key assumptions for each study is noted in the tables.

Overall capacity study results. Table 44 provides an overview of the results for KQ 4. In each row are the types of procedures for which the outcomes of capacity and demand were available (total FS, total colonoscopy, and screening colonoscopy); the columns contain the outcomes of current capacity (current volume and additional available capacity) and projected demand under various demand scenarios. For each demand scenario, we also present an assessment of whether current capacity is able to meet projected demand.

Studies varied in their estimates of current volume of FS procedures (2.8 million to 4.9 million) and screening colonoscopy procedures (1.6 million to 6.6 million) (Table 44). A single study provided estimates of additional available capacity of 6.7 million FSs and 8.2 million colonoscopies.

Results of the modeling studies suggest that current volume of FS is not sufficient to meet projected demand if a significant proportion of the population is screened by FS or FOBT/FS. Current volume of colonoscopy is likely to be sufficient to meet projected demand if a significant proportion (70 percent to 75 percent) of the US population is screened by FOBT or FS but not by colonoscopy. Only one estimate of additional available capacity is available; based on this study's results, current capacity for FS is sufficient for a screening program by FOBT/FS or FS alone. Based on this study's estimates of additional available capacity for colonoscopy,

Table 44. Overview of results of capacity studies

Type of Procedure	Current Capacity		Projected Demand: FOBT Scenario		Projected Demand: FS Scenario		Projected Demand: FS/FOBT Scenario		Projected Demand: Colonoscopy Scenario	
	Current Volume	Additional Available Capacity	Number	Able To Meet Demand?	Number	Able To Meet Demand?	Number	Able To Meet Demand?	Number	Able To Meet Demand?
FS (total)	2.8-4.9 million	6.7 million			10 million	Yes*	6.9 million	Yes*		
Colonos-copy (total)	4.0-14.2 million		3.8 million	Yes	2.7 million	Yes	2.9-4.7 million	Yes		
Colonos-copy (screening)	1.6-6.6 million	8.2 million							4.8-8.1 million	Yes*

FOBT, fecal occult blood test; FS, flexible sigmoidoscopy.
* If additional available capacity is included in calculations.

current capacity for colonoscopy may be sufficient for a screening program by colonoscopy alone.

All these estimates represent steady-state scenarios. None of these models incorporated current estimates of the unscreened. In the single study that modeled available capacity to screen the unscreened population, using 100 percent of additional available capacity, it would take 3 years at current screening patterns, 6 years using 100 percent FS or FOBT/FS, or 5 years using 100 percent colonoscopy to screen the unscreened population.

National-Level Estimates of Current Capacity of Endoscopy Screening

This section consists of two parts. We first describe the studies that present data on current volume of endoscopy screening. We next describe studies of additional available capacity of endoscopy.

Current volume of endoscopy. *Study characteristics.* Four studies provided national-level estimates of current volume of endoscopy; all four provided estimates for colonoscopy[195-196,199-200] and two also did so for FS (Table 45).[195-196] Two studies reporting estimates for both FS and colonoscopy[195-196] obtained the data through national surveys, either of endoscopic facilities[196] or of endoscopic providers.[195] In these studies the facility or provider reported the number of colonoscopies they perform per week or month. The remaining two studies,[199-200] which reported only on current volume of colonoscopy, report analyses of a database from the Clinical Outcomes Research Initiative (CORI), a voluntary consortium of 400 endoscopists at 42 sites in 22 states. The year for which current volume was reported in these studies varied from 2000 through 2003. Current volume in each of these studies was compared with projected demand (described in the section below, "National Estimates of Ability to Meet Projected Demand for Endoscopy, by Different Demand Scenarios").

We rated one study as good quality[196] and three studies as fair.[195,199-200] Two of the three rated fair quality[199-200] received this rating because they extrapolated data from a limited dataset of voluntary gastroenterologist physicians to estimate the number of colonoscopies performed by the entire number of gastroenterologists in the United States. The third study[195] was rated fair quality because of limitations in measurement of the outcome.

Table 45. National estimates of current volume of endoscopy screening

Author, Year Study Design Setting	Data Collection or Estimation	Results	Quality Rating for National Estimates of Current Volume
Seeff et al., 2004 (CDC)[196] Cross-sectional National sample of endoscopy practices	Current volume and additional estimated by survey of national sample of practices performing FS or colonoscopy	Current volume (2002): 2.8 million FSs 14.2 million colonoscopies 1.5 million FSs for screening (54%) 6.6 million colonoscopies for screening (47%)	Good
Brown et al., 2003 (NCI)[195] Cross-sectional and modeling National sample of physicians US population	Current volume estimated by survey of national sample of primary care physicians, gastroenterologists, and general surgeons	Current volume (2000): 4.9 million FSs 4.0 million colonoscopies 1.6 million colonoscopies for screening (40%) Average colonoscopies per month performed by: general surgeons, 8; gastroenterologists, 32	Fair
Hur et al., 2004[199] Secondary data analysis and modeling US population	Current volume of colonoscopy estimated from CORI database; 2001 data used and inflated to reflect national trends	Current volume (2003): 6.47 million colonoscopies 1.98 million colonoscopies for screening (29%)	Fair
Vijan et al., 2004[200] Secondary data analysis and modeling US population	Current volume of colonoscopy conducted by gastroenterologists estimated from CORI database; estimates were increased by 33% to include nongastro-enterologist providers	Current volume (2002-2003): Average 21 colonoscopies per endoscopist per month Estimated 1.27 million colonoscopies per year conducted by gastroenterologists for screening Estimated 1.69 million colonoscopies per year conducted by all types of providers 46% of colonoscopies for screening Average number of colonoscopies per month: 21 (range 0-102)	Fair

CORI, Clinical Outcomes Research Initiative; FS, flexible sigmoidoscopy.

Overview of results. Studies varied in their estimates of current volume of FS and colonoscopy. Differences between this study and the three fair-quality studies (giving data for, variously, 2000 to 2003) were greater for estimates of current volume of screening colonoscopy (1.6 to 6.6 million colonoscopies per year among four studies) than for FS (2.8 to 4.9 million per year in two studies). Differences may reflect differing methods of data collection or underlying issues of validity of self-report or report of volume by clinic administrators; they may also be consistent with increases in current volume of colonoscopy over a short period and concurrent decreases in current FS volume.

Detailed assessment, colonoscopy. In the good-quality study, authors from the Centers for Disease Control and Prevention (CDC) surveyed a national sample of 1,809 endoscopic facilities in the United States.[196] They identified practices using lists of facilities known to have purchased or leased lower endoscopic equipment between 1996 and 2000 and then screened practices by

telephone to ensure that they did in fact conduct CRC screening. A physician or clinic administrator completed this survey. The survey, which achieved a response rate of 74 percent, found that, in 2002, 6.6 million screening colonoscopies had been conducted.

Three studies rated fair quality produced similar estimates of the current volume of colonoscopy, but their results differed from those from the CDC study.[195,199-200] One study, conducted by the National Cancer Institute (NCI),[195] surveyed a national sample of primary care physicians, gastroenterologists, and general surgeons to estimate the current volume of colonoscopy among these providers nationally. The study did not adjust estimates of current volume for procedures by other types of providers. The NCI study estimated current colonoscopy volume in 2000 to be 4.0 million, including 1.6 million colonoscopies for screening. The two studies using data from the CORI database[199-200] reported results similar to those of the NCI study. The first found that, in 2003, the estimated current volume (provided by gastroenterologists alone) was 6.47 million colonoscopies, with 1.98 million for screening; [199] the second estimated that, in 2002-2003, the current volume for screening colonoscopy, adjusted to estimate colonoscopies done by all provider types, was 1.69 million.[200]

Several differences in methods may account for the widely varying estimates among the four studies. Results from the two CORI-based investigations are likely based on nonrepresentative data, as the dataset includes volunteer physicians participating in this registry. Of the two studies with the stronger methods, the CDC study was conducted 3 years later than the NCI study and asked for actual numbers of procedures; the NCI study gave categories for response with ranges such as “11-20 procedures.” The highest category was “more than 20 procedures” per month, which may have set a potentially inaccurate ceiling on numbers for very active endoscopists. The CDC study also surveyed endoscopy practices, whereas the NCI study surveyed three types of providers; thus, the latter study may have missed perhaps up to 8 percent of colonoscopies (based on data from the CDC study).

Studies varied as to whether the investigators included surveillance colonoscopies in estimates of current volume. In the two CORI studies, one included such procedures[200] and the other did not.[199] In the NCI study, the authors could not determine whether respondents classified followup procedures as screening or diagnostic.[195] (We contacted the author of the CDC study but received no response.) All four studies provided estimates of the percentage of all colonoscopies that are conducted for screening purposes: 29 percent,[199] 40 percent,[195] and 46 percent.[196,200] Two studies estimated the average number of procedures per month: 32 for gastroenterologists and 8 for colorectal surgeons[195] and, in another study, 21 for gastroenterologists.[200]

Detailed assessment, FS. Two estimates of current volume for FS were available. The NCI study estimated the 2000 current volume of FS at 4.9 million;[195] the CDC study estimated that the 2002 FS current volume was 2.8 million.[196]

Additional available capacity of endoscopy. *Study characteristics.* The CDC study reported on additional available capacity of FS and colonoscopy at the national level (Table 46).[196] This study was a survey of a national sample of 1,809 endoscopic practices; they reported the number of colonoscopies they perform per week and the weekly maximum number they could perform.

Table 46. National estimates of additional available capacity of endoscopy screening

Author, Year Study Design Setting	Data Collection	Results	Quality Rating
Seeff et al., 2004[196] Cross-sectional National sample of endoscopy practices	Additional available capacity estimated by survey of sample of practices performing FS or colonoscopy	Current volume (2002): 2.8 million FSs 14.2 million colonoscopies 1.5 million FS for screening (54%) 6.6 million colonoscopies for screening (46%) Additional available capacity: 6.7 million FSs (239%) 8.2 million colonoscopies (58%)	Good

FS, flexible sigmoidoscopy.

Overview of results. The CDC article reported additional available capacity in 2002 of 6.7 million for FS (239 percent of current volume) and 8.2 million for colonoscopy (58 percent of current volume).[196]

Detailed assessment. The CDC study asked respondents (clinic physicians or administrators) to estimate the weekly number of FSs and colonoscopies that the practice performed per week, and the weekly potential maximum the practice could perform. Available capacity was determined by subtracting the current volume from the maximum. For national estimates, these investigators imputed missing values of these numbers and incorporated weights into their analysis to make estimates generalizable to all US health care practices that use endoscopic equipment for CRC screening.

National Estimates of Ability to Meet Projected Demand for Endoscopy, by Different Demand Scenarios

Projected demand. *Study characteristics.* Six studies provided estimates at the national level of ability of current volume or additional available capacity to meet projected demand for endoscopy (

Table 47). Many of these studies evaluated ability to meet demand for colonoscopy, even under screening scenarios using FOBT or FS, as it is capacity for colonoscopy that is most likely restricted and is of most interest.

We rated three studies as good quality[195,201-202] and two studies as fair quality;[199,203] for a sixth study, we rated separate parts as good and fair.[200] The studies rated fair quality received this rating because of either the representativeness of the data used to estimate capacity or the assumptions made for modeling demand. We rated an additional study as poor quality and excluded it because it did not incorporate increased demand for surveillance colonoscopy following use of FOBT in its estimates.[204]

Two studies collected and analyzed survey data of physicians or endoscopic facilities to estimate current volume and additional available capacity.[195,202] Of the four other studies that estimated capacity, two studies used secondary data from a survey of endoscopic practitioners,[199-200] one study used secondary data providing the number of CT scanners,[203] and the final study modeled only demand and did not have estimates of current or additional available capacity.[201]

Table 47. National estimates of ability of current volume or additional available capacity of flexible sigmoidoscopy or colonoscopy to meet projected demand for endoscopy, by different demand scenarios

Author, Year Study Design Setting	Data Collection or Data Inputs for Capacity/Volume	Model Description to Project Demand	Results	Quality Rating
Demand scenario: all FOBT screening				
Ladabaum et al., 2005[201]	None	Current and projected demand (in various screening scenarios) estimated by Markov model	Assuming 75% uptake, demand for colonoscopy would be 3.8 million if all screening by FOBT	Good
Demand scenario: FS screening every 5 years				
Ladabaum et al., 2005[201]	None	Current and projected demand (in various screening scenarios) estimated by Markov model	Assuming 75% uptake, demand for FS would be 10 million and demand for colonoscopy would be 2.7 million if all screening by FS	Good
Brown et al., 2003[195] Cross-sectional and modeling National sample of MDs; US population	Current volume estimated by survey of national sample of primary care physicians, gastroenterologists, and general surgeons	Demand estimated by microsimulation model that incorporates population estimates, assumptions about test performance and screening program policy	Assuming 70% adherence: screening of national population with FS every 5 years would require the delivery of "almost 10 million" FSs in 2000 (2 times current volume)	Fair
Demand scenario: annual FOBT/FS every 5 years				
Ladabaum et al., 2005 (2887)[201]	None	Current and projected demand (in various screening scenarios) estimated by Markov model	Assuming 75% adherence, demand for FS would be 6.9 million and demand for colonoscopy would be 4.7 million if all screening by FOBT/FS	Good
Vijan et al., 2004[200] Secondary data analysis and modeling US population	Current volume of colonoscopies conducted by gastroenterologists estimated by analysis of CORI database	Demand estimated by Markov model; number of lifetime colonoscopies and FSs per patient for the US population under various scenarios	Assuming 70% adherence, an FOBT/FS screening strategy would require an incremental number of 1.2 million colonoscopies (above baseline of 1.69 million per year) Assuming 100% adherence, an FOBT/FS screening strategy would require an incremental number of 2.39 million colonoscopies (above baseline of 1.69 million per year)	Fair (volume estimates) Good (demand estimates)
Demand scenario: all colonoscopy screening				
Ladabaum et al., 2005[201]	None	Current and projected demand (in various screening scenarios) estimated by Markov model	Assuming 75% uptake, demand for colonoscopy would be 8.1 million if all screening by colonoscopy	Good

CORI, Clinical Outcomes Research Initiative; CRC, colorectal cancer; CT, computed tomography; CTC, computed tomography colonography; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; MDs, physicians; NHIS, National Health Interview Survey.

Table 47. National estimates of ability of current volume or additional available capacity of flexible sigmoidoscopy or colonoscopy to meet projected demand for endoscopy, by different demand scenarios (continued)

Author, Year Study Design Setting	Data Collection or Data Inputs for Capacity/Volume	Model Description to Project Demand	Results	Quality Rating
Vijan et al., 2004[200] Secondary data analysis and modeling US population	Current volume of colonoscopies conducted by gastroenterologists estimated by analysis of CORI database	Demand estimated by Markov model; number of lifetime colonoscopies and FSs per patient for the US population under various scenarios	Assuming 70% adherence, a colonoscopy screening strategy every 10 years would require an incremental number of 5.0 million colonoscopies (above baseline of 1.69 million per year) Assuming 100% adherence, a colonoscopy screening strategy every 10 years would require an incremental number of 6.3 million colonoscopies (above baseline of 1.69 million per year)	Fair (volume estimates) Good (demand estimates)
Brown et al., 2003[195] Cross-sectional and modeling National sample of MDs; US population	Current volume estimated by survey of national sample of primary care physicians, gastroenterologists, and general surgeons	Demand estimated by microsimulation model that incorporates population estimates, assumptions about test performance, and screening program policy	Assuming 70% adherence, screening of national population with colonoscopy every 10 years would require 4.8 million screening/ surveillance colonoscopies in 2000 (3 times the current volume of 1.6 million)	Fair
Demand scenario: screening the unscreened by various strategies				
Seeff et al., 2004[202] Modeling US population	Additional available capacity estimates from Seeff et al., 2004	Current unscreened population at average risk estimated using census data, adjusted for estimates of persons at higher risk and using screening rates from NHIS	41.8 million persons unscreened Using 100% of additional available capacity, it would take 3 years at current screening patterns or 6 years using 100% FS or FOBT/FS to screen the unscreened population Using 100% of additional available capacity, it would take 5 years to screen the unscreened population with colonoscopy For a program using FOBTs, there would be enough capacity for the necessary follow-up colonoscopies within 1 year	Good

Table 47. National estimates of ability of current volume or additional available capacity of flexible sigmoidoscopy or colonoscopy to meet projected demand for endoscopy, by different demand scenarios (continued)

Author, Year Study Design Setting	Data Collection or Data Inputs for Capacity/Volume	Model Description to Project Demand	Results	Quality Rating
Demand scenario: Increasing demand for CT colonography				
Ladabaum et al., 2005 (2887)[201]	None	Current and projected demand (in various screening scenarios) estimated by Markov model	Assuming 75% uptake, demand for colonoscopy would be 6.2 million CTC and 3.3 million colonoscopies if all screening by CTC	Good
Hur et al., 2004[199] Secondary data analysis and modeling US population	Current colonoscopy volume estimated from CORI database	Demand for colonoscopy predicted from mathematical model	Current volume: 6.47 million colonoscopies 1.98 million colonoscopies for screening (29%) If CTC used as primary modality for CRC screening, assuming 55% adherence to screening and 67% of screening is CTC, in the initial 5-year period after implementation of CTC, demand for colonoscopy could decrease by 1.78 million; partially offset by 0.34 million follow-up colonoscopies for CTC with positive findings (10 mm polyp)	Fair
Pickardt et al., 2008[203] Modeling US population	Current volume of CTC estimated from secondary data on CT scanners in the US	Markov model used to estimate demand for the US population	Assuming 60% compliance with screening, 67% of screening is CTC, and rise in number and percentage of CT scanners performing CTC (from n = 718/10% to n = 10,000/90%), there is sufficient capacity to screen 10 years from now in a steady-state scenario	Fair

All six studies used census data with specific refinements (such as omitting persons who are above average risk or who may be too "sick" for screening) as inputs into mathematical models to estimate current and projected demand. The types of refinements of population estimates, the types of models, and the assumptions regarding demand (most importantly, what percentage of the population would be included in a future screening scenario) used to construct the models varied widely among the studies. The percentage of the population included in future screening scenarios ranged from 40 percent to 100 percent.

Overview of results. Six studies provided some data on the ability of current capacity or volume to meet projected demand under various steady-state scenarios. For each scenario, we present estimates of projected demand from across all studies and compared these levels of projected demand with estimates of current capacity from across all studies.

In the first scenario, in which 75 percent of the US population is screened by FOBT alone, the projected demand for colonoscopy is 3.8 million.[201] Based on estimates of current capacity

from across the studies, current capacity is likely sufficient to meet the demand for colonoscopy. If a similar proportion (70 percent to 75 percent) of the US population is screened using either FS or combined FS/FOBT, an estimated 6.9 million to 10 million FSs and 2.7 million to 4.7 million colonoscopies are needed. Current volume of FS is not sufficient, but current capacity, including estimates of additional available capacity, is likely sufficient to meet projected demand; current volume of colonoscopy is sufficient. Finally, if 70 percent of the US population is screened by a colonoscopy alone, the projected demand is 4.8 million to 8.1 million colonoscopies. Current volume is not sufficient to meet the projected demand, but current capacity, including additional available capacity, may be sufficient. All of these estimates represent steady-state scenarios; none of these models incorporated current estimates of the unscreened.

In the single study that modeled the extent to which available capacity was sufficient to screen the unscreened population, the investigators determined that, using 100 percent of additional available capacity, it would take 3 years at current screening patterns, 6 years using 100 percent FS or FOBT/FS, or 5 years using 100 percent colonoscopy to screen the unscreened population.

Detailed assessment, FOBT screening scenario. One good-quality study used a Markov model to estimate endoscopic demand under various screening demand scenarios.[201] It reported that if 75 percent of the US population were screened by FOBT alone, 3.8 million colonoscopies would be needed for followup of abnormal FOBTs, for post polypectomy surveillance, or for diagnosis of symptomatic CRC or followup after CRC treatment.

Detailed assessment, FS screening scenario. Two studies, one rated good and one rated fair, reported similar estimates on the number of FS needed if a large proportion of the population were screened with FS every 5 years. One study, which used a Markov model to estimate endoscopic demand under various screening demand scenarios, found that if 75 percent of the US population were screened by FS alone, 10.0 million FSs and 2.7 million colonoscopies would be needed annually.[201] The NCI study also used a microsimulation model that incorporated population estimates and assumptions about test performance to estimate demand for FS.[195] They found that if 70 percent of the US population were screened by FS every 5 years, the number of FS procedures required annually would be “almost 10 million,” which is approximately twice their estimate of FS current volume.

Detailed assessment, FOBT/FS screening scenario. Two studies, both rated good, reported on the number of colonoscopies needed if a proportion of the population were screened with FS every 5 years and FOBT every year. One used a Markov model to estimate endoscopic demand under various screening demand scenarios and found that if 75 percent of the US population were screened by FOBT/FS, 6.9 million FSs and 4.7 million colonoscopies would be needed annually.[201] The other study, which estimated current volume using the CORI database and demand based on a Markov model, found that, assuming 70 percent adherence to a FOBT/FS screening strategy, an incremental number of 1.2 million colonoscopies would be needed above the baseline of 1.69 million per year (total of ~2.9 million screening colonoscopies).[200]

Detailed assessment, colonoscopy screening scenario. Three studies, two rated good and one rated fair, reported on projected demand if 70 percent to 75 percent of the US population were screened by colonoscopy alone. The study that estimated demand scenarios found that if 75 percent of the US population were screened by colonoscopy alone, 8.1 million screening colonoscopies would be needed annually.[201] The study that estimated current volume using the CORI database and demand based on a Markov model, found, assuming 70 percent adherence to

a colonoscopy screening strategy every 10 years, that an incremental number of 5.0 million colonoscopies would be needed above a baseline of 1.69 million per year (total of 6.69 million screening colonoscopies).[200] The NCI study found that if 70 percent of the US population were screened by colonoscopy every 10 years, the number of screening colonoscopy procedures required annually would be 4.8 million (which was three times the estimated current volume in that study).[195]

None of these studies gave estimates of additional available capacity. Of the two studies that estimated current volume in addition to projected demand, projected demand far exceeded current volume. This pattern suggested that a colonoscopy screening strategy for a large proportion of the population could not be supported. However, if the estimates of current available capacity from Seeff and colleagues[202] are taken into account (an additional 8.2 million colonoscopies per year), the current endoscopy infrastructure might possibly support a colonoscopy strategy of this sort.

Detailed assessment, screening the unscreened by various scenarios. One study was unique in that it modeled the ability of additional available capacity (rather than current volume) to screen all current average-risk unscreened persons in the US population (rather than modeling various screening strategies for the entire US population).[202] This study, rated good quality, modeled the time needed to screen the current unscreened US population (41.8 million persons) by various strategies. This study found that, using 100 percent of additional available capacity, it would take 3 years at current screening patterns or 6 years using 100 percent FS or FOBT/FS to screen the average-risk unscreened population. Using 100 percent of additional available capacity, it would take 5 years to screen the unscreened population with colonoscopy.

Detailed assessment, increasing demand for CT colonography (CTC) scenario. Three studies, one rated good and two rated fair, modeled increasing demand for CTC. Two had as outcomes the effect on demand for colonoscopy;[199,201] the third asked whether projected CTC capacity is sufficient to meet projected CTC demand.[203] The good-quality study using a Markov model to estimate endoscopic demand under various screening demand scenarios reported, assuming 75 percent uptake, that demand for colonoscopy would be 6.2 million if all screening was done by CTC.[201] The fair-quality study, estimated capacity from data from the CORI database and modeled demand based on a mathematical model. Assuming 55 percent adherence to any kind of screening and 67 percent of screening being CTC (overall 37 percent utilization of CTC), these investigators reported that, in the initial 5-year period after implementation of CTC, demand for colonoscopy could decrease by 1.78 million. This would be partially offset by 0.34 million follow-up colonoscopies for CTC with positive findings.[199] Because assumptions for utilization of CTC varied widely between the two studies, they cannot be directly compared.

The third study asked a very different question: whether projected capacity of CTC is sufficient to meet projected demand.[203] The authors assumed 60 percent compliance with any kind of screening, 67 percent of screening being CTC, and a rise in the number and percentage of CT scanners performing CTC from 718 and 10 percent to 10,000 and 90 percent. Given these factors, they concluded that the nation will have sufficient capacity to screen 10 years from now in a steady-state scenario.

KQ 5: Effective Approaches for Monitoring Use and Quality of Colorectal Cancer Screening

Valid data on the use and quality of CRC screening are central to efforts to decrease morbidity and mortality from CRC in the United States. To understand the current status of CRC screening and the effects of interventions to increase the use and quality of screening, we must have both valid measures of CRC screening use and quality of those services and effective monitoring approaches to obtain data on these measures. KQ 5 examines the approaches for monitoring use and quality of CRC screening in populations and the effectiveness of these monitoring approaches.

As a starting point for defining an effective approach for monitoring use and quality of CRC screening, we identified frameworks for public health monitoring (or surveillance) systems from both the United States and Canada.[47,205] To avoid confusion over the term 'surveillance', we have opted to use it to describe surveillance colonoscopy (colonoscopy for patients who have had a previous colonic polyp (and, usually, polypectomy)) and have replaced the term 'surveillance' with regard to data collection related to CRC test use to the term 'monitoring'. Therefore, all discussions about data systems will be referred to as those that monitor use or quality. These frameworks provide complementary lists of characteristics or attributes of monitoring systems that are applicable to the design of an ideal approach to monitoring CRC use and quality. Although the notion of a monitoring system may be more common for infectious diseases than for cancer or other chronic conditions, these frameworks are intended to be applicable to both chronic and infectious diseases. Also, although monitoring systems are often thought of in terms of disease incidence and mortality (rather than health care utilization or health care quality), public health is beginning to monitor risk factors and preventive services such as CRC screening, not just diseases.

The frameworks that we identified provide a comprehensive and logical way to think about evaluating existing approaches to monitoring the use and quality of CRC screening, and they provide guidance for the design of optimal monitoring approaches. Table 48 describes characteristics or attributes of monitoring systems that the review team found applicable to CRC screening; it also gives working definitions adapted from the US and Canadian frameworks. In addition to these characteristics, the frameworks described more global system performance characteristics of usefulness, effectiveness, and/or efficiency. The items in this table are considered to contribute to overall system performance, including effectiveness; in addition to these characteristics, a critical component of effectiveness as defined in one framework is how well the system achieves its intended results.[205]

Table 48. Characteristics of public health monitoring systems that contribute to effectiveness

Characteristic	Working definition
Data quality	Completeness and validity of the data in the system
Timeliness	Interval between occurrence of an event and reporting of the event
Acceptability	Willingness of persons and organizations to participate in the monitoring system
Simplicity	Structure and ease of operation
Flexibility	Ability of the system to accommodate changes in operating conditions or information needs
Compliance	Degree to which a system complies with all relevant legislation, regulations, and policies
Stability	Reliability (ability to collect, manage and provide data properly without failure) and availability (ability to be operational when it is needed) of the monitoring system
Cost	Indirect and direct costs

Adapted from Health Canada, 2004[205]

In our literature search, all the articles identified relevant to KQ 5 pertained only to the first system characteristic, data quality. We found no articles that measured other characteristics of a monitoring system or that compared any of these characteristics between systems. Also, we found no articles that addressed the monitoring of quality of CRC screening, just monitoring of CRC screening use.

Specifically, most of the articles that we identified evaluated the accuracy of measures of CRC screening as obtained from various data sources (self-report, medical record review, or administrative data);[35,39-40,206-207] these studies add to the evidence from a recent systematic review[208] and other literature that appeared before our time period of included articles. We also found one study that described an attempt to solve one of the barriers in using administrative data to determine screening rates, that of distinguishing screening from diagnostic endoscopies,[209] and two studies that evaluated novel means of combining more than one data source to produce hybrid measures of CRC use.[35,210]

Other than establishing the quality of data on CRC screening use by evaluating the accuracy of measures of CRC screening as obtained from various data sources (self-report, medical record review, or administrative data), we found no other studies that measured or compared any of the other characteristics of monitoring systems (such as acceptability or cost). Thus, although this body of literature gives indications of data quality of the various sources for monitoring CRC use, it provides little evidence to inform the larger questions of what monitoring approaches, overall, are effective.

Our overall summary and strength of evidence tables for studies addressing this KQ are presented at the beginning of this section. The remainder of this section provides a more detailed assessment of the individual studies that informed our conclusions and our assessment of the strength of evidence.

KQ 5: Overall Summary and Strength of Evidence

In

Table 49, our overall grades of the strength of evidence appear in the far right column; grades for key domains to determine the strength of evidence are in the intermediate columns. In assessing research specific to KQ 5 about effectiveness of varying approaches to monitoring CRC use and quality, we found varying grades between low and high depending for different aspects of this KQ. The grade can be interpreted as the confidence that the evidence reflects the true effect. For example, a grade of low means that further research is likely to change the confidence in the estimate of effect, and is likely to change the estimate.

Overall, the evidence suggests that self-reported rates of CRC screening are higher than rates obtained by medical record review or administrative data (high strength of evidence). Nevertheless, rates of agreement between self-reported CRC screening and information found in medical records or administrative data are at least moderate (moderate strength of evidence), indicating that all three methods are generally appropriate for monitoring CRC screening use. The evidence suggests, although strength of evidence is low, that concordance among data sources is higher for rates of endoscopy screening than for rates of FOBT screening. Evidence was insufficient for using algorithms to determine whether a colonoscopy identified in administrative data was conducted for screening or for diagnostic purposes. The evidence also suggests that using a hybrid method (administrative data plus medical record review or self report of CRC screening) will increase the reported prevalence of screening, but whether validity is increased is not known (low strength of evidence).

Table 49. Strength of evidence for approaches to monitoring effectiveness of CRC screening use and quality

Number of studies; Number of subjects	Risk of Bias Design/Quality	Consistency	Directness	Precision	Results	Overall strength of evidence
Effective approaches of monitoring use and quality of CRC screening						
No study	NA	NA	NA	NA	NA	Insufficient
Validity of self-report, administrative data, and medical record review ot measure CRC screening use: Comparing prevalence of CRC screening rates by various sources						
Hall et al., 2004[206] Schenck et al., 2007[39] Schenck et al., 2008[40] Fiscella et al., 2006[207] Schneider et al., 2008[35] 4: 190,358	Low 4 Cross sectional/3 Good, 1 Fair	No inconsistency	Direct	NR	Self-reported CRC screening rates are higher than rates obtained by medical records or administrative data	High
Validity of self-report, administrative data, and medical record review to measure CRC screening use: Concordance among data sources for CRC screening measures						
Hall et al., 2004 [206] Schenck et al., 2007[39] Schenck et al., 2008[40] Fiscella et al., 2006[207] 3: 4,165	Low 3 Cross sectional/3 Good	Inconsistency present	Direct	Precise	Concordance between self-reported CRC screening and medical record or administrative data was at least moderate (agreement >70% or kappa > 0.4)	Moderate
Validity of self-report, administrative data, and medical record review to measure CRC screening use: Concordance among data sources for CRC screening measures, by screening test						
Hall et al., 2004 [206] Schenck et al., 2007[39] Schenck et al., 2008[40] 2: 2,691	Low 2 Cross sectional/2 Good	Inconsistency present	Direct	Precise	Concordance between self-report and medical record or administrative data is higher for endoscopy than for FOBT	Low
Distinguishing screening from diagnostic endoscopy using an algorithm for administrative data						
Haque et al., 2005[209] El-Serag et al., 2006[64] 1: 523	Moderate 2 Cross sectional/2 Fair	No inconsistency	Direct	NR	Algorithms have not been able to distinguish between diagnostic and screening endoscopic exams in administrative data	Low
Ability of a hybrid method (using administrative data and self-report) to increase validity of measurement						
Pignone et al., 2009[210] Schneider et al., 2008[35] 2: 194,952	Moderate 2 Cross sectional/2 Fair	Consistent	Direct	NR	Hybrid methods will increase reported prevalences of CRC screening, but whether validity is increased is unknown.	Insufficient

CRC, colorectal cancer; FOBT, fecal occult blood test; NA, not applicable; NR, not reported.

Overall study characteristics. We found seven studies of good or fair quality that reported data on effectiveness of approaches to monitor use of CRC screening.[35,39-40,206-207,209-210] Three

studies that were specific to validation of a set of survey questions developed by the National Cancer Institute[211] were not included as they did not meet our inclusion criteria.[212-214] Four studies took place within a managed care setting or a health plan[35,206,209-210] and three included Medicare patients seen in non-managed care settings.[39-40,207] All were cross-sectional studies that compared two or more data sources on CRC screening to evaluate the accuracy of the method of interest.

Overall study results. Included studies addressed only data quality; we found no studies that described or compared other monitoring system attributes. Although none of the three data sources can be considered a gold standard, all three appear to be generally appropriate for monitoring CRC screening status. However, self-reported rates of CRC screening are consistently higher than rates obtained from either medical records or administrative data.

The included studies reported a wide range of measures of concordance (agreement and/or kappa statistic, which accounts for agreement expected by chance) comparing CRC screening measures from the three data sources.[35,39-40,206-207] In most studies that report accuracy of self-report for FOBT, any endoscopy, or any testing, concordance between self-report and medical record or administrative data was at least moderate (agreement greater than 70 percent or kappa greater than 0.40). Concordance appears to be higher for endoscopy than for FOBT.

One problem with using administrative data is that distinguishing screening from diagnostic examinations is difficult; the single study reviewed was not able to use an algorithm to do so effectively.[209] Two studies demonstrated that administrative claims will underreport CRC screening rates (by showing that survey or medical record review will pick up additional screenings that were false negatives in the claims data), but they do not demonstrate conclusively that measuring CRC screening rates using hybrid methods is a more valid or a more effective approach overall.[35,210]

The following chapter is divided into three sections, based on the purpose of the studies. The first category includes studies that compared two or three types of data sources to evaluate data validity.[35,39-40,206-207] The second category includes one study, which evaluated the use of a computer algorithm to distinguish diagnostic from screening endoscopy in administrative data.[209] The final category includes two studies that used combinations of administrative, medical record, and survey data to assess the accuracy of these novel ways of CRC screening measurement.[35,210]

As with other KQs, tables in this section list studies by quality (good followed by fair) and then alphabetically by last name of the first author of the article(s). Appendix C[***] presents the evidence tables with the details of these studies.

Validity of Self-Report, Administrative Data, and Medical Record Review to Measure CRC Screening Status

Study characteristics. We found five studies of good or fair quality that reported data on the validity of various data sources of CRC screening rates.[35,39-40,206-207] The single study rated fair did not report detail on methods to ensure valid medical record abstraction.[35]

Two studies took place within a managed care setting or a health plan;[35,206] of these, one included all plan members 51 years or older,[35] and one used slightly different age cutoffs for men and women (45 and older for men and 55 and older for women).[206] Three studies evaluated

[***] Appendixes and Evidence Tables for this report are provides electronically at http://www.ahrq.gov/downloads/pub/evidence/pdf/crcuse/crcuse.pdf.

measures of CRC screening in Medicare populations.[39-40,207] Of these, two included Medicare patients ages 55 to 80[39-40] and the third included Medicare patients 65 and older.[207]

All studies were cross-sectional studies that compared two or more data sources on CRC screening to evaluate the accuracy of the method of interest. One study compared self-report of CRC screening with medical record review only,[206] whereas the remaining studies examined all three sources of data—self-report, medical records, and administrative data. One study used secondary data from the Medicare Current Beneficiary Survey (MCBS);[207] the remaining four studies involved surveys of patients for self-reported CRC screening history.

In general, these studies asked questions about several types of screening tests, followed by questions about the time frame when the tests occurred. Two studies reported that their questions were modeled after national studies such as the NHIS and BRFSS.[35,206] Studies generally compared the prevalences of CRC screening as measured by different data sources and/or reported agreement, defined as the percentage of persons for whom the two data sources agreed and a kappa statistic.

Overview of results. Results of the studies were of two main types (Tables 50 and 51). In the five studies that compared prevalence rates of CRC screening from self-report with prevalence rates from medical record data or administrative data, the rates of FOBT, FS, and colonoscopy are generally higher as measured by self-report than by medical record data or by administrative data (Table 50). In the two studies that compared medical record data with administrative data, both in Medicare patients, administrative data may have slightly higher prevalence rates than those reported by the medical records. The range of concordance among the studies that compared the three data sources (Table 51) was wide. In most studies that reported accuracy of self-report for FOBT (two studies), for endoscopy (two studies), and for any testing (one study), concordance between self-report and medical record or administrative data was at least moderate (agreement greater than 70 percent or kappa greater than 0.40). Concordance appears to be higher for endoscopy than for FOBT.

Detailed assessment. In the first study, conducted by CDC staff and authors from three health plans (in Georgia, Minnesota, and North Carolina), participants were recruited who had been enrolled in their plan for at least 5 years and were ages 45 years and older (men) or 55 and older (women).[206] The investigators stratified the sample by site and sex and oversampled African-Americans members. Participants were recruited by letter and telephone; the cooperation rate was 64.8 percent. Investigators examined participants' medical records for the previous 5 years. The study found that a higher percentage of respondents received testing when measured by self-report than by medical record audit (Table 51). The authors calculated a kappa statistic and used a cutoff of 0.40, above which indicates at least fair agreement (by the authors' definition of poor less than 0.40; fair to good of 0.40-0.75; and excellent of > 0.75). They concluded that agreement was fair to good for FS and colonoscopy among most groups and poor for FOBT in two or three HMOs (Table 51).

In the second study, researchers compared Medicare claims data with self-report from the MCBS of having received an FOBT, FS, or colonoscopy among white, African-American, or Hispanic enrollees who were at least 65 years, did not reside in a long-term care facility, and were not enrolled in a Medicare HMO.[207] The survey was conducted in 2000; the study did not mention the time frame for administrative claims review nor distinguish screening from diagnostic procedures in either data source. Only race-specific prevalences were reported, as the goal of the study was to examine disparities in screening rates as measured by different data sources. In this study, rates of screening were as follows: white, self-report 38 percent; white,

claims 30.1 percent; minority, self-report 34.8 percent; and minority, claims 20.4 percent (Table 50). The kappa score measuring agreement between self-report and claims was 0.37 for whites and 0.19

Table 50. Assessing validity of CRC screening measures: Comparing prevalence of CRC screening rates by various data sources

Author, Year Study Design Population Setting Sample Size Quality	Study Aim	Data Sources	Results
Hall et al., 2004[206] Cross-sectional Three HMOs in Georgia, Minnesota, and North Carolina N: 363 (black men), 847 (white/other men), 920 (women) Good	Examine the accuracy of self-report of CRC screening among members of 3 health plans	Medical record review to determine whether any of the tests had been recorded within 5 years Survey of sampled health plan members for self-reported CRC screening history	Among 3 demographic groups in 3 health plans (data combined), the percentage of respondents who received testing was higher when measured by self-report (survey) than by medical record review Black men; white/other men; women: FOBT Survey 22.2; 20.3; 25.9 Medical record review 11.6; 9.5; 14.1 FS Survey 38.4; 42.0; 50.0 Medical record review 29.6; 30.6; 34.1 Colonoscopy Survey 13.7; 14.6; 15.7 Medical record review 8.1; 11.1; 9.6 Endoscopy Survey 44.4; 49.8; 58.6 Medical record review 34.4; 37.8; 39.8
Fiscella et al., 2006[207] Cross-sectional Medicare beneficiaries, age ≥ 65, community dwelling who were included in the MCBS; white race compared with minority (Hispanic plus non-Hispanic African American) N: 1,474 Good	Determine whether estimates of racial disparities in receipt of CRC screening and other preventive procedures differ between self-report and Medicare claims data	Prevalence of receipt of FOBT, FS, or colonoscopy as measured by: Self-report (survey) of having any of the tests in the last year (MCBS) (indication was not specified) Medicare claims, including both screening and diagnostic codes (administrative data)	CRC screening White: Survey 38.0 Administrative 30.1 Minority: Survey 34.8 Administrative 20.4

CRC, colorectal cancer; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; HEDIS, Health Plan Employer Data and Information Set; HMO, health maintenance organization; MCBS, Medicare Current Beneficiary Survey; N, number; NA, not applicable.

Table 50. Assessing validity of CRC screening measures: Comparing prevalence of CRC screening rates by various data sources

Author, Year Study Design Population Setting Sample Size Quality	Study Aim	Data Sources	Results
Schenk et al., 2007[39] Cross-sectional Medicare beneficiaries, white or African-American between the ages of 55-80, no history of CRC, in 10 urban counties in North Carolina who had responded to a telephone survey in 2002 on CRC screening N: 561 Good	Compare ascertainment of endoscopy screening among 3 data sources: self-report, Medicare claims, and medical record review	Prevalence of receipt of FS (in last 4 years) or colonoscopy (in last 5 years) as measured by: Self-report in 2002 on a telephone survey; FS vs. colonoscopy were described and queried for separately; respondents were asked if the exam was part of a check up or because of a problem Medicare claims: inpatient, physician, and hospital outpatient claims from 1/1998-12/2002 (screening vs. diagnostic exams were distinguished) (administrative data) Medical record review: record abstraction between 1/1998 and 12/2002 from the primary care provider (or a provider identified by an algorithm) and for some, the MD performing the procedure. Exams were classified as screening if the test was conducted for screening or as part of a well-adult visit, and all others were classified as diagnostic	Prevalence of endoscopy in the past year Overall: Survey 50.1 Administrative 44.9 Medical record review 42.3 By sociodemographic characteristics: Age 55-64; 65-74; 65-80 Survey 50.8; 52.4; 44.0 Administrative 35.6; 43.9; 50.7 Medical record review 32.2; 40.7; 50.0 All African Americans; all whites; all women, all men: Survey 40.9; 52.9; 46.8; 55.3 Administrative 41.7; 45.9; 43.6; 47.0 Medical record review 42.4; 42.2; 42.7; 41.6 Less than high school; high school diploma; more than high school: Survey 28.7; 46.9; 59.8 Administrative 39.4; 45.9; 45.8 Medical record review 38.3; 41.8; 43.6

Table 50. Assessing validity of CRC screening measures: Comparing prevalence of CRC screening rates by various data sources

Author, Year Study Design Population Setting Sample Size Quality	Study Aim	Data Sources	Results
Schenk et al., 2008[40] Cross-sectional Medicare beneficiaries, white or African-American between the ages of 55-80, no history of CRC, in 10 urban counties in North Carolina who had responded to a telephone survey in 2002 on CRC screening N: 561 Good	Compare ascertainment of FOBT among 3 data sources: self-report, Medicare claims, and medical record review	Prevalence of receipt of FOBT as measured by: Self-report in 2002 on a telephone survey: at-home FOBT described and respondents asked whether they had ever had a test and the date of most recent test; respondents were asked if the exam was part of a check up or because of a problem Medicare claims: billing for FOBT (diagnostic or screening codes) from 1/1998 to 12/2002 (administrative data) Medical record review: record abstraction between 1/1998 and 12/2002 (distinguishing in-office tests from home kits where possible)	Prevalence of FOBT in the past year Overall: Survey 28.7 Administrative 21.2 Medical record review: 19.4 By sociodemographic characteristics: Age 55-64; 65-74; 65-80 Survey 35.2; 27.9; 28.4 Administrative 19.3; 21.0; 23.6 Medical record review: 19.3; 19.8; 19.6 All African Americans; all whites; all women, all men Survey 32.0; 27.8; 30.6; 25.9 Administrative 18.8; 22.4; 25.5; 15.3 Medical record review: 12.5; 21.9; 21.7; 16.7 Less than high school; high school diploma; more than high school Survey 26.6; 26.0; 31.6 Administrative 20.2; 20.4; 22.8 Medical record review: 19.1; 16.3; 22.4
Schneider et al., 2008[35] Cross-sectional 5 health plans in the US N: 189,193 administrative data and 1,250 survey respondents Fair	Describe a field test of a screening measure included in the HEDIS	Prevalence of specific CRC screening tests or any CRC screening compared among: Survey data Administrative data Hybrid of administrative and medical record review data	Among members in each of 5 health plans, the percentage of respondents who received testing was generally higher when measured by self-report than by administrative data By health plan A; B; C; D; E: FOBT Survey 25.4; 26.3; 20.5; 21.8; 25.1 Administrative 23.6; 15.0; 31.1; NA; 24.7 FS Survey 29.7; 39.6; 33.9; 33.6; 30.6 Administrative 14.2; 17.9; 18.4; 15.3; 15.4 Colonoscopy Survey 19.9; 39.0; 33.6; 33.7; 40.7 Administrative 12.8; 12.1; 9.4; 10.5; 14.2

Table 50. Assessing validity of CRC screening measures: Comparing prevalence of CRC screening rates by various data sources

Author, Year Study Design Population Setting Sample Size Quality	Study Aim	Data Sources	Results
Schneider et al., 2008[35] (continued)			Any CRC screening Survey 53.2; 69.7; 55.0; 62.1; 66.2 Administrative 41.5; 38.6; 47.1; 27.3; 44.4 Hybrid 41.5; 53.5; 52.6; 38.8; 45.6 Survey respondents were more likely than nonrespondents to have evidence of CRC screening (62.7% vs. 46.5%; *P* < 0.001)

Table 51. Assessing validity of CRC screening measures: Concordance among data sources for CRC screening measures

Author, Year Study Design Population Setting Sample Size Quality	Study Aim	Data Sources	Results
Hall et al., 2004[206] Cross-sectional Three HMOs in Georgia, Minnesota, and North Carolina N: 363 (black men), 847 (white/other men), 920 (women) Good	Examine the accuracy of self-report of CRC screening among members of 3 health plans	Medical record review to determine whether any of the tests had been recorded within 5 years Sampled health plan members were asked whether they had ever been tested and date of most recent test	Concordance between self report and medical records is reported as the range of the nine values (for each of 3 demographic groups in each of 3 HMOs) for each of the following items: FOBT Agreement: 0.78-0.86* Kappa: 0.23-0.62† FS Agreement: 0.63-0.89 Kappa: 0.31-0.77 Colonoscopy Agreement: 0.86-0.94 Kappa: 0.30-0.69 Any endoscopy Agreement: 0.61-0.92 Kappa: 0.30-0.83

CRC, colorectal cancer; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; HEDIS, Health Plan Employer Data and Information Set; HMO, health maintenance organization; MCBS, Medicare Current Beneficiary Survey; N, number.
*Agreement is the percentage of persons for whom the two data sources agree.
†Kappa statistic is a measure of agreement that accounts for agreement expected by chance.

Table 51. Assessing validity of CRC screening measures: Concordance among data sources for CRC screening measures

Author, Year Study Design Population Setting Sample Size Quality	Study Aim	Data Sources	Results
Fiscella et al., 2006[207] Cross-sectional Medicare beneficiaries, age ≥ 65, community dwelling who were included in the MCBS; white race compared with minority (Hispanic plus non-Hispanic African American) N: 1,474 Good	Determine whether estimates of racial disparities in receipt of CRC screening and other preventive procedures differ between self-report and Medicare claims data	Prevalence of receipt of FOBT, FS, or colonoscopy as measured by: Self-report of having any of the tests in the last year (MCBS) (indication was not specified) Medicare claims, including both screening and diagnostic codes (administrative data)	Concordance between self-report and administrative data (measured by kappa score) for CRC screening White 0.37 Minority 0.19
Schenk et al., 2007[39] Cross-sectional Medicare beneficiaries, white or African-American between the ages of 55-80, no history of CRC, in 10 urban counties in North Carolina who had responded to a telephone survey in 2002 on CRC screening N: 561 Good	Compare ascertainment of endoscopy screening among 3 data sources: self-report, Medicare claims, and medical record review	Prevalence of receipt of FS (in last 4 years) or colonoscopy (in last 5 years) as measured by: Self-report in 2002 on a telephone survey; FS vs. colonoscopy were described and queried for separately; respondents were asked if the exam was part of a check up or because of a problem Medicare claims: inpatient, physician, and hospital outpatient claims from 1/1998-12/2002 (distinguished screening vs. diagnostic exams) (administrative data)	Measures of concordance for endoscopy use Administrative to medical record review Agreement: 95 (93-97) Kappa: 0.89 (0.81-0.98) Self-report to medical record review Agreement: 70 (66-73) Kappa: 0.39 (0.31-0.47) Self-report to administrative Agreement: 70 (66-74) Kappa: 0.40 (0.32-0.49) Agreement regarding test type (FS or colonoscopy) Claims to medical record review: 93 (88-97) Self-report to medical record review: 82 (75-89) Self-report to claims: 77 (70-85) Agreement regarding test purpose (screening or diagnostic): Administrative to medical record review: 52 (43-61) Self-report to medical record review: 65 (55-74) Self-report to administrative: 29 (20-36)

Table 51. Assessing validity of CRC screening measures: Concordance among data sources for CRC screening measures

Author, Year Study Design Population Setting Sample Size Quality	Study Aim	Data Sources	Results
Schenk et al., 2007[39] (continued)		Medical record review: record abstraction between 1/1998 and 12/2002 from the primary care provider (or a provider identified by an algorithm) and for some, the MD performing the procedure; exams were classified as screening if the test was conducted for screening or as part of a well-adult visit, and all others were classified as diagnostic	
Schenk et al., 2008[40] Cross-sectional Medicare beneficiaries, white or African-American between the ages of 55-80, no history of CRC, in 10 urban counties in North Carolina who had responded to a telephone survey in 2002 on CRC screening N: 561 Good	Compare ascertainment of FOBT among 3 data sources: self-report, Medicare claims, and medical record review	Prevalence of receipt of FOBT as measured by: Self-report in 2002 on a telephone survey; description of at-home FOBT provided, and persons asked whether they had ever had a test and the timing of most recent test Medicare claims: billing for FOBT (diagnostic or screening codes) from 1/1998 to 12/2002 (administrative data) Medical record review: record abstraction between 1/1998 and 12/2002 (distinguishing in-office tests from home kits where possible)	Measures of concordance for FOBT Administrative to medical record review Agreement: 82 (79-85) Self-report to medical record review Agreement: 70 (66-74) Self-report to administrative Agreement: 67 (63-71) Sensitivity analyses included: excluding claims of FOBT on day of medical visit; including all medical record review of FOBTs (likely including in-office, single card FOBTs with digital rectal exams); did not appreciably change the measures

for minorities. The authors also calculated ORs for reporting a procedure in the absence of a claim, or vice versa. Minorities were more likely to report receipt of CRC screening in the absence of a claim (OR, 1.92, 95% CI, 1.32-2.79), with little change after adjustment for age, gender, income, educational level, health status, proxy response, and supplemental insurance. Having a claim for CRC testing in the absence of self-report did not differ by race or ethnicity.

The North Carolina Quality Improvement Organization (the Carolinas Center for Medical Excellence) did two studies to evaluate all three data sources, namely self-report, medical records, and administrative data, for measuring CRC screening among Medicare patients. One

study evaluated these data sources for measuring endoscopy[39] and the other for measuring FOBT.[40] Included persons were Medicare beneficiaries who were white or African-American, between the ages of 55 and 80, with no history of CRC, and residing in 10 urban counties in North Carolina who had responded to a telephone survey in 2002 on CRC screening.

The *survey* provided explanations of the FOBT, FS, and colonoscopy procedures, attempting to distinguish in-office FOBT from home FOBT, and also asked respondents if the examination was part of a check up or because of a problem. For the *medical record review*, the investigators linked patients to a medical provider (to complete the medical record review) using a hierarchical approach. First, they asked survey respondents to name a provider; if that provider could not be located or if the response to the question was missing or unusable, they used a claims algorithm to identify a likely primary care provider. If the abstracted record from the primary care provider did not contain information about an endoscopy noted in claims data, then the claims data were used to identify the physician who had performed the procedure and the researchers then abstracted the medical record from this physician as well. Specific to the endoscopy study, medical record review captured whether the test was done for screening or diagnostic reasons. Specific to the FOBT study, data on the four most recent FOBTs were abstracted, including the reason for the test and the nature of the test (sending three samples collected at home to the laboratory, a digital rectal examination [DRE] with a FOBT performed in the office, or not specified). For the *claims data*, Medicare inpatient, physician, and outpatient claims for endoscopies were obtained for the 5-year period 1/1/1998 through12/31/2002. Screening and diagnostic codes were available for both FOBT and endoscopic procedures.

In the first study, self-reported FS within the past 4 years or colonoscopy in the past 5 years was compared with evidence in claims or medical record review that the procedure had been done. Prevalence of endoscopy screening was highest when measured by self-report (50.1 percent) followed by claims data (44.9 percent) and medical record review (42.3 percent); sociodemographic subgroups differed somewhat in these percentages (Table 50). The authors also found high agreement (95 percent; kappa = 0.89) between claims and medical records and good agreement (70 percent) between self-report and medical records and self-report and claims (kappa = 0.39-0.40) (Table 51). Also, all three data sources were able to distinguish the type of procedure done (FS versus colonoscopy), based on agreement between the data sources (77 percent to 93 percent), but none showed reliable levels of agreement regarding whether the test was screening or diagnostic (Table 51).

The second North Carolina study evaluated measurement of FOBT in the past year in a similar fashion.[40] Overall, the level of self-report of FOBT was higher (28.7 percent) than the level measured by claims (21.2 percent) or medical record review (19.4 percent); again, subgroups differed somewhat in these rates (Table 50). Lower rates of agreement were found among the three data sources for FOBT (67 percent to 82 percent) than for endoscopy (Table 51). The authors concluded that no data source could be established as providing valid information about FOBT among Medicare enrollees.

The final study, which we rated fair quality, was a field test of a National Committee for Quality Assurance (NCQA) performance measure.[35] The investigators randomly selected 200 persons age 51 or older from each of five health plans who had been enrolled continuously for at least 2 years and who lacked evidence of recent CRC screening; they conducted both a survey and medical record review. For the survey, they selected an additional 400 persons per plan were selected (for a total of 600 per plan). The response rate to the survey, which asked about CRC screening and time frames in which they occurred, was 48.1 percent. CRC screening status was

ascertained from administrative data, from the survey, and from a hybrid method of administrative records plus medical record review (for overall, not test-specific, screening status). Among members in each plan, the percentages of respondents who received testing were generally higher when measured by self-report than by administrative data (Table 50). Of note, survey respondents were more likely than nonrespondents to have evidence of CRC screening (62.7 percent versus 46.5 percent; $P < 0.001$).

Distinguishing Screening from Diagnostic Endoscopy Using an Algorithm for Administrative Data

Study characteristics. Two studies evaluated an algorithm's ability to distinguish between screening and diagnostic endoscopy (Table 52).[64,209] We rated both studies as fair quality, the first because of the limitations in their methods used to ensure validity of the medical record review data[209] and the second because of limited reporting of the outcome.[64] One study took place in a sample of patients from one HMO;[209] the second in VA patients from one medical center.[64]

Overview of results. Algorithms that use concomitant diagnostic codes to distinguish whether an endoscopy is screening or diagnostic have not been able accurately to distinguish the two types of endoscopies.

Detailed assessment. In the first study, using data from a large staff-model HMO, the algorithm classified an endoscopy as diagnostic if administrative data included certain conditions in the year before the examination or either specific signs or symptoms or an FOBT within 45 days before the examination. All participants in this HMO ages 50 to 70 who had been continuously enrolled for 5 years and who had completed an endoscopy during that time were eligible for the study. The investigators selected a stratified random sample of 220 participants based on the algorithm's classification of the endoscopy (for each of FS and colonoscopy, 30 diagnostic and 80 screening). They then reviewed medical charts and classified the examination as diagnostic based on the chart review if it was a follow-up to a previous abnormality or if clear-cut conditions or signs were present, using the same list as the algorithm. The algorithm had a low sensitivity for diagnostic endoscopies (48.1 percent for FS and 23.8 percent for colonoscopy). Overall, the agreement was better for sigmoidoscopies (kappa = 0.76) than for colonoscopies (kappa = 0.44).

In the second study, national VA datasets were used to identify all FOBT, FS, DCBE, and colonoscopy procedures performed in the VA between 1998 and 2003. All FOBTs were designated screening. All FS, DCBE, and colonoscopy procedures were classified as screening, followup, or diagnostic based on an algorithm considering diagnoses in the year before the procedures. A random sample of 303 medical records from a single VA hospital was reviewed by two gastroenterologists blinded to the designated status given by the algorithm. Agreement between the reviewers was achieved in 92 percent of cases; they resolved differences by discussion. Results from the medical record review were compared with the designation by the algorithm; only sensitivity and specificity for the algorithm's ability to identify screening colonoscopy were reported, 70.1 percent and 71.l6 percent, respectively.

Table 52. Comparison of classification of diagnostic versus screening procedure using an algorithm for administrative data

Author, Year Study Design Population Setting Sample Size Quality	Study Aim	Data Sources	Results
Haque et al., 2005[209] Cross-sectional Large HMO in southern California N: 220 Fair	Develop an automated data algorithm designed to distinguish screening and diagnostic endoscopy; the algorithm was compared with medical record review as the gold standard	Administrative data: endoscopies were identified using ICD-9 and CPT-4 codes and were classified as diagnostic vs. screening using presence of a list of diagnostic codes and signs and symptoms (that would suggest the procedure were diagnostic) Medical record review to establish whether diagnostic or screening exam	FS Sensitivity of diagnostic classification: 48.1 Specificity of diagnostic classification: 12.1 Sensitivity of screening classification: 87.9 Specificity of screening classification: 51.9 Kappa 0.76 Colonoscopy Sensitivity of diagnostic classification: 23.8 Specificity of diagnostic classification: 15.6 Sensitivity of screening classification: 84.4 Specificity of screening classification: 76.2 Kappa: 0.44
El-Serag et al., 2006[64] Cross-sectional A single Veterans Administration hospital N:303 Fair	Investigate whether colonoscopy use increased disproportionately in the VA system and changes in rates of FS, DCBE, and FOBT use	Administrative data: Inpatient and outpatient databases searched for codes indicating FS, FOBT, DCBE, and colonoscopy Indications for tests were classified using an algorithm based on diagnoses in the one year before the test Medical record review to establish whether diagnostic or screening exam	Colonoscopy Sensitivity of screening classification: 70.1 Specificity of screening classification: 71.6

CPT, Current Procedural Terminology; DCBE, double contract barium enema; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; HMO, health maintenance organization; ICD, International Classification of Diseases; N, number.

Evaluating Novel Ways to Combine Data Sources for CRC Screening Measurement

Study characteristics. We found two studies that evaluated novel ways to combine data sources to improve routine measurement of CRC screening use.[35,210] We rated these studies as fair quality; one lacked data to assess the outcome fully,[210] and the other did not ensure valid medical record abstraction.[35,209] Both studies took place within a managed care or health plan setting. One study attempted to improve measurement of CRC screening use by augmenting administrative data with survey data, and the second by augmenting with medical record data. Although one study compared the rates of CRC screening from the hybrid method with both

administrative and survey data for the entire sample,[35] the second could compare its rates only with administrative data,[210] because the survey was conducted only among persons for whom no evidence of CRC screening had been found in the administrative data.

Overview of results. In both studies, reported rates of CRC screening increased when administrative data were combined with either survey data or medical record data. The investigators provided no evidence (other than reporting prevalences) of the validity of these hybrid methods.

Detailed assessment. In one study, the researchers recruited a sample of members in a single health plan (Aetna), ages 52 to 80, from 32 primary care practices in Florida and Georgia that were taking part in a randomized trial of a CRC decision aid and practice-level academic detailing.[210] Participants with no evidence of screening in the claims data were surveyed about completion of any CRC tests and the time frame (within 1 year, 1 to 5 years, 5 to 10 years, or more than 10 years). The researchers excluded from their calculations persons with evidence of medical exclusions in the claims data and persons found to be at above-average risk on the survey. Insurance claims were examined for evidence of FOBT within 1 year, FS or barium enema within 5 years, or colonoscopy within 10 years. The indication for the test was not specified in the survey and the authors do not discuss using screening versus diagnostic codes in analyzing the claims data. The authors reported that the prevalence of current screening among average-risk persons by claims data was 27 percent; combining claims data and survey data and accounting for survey nonresponse, they estimated that 47 percent to 59 percent of member patients were actually up-to-date.

In the NCQA field test, described above, the investigators constructed samples in five geographically dispersed health plans of persons both with and without administrative claims evidence of CRC screening.[35] Among those with such evidence, the researchers selected a sample for the survey; of those without evidence in the claims, they selected a sample for both medical record review and the survey. The hybrid method combined administrative and medical record data to provide an estimate based on both. Among members in each of the five health plans, the percentages of respondents who received testing were generally higher when measured by the hybrid method than by administrative data, but they were lower than those recorded by survey data (

Table 53).

Table 53. Evaluating novel ways to combine data sources for CRC screening measurement

Author, Year Study Design Population Setting Sample Size Quality	Study Aim	Data Sources	Results
Pignone et al., 2009[210] Cross-sectional Aetna members ages 52-80 from 32 primary care practices in Florida and Georgia taking part in a randomized trial of a CRC decision aid and practice-level academic detailing N: 5,759 age-eligible in claims and 1,595 survey responders Fair	Evaluate the independent and combined yield of claims and direct survey for identifying CRC screening among average-risk health plan beneficiaries	Insurance claims for FOBT within 1 year, FS or barium enema within 5 years, or colonoscopy within 10 years (indication not specified) Survey of persons with no evidence of screening in claims data to ask about completion of any of the same CRC tests and time frame (within 1 year, 1-5 years, 5-10 years, or > 10 years)	Prevalence of current screening among persons without medical exclusions, by claims data alone: 27% Prevalence combining claims data plus self-reported data (not including nonresponders to the survey): 47% Prevalence combining claims data plus self-reported data (assuming nonresponders were screened at the same rate as average-risk responders): 59%
Schneider et al., 2008[35] Cross-sectional 5 health plans in the US N: 189,193 in administrative data and 1,250 survey respondents Fair	Describe a field test of a screening measure included in HEDIS	Prevalence of specific CRC screening tests or any CRC screening compared among: Survey data Administrative data Hybrid of administrative and medical record review data	Among members in each of 5 health plans, the percentage of respondents who received testing was generally higher when measured by self-report than by administrative data The percentage of persons who received testing as measured by the hybrid method generally fell between percentages based on survey or administrative data Plans A; B; C; D; E Any CRC screening by: Survey 53.2; 69.7; 55.0; 62.1; 66.2 Administrative 41.5; 38.6; 47.1; 27.3; 44.4 Hybrid 41.5; 53.5; 52.6; 38.8; 45.6 Survey respondents were more likely than nonrespondents to have evidence of CRC screening (62.7% vs. 46.5%; *P*<0.001)

CRC, colorectal cancer; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; HEDIS, Health Plan Employer Data and Information Set; N, number.

Chapter 5. Discussion

The RTI International-University of North Carolina Evidence-based Practice Center (RTI-UNC EPC) prepared this report for the National Institutes of Health (NIH) State-of-the-Science Conference on Enhancing Use and Quality of Colorectal Cancer Screening, which is scheduled for February 2010. This chapter summarizes and discusses the findings of our review of peer-reviewed literature concerning improving the appropriate use and quality of colorectal cancer (CRC) screening.

We adopted three outcomes on which to focus: use of CRC screening, patient-physician discussions about CRC screening, and quality of CRC screening. The screening tests included in our review are the at-home fecal occult blood test (FOBT), flexible sigmoidoscopy (FS), colonoscopy, and double contrast barium enema. We attempted to find studies on the uses of tests recently introduced to clinical practice for CRC screening, including the fecal immunochemical test, fecal DNA testing, and computed tomographic colonoscopy, but found no studies concerning the trends in use and quality of these tests. We further examined "appropriate" use in terms of three constructs: underuse, overuse, and misuse. This report presents findings from a systematic review of literature from January 1998 to September 2009 of four key questions (KQs):

KQ 2: What factors influence the use of CRC screening?

KQ 3: What strategies are effective in increasing the appropriate use of CRC screening and followup?

KQ 4: What are the current and projected capacities to deliver CRC screening and surveillance at the population level?

KQ 5: What are the effective approaches for monitoring the use and quality of CRC screening?

We also present background information on trends in the use and quality of CRC screening (KQ 1), relying on national studies and relevant articles from our extensive search for KQs 2 through 5. Finally, we comment on research needs (KQ 6).

Results for KQ 2 are largely descriptive. KQ 3, KQ 4, and KQ 5 are more analytic; each asks for information about the effectiveness of different approaches and an interpretation of comparisons presented in study analyses. For this reason, we provide strength of evidence evaluations for KQ 3, KQ 4, and KQ 5 but not for KQ 2; the strength of evidence tables and overall grades can be found in Chapter 4 in the relevant sections. We refer readers to Chapter 2 for methods for rating the quality (internal validity, or risk of bias) of individual studies and for grading the overall strength of evidence for specific groups of studies.

In the remainder of this chapter, we first give an overall summary of our findings, for all KQs. We then consider some implications of our findings and discuss the limitations of the review. Finally, we present suggestions for future research (KQ 6).

Summary of Findings

As summarized in Table 54, our extensive literature review for KQ 1 found many problems of underuse, overuse, and misuse of CRC screening. To guide our systematic reviews for KQs 2

Table 54. Summary of the evidence and strength of evidence grades by key question

Key Question	Strength of Evidence Grades*	Conclusions
KQ 1: What are the recent trends in the use and quality of colorectal cancer screening?	**NA**[†]	(1) Both CRC screening and patient-physician discussions of CRC screening are underused. Self-reported screening rates by national surveys, which are likely to be overestimates of actual screening, in 2005-2006 were about 50- 60%; an even smaller percentage of people had had a discussion about CRC screening with their primary care physician. Less certain, but likely, is underuse of surveillance colonoscopy (colonoscopy for patients who have had a previous colonic polyp [and, usually, polypectomy]) in some individuals who have previously had a polypectomy for an advanced adenoma. (2) Screening is also overused, insofar as people who are unlikely to benefit may be screened. This includes people over age 85 or people with severe comorbidities. Surveillance colonoscopy is also probably overused. Polypectomy for polyps less than 5 mm (for which benefit is uncertain but increased risk is clear) may also be considered an overuse category. (3) Problems of misuse also arise. These include use of in-office rather than home FOBT, nonreturn of FOBT cards, lack of adequate followup of positive FOBT results, and colonoscopy that does not reach the cecum, that has too rapid withdrawal time, or that misses important lesions. (4) We found no reliable data among studies included in this review on the trends of use or quality of fecal immunochemical test (FIT), fecal DNA testing, or computed tomographic colonoscopy.
KQ 2: What factors influence the use of colorectal cancer screening?[‖]	**NA**[‡]	(1) Several factors are consistently associated with reduced CRC screening (i.e., $P < 0.05$ or confidence intervals that do not overlap or include 1.0). They include: • low patient income[1-2,42,46,107,114,120,122-123,126,130,150-151,156] • **low education**[21,46,151] • **being uninsured**[21,46,56,113-114,128,151,160] • being Hispanic[1,21,46,111,115-116,119-120,126,141,147,151,163] or Asian[1-2,114,147] • not being acculturated into the United States (i.e., **English language proficiency**, US or foreign born, years living in US) [1-2,118,120-122,141,147,149,161] • **having less/reduced access to care, such as lack of a regular source of primary care**[1-2,21,42,46,56,107-108,111,120,128,130,133-134,151,157,163,215] **or no visits in previous year to provider**[2,21,46,55,107,126,132,137,151,158,166] • **lack of a physician recommendation to be screened**.[21,46,55-57,107,111,136,142,148,153,159]

CRC, colorectal cancer; DNA, Deoxyribonucleic acid; FOBT, fecal occult blood test; FIT, fecal immunochemical test; mm, millimeters; NA, not applicable; P, probability; US, United States.

* Strength of evidence grades and definitions (see Chapter 2 for details): High=High confidence that the evidence reflects the true effect. Further research is very unlikely to change our confidence in the estimate of effect. Moderate=Moderate confidence that the evidence reflects the true effect. Further research may change our confidence in the estimate of effect and may change the estimate. Low=Low confidence that the evidence reflects the true effect. Further research is likely to change our confidence in the estimate of effect and is likely to change the estimate. Insufficient=Evidence either is unavailable or does not permit estimation of an effect.

† KQ 1 is a background question that does not employ exhaustive systematic review methodology. Thus, strength of evidence grades are not applicable for this topic.

‡ KQ 2 was also not done through an exhaustive systematic review methodology, so we did not grade strength of evidence for this topic.

§Strength of evidence graded for KQ 3, KQ 4, and KQ 5 only.

‖ Those that are mutable are in bold font to highlight areas where interventions and policies could be implemented to improve screening rates.

Table 54. Summary of the evidence by key question (continued)

Key Question	Strength of Evidence Grade*	Conclusions
KQ 2: What factors influence the use of colorectal cancer screening? (continued)	**NA§**	(2) Factors positively associated with CRC screening (i.e., $P < 0.05$ or confidence intervals that do not overlap or include 1.0) include • **having private insurance**[21,46,107,113-114,124,128,151] • being non-Hispanic white,[21,46,106,120,125,128,138,142,151] • completing a higher levels of education[21,46,151] • **participating in regular screenings for other cancers**[21,42,46,108,122-123,133-134,151,156,158,215] • having a family history of CRC or personal history of another cancer[2,21,42,46,107,122,134,151,158] • **having regular access to care, having effective provider-patient communication**[56,135,140,154,167] (3) We only found one study each that examined the association between screening and either specific physician characteristics or patient-physician connectedness, thereby providing insufficient evidence to draw conclusions about these relationships. (4) We found six studies that examined the association of system variables with CRC screening.[66,110,127,139,143,173] Several single system variables were associated with higher screening rates; the only variable associated with higher screening in more than one study was use of nonphysician staff in assisting patients with understanding or completing screening. (5) We found no studies that examined factors associated with overuse or misuse of CRC screening or surveillance.
KQ 3: Which strategies are effective in increasing the appropriate use of colorectal cancer screening and followup?	**High**	(1) Interventions that provide patient reminders lead to small to moderate increases in CRC screening (four studies, with absolute increases of 5.0 percent, 5.9 percent, 11.7 percent, and 15.0 percent).[175,182-183,186]
	High	(2) Four studies of small media (educational print or video messages) to increase CRC screening show no benefit.[177-178,181,185]
	Low	(3) Evidence concerning decision aids to increase screening is mixed. With two of three studies showing benefit, some types of decision aids may be effective for increasing screening (14.0 to 23.0 percentage point increases in screening rates reported in the two positive studies).[175,182-183]
	Low	(4) Two studies on group education interventions to increase CRC screening showed no benefit.[184-185]
	High	(5) One-on-one interactions, especially intensive contact with patients, increase screening rates, sometimes to a large degree;[85,179-180] observed percentage point increases included 14.6 percentage points for FOBT completion,[85] 20.9 percentage points for any CRC test,[180] and 41.9 percentage points for FOBT completion.[179]
	High	(6) Interventions that provided a means for eliminating structural barriers, such as improving access to CRC screening tests or reducing language barriers,[85,175,179,183,187] demonstrated the highest impact on screening rates overall (ranging from an increase of 14.6 to 41.9 percentage points).

Table 54. Summary of the evidence by key question (continued)

Key Question	Strength of evidence	Conclusions
KQ 3: Which strategies are effective in increasing the appropriate use of colorectal cancer screening and followup? (continued)	**Low**	(7) Use of small media with or without decision aids vs. no intervention increases discussions with providers (25.1 percentage point difference from one study).[177]
	Low	(8) One study found providing reminders to physicians to be slightly effective in raising appropriate surveillance colonoscopy rates;[188] one study found no difference in CRC screening among patients whose providers received reminders.[186]
	High	(9) Five studies on system-level interventions[162,189-193] consistently reported increased screening rates for patients for whom a patient navigator or prevention care manager (PCM) was provided or when organizational processes and procedures were changed to help patients obtain timely CRC screening.
	Insufficient	(10) We found no evidence to determine the efficacy of any intervention to reduce overuse or misuse of CRC screening,
KQ 4: What are the current and projected capacities to deliver colorectal cancer screening and surveillance at the population level?	**Low**	(1) Current volume of FS is 2.8-4.9 million and additional available capacity is 6.7 million.[195-196]
	Low	(2) Current volume of colonoscopy is1.6-6.6 million and additional available capacity is 8.2 million.[195-196,199-200]
	Low	(3) Based on one study's estimates of additional available capacity, current capacity for colonoscopy is sufficient for a screening program by FOBT.[195-196,199-201]
	Low	(4) Based on one study's estimates of additional available capacity, current capacity for FS is sufficient for a screening program by FS alone.[195-196,201]
	Low	(5) Based on one study's estimates of additional available capacity, current capacity for colonoscopy is sufficient for a screening program by FS alone.[195-196,199-201]
	Low	(6) Based on one study's estimates of additional available capacity, current capacity for FS is sufficient for a screening program by FOBT/FS.[195-196,201]
	Low	(7) Based on one study's estimates of additional available capacity, current capacity for colonoscopy is sufficient for a screening program by FOBT/FS.[196,199-201]
	Low	(8) Based on one study's estimates of additional available capacity, current capacity for colonoscopy is sufficient for a screening program by colonoscopy.[195-196,200]
	Low	(9) If the United States were to adopt a colonoscopy-only approach to CRC screening, colonoscopy capacity would need to be substantially increased or at least 5 years would be needed to do the "catch-up" screening required to screen people who have not yet been screened.[202]

Table 54. Summary of the evidence by key question (continued)

Key Question	Strength of evidence	Conclusions
KQ 5: What are the effective approaches for monitoring the use and quality of colorectal cancer screening?	**High**	(1) Self-reported rates of CRC screening are higher than rates obtained from either medical records or administrative data.
	Medium	(2) Concordance between self-reported CRC screening and medical record or administrative data was at least moderate (agreement > 70.0 percent or kappa > 0.4).
	Low	(3) Concordance between self-report and medical record or administrative data is higher for endoscopy than for FOBT.
	Low	(4) Algorithms have not been able to distinguish between diagnostic and screening endoscopic exams in administrative data.
	Insufficient	(5) Hybrid methods will increase reported prevalences of CRC screening, but whether validity is increased is unknown.

to 5, we developed an analytic framework (Figure 1, Chapter 2). Our review helped us to specify better the important factors in the analytic framework that may be helpful in considering ways to improve the appropriate use and quality of CRC screening.

From the patient's point of view in Figure 1, we found that access to health care in general (including having health insurance and a regular source of primary care) is a necessary predisposing factor to CRC screening. Our KQ 2 review found specifically that having health insurance and a regular physician are strongly associated with higher levels of CRC screening. People without health insurance and a regular source of primary care have very low screening rates. This is not surprising; the nature of CRC screening, and the absence of a national program outside of primary care to deliver screening to the uninsured, is such that having a regular source of primary care is essential to improving CRC screening rates.

As shown in the analytic framework (Figure 1), however, access to care alone is insufficient to guarantee high levels of screening. After patients have access to care, they still need a simple and reliable mechanism by which to engage with physicians and/or others in the health care system to understand the idea of screening and the pros and cons of screening strategies. Few health care systems build such discussions into routine care, as shown by our KQ 1 finding of suboptimal numbers and quality of discussions about CRC screening. With such a varied range of screening strategies for CRC screening, this lack of a mechanism to promote and assist patient understanding and choice is a major barrier to appropriate use. An important finding in our KQ 2 review is that unscreened patients did not know about the need for CRC screening, and "just didn't think about it." The great majority of patients with physicians who recommend screening actually complete screening. Ideally, this recommendation would be accompanied by a reasonable discussion of screening options.

Helping patients understand CRC screening entails more than giving information in a one-sided, noninteractive manner. Our KQ 3 review found that small media messages with such materials as brochures alone were ineffective in increasing appropriate screening. Certain decision aid designs may be a useful approach in assisting patients to understand the pros and cons of screening and to make informed decisions about which screening strategy is right for them. The evidence to date on the effectiveness of decision aids is insufficient to determine the best design and delivery models; more research is needed.

In developing systems that can reliably help patients understand CRC screening and choose an appropriate screening strategy, several groups of disadvantaged patients need special attention. Patients who are not fluent in the English language, patients whose culture differs from that of the prevailing US medical culture, and (probably) patients with low levels of health literacy need specially designed approaches to help them understand CRC screening. Our KQ 2 review showed the screening rates of Hispanic people and of people not acculturated into the United States to be significantly lower than those of non-Hispanic whites and/or those born or living in the United States for longer periods of time.

Because of the few studies of the association between physician characteristics or health care systems and CRC discussions/screening, we cannot say whether certain types of physicians, or certain types of systems within which physicians work, are or are not more associated with appropriate screening. Some evidence indicates (KQ 2) that system factors such as involving nonphysician staff and having electronic medical records may be associated with appropriate screening.

Although access to care (e.g., a regular source of primary care that one visits at least annually), together with health insurance coverage for screening, combined with patient understanding and physician recommendation of screening, increases appropriate screening for many people, though some groups still need further assistance with completing screening. This step, between patient decision and appropriate test use, appears straightforward in the analytic framework (Figure 1); we found it is often more complex than depicted in this framework.

Because CRC screening strategies require people to carry out unusual procedures of preparation and testing, and then to navigate the medical system to complete screening, assisting people in the details of completing screening is sometimes necessary to reach high rates of appropriate screening. Our KQ 3 review found that, in some populations, employing more intensive one-on-one approaches, eliminating or reducing structural barriers for patients, and making overall system changes successfully increase appropriate screening. These sometimes intensive approaches are likely not necessary for all populations, although reducing barriers and streamlining and simplifying the screening process are likely to be helpful for all.

We developed our analytic framework and conducted our review with the understanding that, from the major guideline groups, a range of appropriate options for CRC screening exists. In contrast to this view, however, the United States might decide to favor a strategy of preferring an initial colonoscopy over other strategies. Our review of KQ 4 indicates a considerable degree of uncertainty about whether the nation has existing—or even latent—capacity to meet the need in this latter assumption. That is, we cannot conclude that the country can either conduct “catch-up” screening of people who have not been screened or to continue steady-state screening and the resulting surveillance for the longer term. Thus, if the United States were to embark on an initial colonoscopy-preferred strategy, and if the above approaches to increasing screening use were effective, then inadequate capacity to screen the eligible population is a real possibility.

Almost all the literature we found and reviewed for KQ 2 and KQ 3 focused on the problem of underuse of CRC screening. Despite our finding in KQ 1 that CRC screening discussions are also underused, we uncovered little evidence concerning factors associated with, or interventions to improve, underuse of screening discussions.

KQ 1 also showed considerable problems with overuse and misuse of CRC screening. No studies reviewed in KQ 2 examined factors associated with overuse of screening; no studies reviewed in KQ 3 examined interventions to reduce overuse of CRC screening. Similarly, little of the literature for KQ 3 examined interventions to reduce misuse in screening.

As shown in our analytic framework (Figure 1), an important (and probably necessary) factor between decisions about screening and *appropriate* use (minimizing overuse and misuse as well as underuse) is monitoring. Our review in KQ 1 found several monitoring systems for self-report of CRC screening use; these include the National Health Interview Survey (NHIX) and the Behavioral Risk Factor Surveillance System (BRFSS). However, few systems monitor overuse and misuse. We found no systems in the United States for reducing overuse and no corrective steps to minimize misuse. We found no direct evidence about monitoring to review in KQ 5.

Table 54 highlights our primary findings and conclusions from KQs 1 to 5.

We have adapted general recommendations for monitoring systems (Table 55) to show what types of data systems might be considered. Some initial systems are being started and could be encouraged and expanded. A national program of breast and cervical cancer screening and a mammography consortium both provide important information to monitor screening for these cancers. A complementary approach might be to expand data collection in the Surveillance, Epidemiology and End Results (SEER) program areas to include screening rates and even misuse data; such information might then be correlated with incidence and pathology data from SEER.

Table 55. Features of an ideal monitoring system for CRC screening use and quality

Characteristics of Monitoring System	Important Features of an Ideal System for CRC screening
Data quality: Use (both underuse and overuse)	• Includes the following variables: – overall screening rates by test type – inappropriate screening rates owing to age or severe comorbidities – percentage of persons with whom adequate screening discussions are held – percentage of FOBT cards that are returned – percentage of persons who attend their screening endoscopy appointment – results of screening tests and the percentage of persons with positive tests who receive complete diagnostic evaluation – percentage of persons with appropriate and inappropriate screening and/or followup – number/rate of polypectomies for colonic lesions < 5 mm
Data quality: Appropriate use or misuse	• Includes the following colonoscopy indicators[216-217] – cecal intubation rates – adenoma detection rates for adenomas ≥10 mm – colonoscopy withdrawal time – percentage of colonoscopies with adequate bowel preparation – complication rates
Data quality: Additional elements	• Links screening monitoring to pathology and tumor registry or SEER data • Represents entire US population
Acceptability	• Has a high participation rate of practices • Has a low burden to report data
Compliance	• Meets all legal standards for data sharing
Costs	• Is low cost • Is sustainable without research funding
Usefulness	• Is designed to meet users' needs. For example, has goals to evaluate quality of screening or to document outcomes of screening in a community-based setting.

FOBT, fecal occult blood test; SEER, Surveillance Epidemiology and End Result.

Implications of This Review

Although we found a gradual increase in CRC screening over the past 10 to 12 years, this increase still leaves the nation at a lower screening rate for CRC than for breast (or even prostate) cancer.[194] Finding interventions to increase appropriate CRC screening has clearly been challenging, perhaps more so than for other cancers. Perhaps because of the complexity (and even invasiveness) of the CRC tests, or because of the problem of having to choose among screening strategies, many people have not understood the need for CRC screening, and others have not been able to complete screening. Medical practice systems have often been inadequate in informing patients, discussing their questions, and assisting them in the complexities of completing CRC screening.

Our summary of our findings highlights certain aspects of our analytic framework (Figure 1) and points to a logical series of steps to improve appropriate CRC screening. The first step concerns access to health care, including having health insurance and a regular source of primary care, as a necessary predisposing factor. The nature of CRC screening is that a physician (or nonphysician medical staff) must be involved in the decision to screen and in the completion of testing.

After access to care, the second step is to find ways for all patients to engage in a discussion at some level. The design and intensity of the discussion will depend on the patient's prior understanding of CRC screening and the health care system. Such discussions take place with a trained health educator (e.g., physician or nonphysician staff), perhaps with an effective and tested decision aid, and focus on the pros and cons of CRC screening and the various screening options open to the patient. This interaction would need to be different for people with special circumstances, such as lack of fluency in English or lack of acculturation to the United States, than for most patients.

The third step in this progression is to simplify procedures for completing CRC screening for everyone. This includes providing proactive assistance to people from disadvantaged groups to complete screening after the screening decision has been made.

The further implications of this review are related to the implications for interventions to increase appropriate CRC screening use and quality (including reducing underuse, overuse, and misuse) and to three cross-cutting themes that underlie our findings: access to CRC screening; communication about CRC screening; and the organization of CRC screening. These three issues are among the strongest, potentially modifiable barriers to improving the use and quality of CRC screening.

Interventions to improve screening. Although we found high strength of evidence and positive effects for patient reminders, one-on-one interactions, eliminating structural barriers, and overall system changes as interventions to improve screening, still not clear is whether any set of interventions would effectively increase appropriate screening rates to high levels across the country. The health system may or may not have the ability to implement these interventions on a broad scale within medical practices and for the general population. To implement and maintain these interventions properly, an effective monitoring and feedback system (KQ 5) is needed. These systems are not in place in most primary care practices or health care systems.

How to overcome the focus in US medical care on nonpreventive care, and how to overcome the time and cost barriers to implementing and maintaining the systems within busy primary care practices, is also unclear. For example, incentives to primary care practices for improving CRC screening rates may or may not work. Partly because of the lack of positive incentives and the required time and effort from primary care practices, the durability of interventions that initially seem successful may be questionable. Another important issue is how interventions to improve CRC screening integrate with other medical practice systems.

Finally, the cost-effectiveness of the sometimes intensive interventions to gain sometimes small increases in screening is also unknown. Until these more fundamental issues are resolved, the question of whether widespread implementation of any interventions will have a large, sustained effect at reasonable cost (including time and effort of the patient, the physician, and the medical practice) remains unanswered.

Access to CRC screening. A critical underlying issue in this literature is access to care, a necessary precursor to access to CRC screening. Among the more striking findings from our review of factors associated with lower rates of CRC screening (KQ 2) is that people without

health insurance, people with no source of usual care, people with no recent physician visits, and people with lower income status have quite low CRC screening rates. Improved communication and medical care organization can be effective only for people who are connected to a primary care provider.

Communication about CRC screening. One positive finding of this report is the overall importance of communication specific to CRC screening between medical staff and patients in improving appropriate CRC screening (i.e., reducing underuse, overuse, and misuse). CRC screening requires a great deal of patient understanding and effort (e.g., knowing which tests to take and when, and how to get them done). Communicating such information to patients and guiding them in making decisions specific to their medical and family history all take time. To make appropriate decisions about individually optimal screening, to carry out the preparation and follow-through correctly, and to obtain screening at recommended intervals all require patient knowledge, motivation, and assistance from medical personnel. When few CRC discussions take place (KQ 1), when many eligible patients do not know that they should be screened (KQ 2), when medical personnel make few recommendations for screening (KQ 2), when many people do not receive periodic health examinations (at which some time might be devoted to discussions of CRC screening [KQ 2]), and when few intensive one-on-one interventions exist to assist patients to decide, prepare, and follow-through (KQ 3), suboptimal screening rates should not be surprising.

An instructive case study for the importance of communication is the situation of Hispanic and Asian populations in the United States, especially because these groups have low rates of CRC screening (KQ 2). Although access to care certainly accounts for some of the disparity in screening rates for Hispanics, even when studies adjust for access, multiple good-quality studies using national population-based data show that screening rates for Hispanics or Asians continue to remain below those of non-Hispanic whites.[1,46,111,120,141,147,151] This finding suggests that other factors, such as language and cultural differences, are also likely to be important determinants of screening.

Determining whether differences in CRC screening test use are mediated primarily through differences in language or differences in cultural beliefs about health and prevention is challenging, since language use is often a central part of the definition of acculturation.[121,149] Determining whether lower screening rates in Hispanics or Asians is driven mainly by cultural beliefs, by possible distrust of the medical health system, or by language is important. If the differences in screening test use reflect true differences in informed choices not to have screening based on culturally mediated values and preferences, then some of the difference in screening test use may be appropriate. However, accumulating evidence suggests that language and possibly literacy barriers contribute to lack of knowledge about the risk that CRC poses and about the potential benefits of screening. Poor communication, at the level of the health care system as a whole, at the community level, and at the level of the patient-physician interaction, clearly contributes to low CRC screening rates in racial and ethnic groups. Language and literacy barriers likely lead to even poorer communication among subpopulations that prefer to obtain health information in a language other than English.

Organization of CRC screening and monitoring. CRC screening in the United States requires the involvement of primary care physicians. Most receive no regular feedback on their CRC screening rates, as might occur in the Veterans Health Administration (VA) or other integrated health care system. Few medical practices involve nonphysician office staff in discussing CRC screening with patients; few reach out to patients who have not been screened or

who miss screening appointments. As suggested by the VA's success with CRC screening (KQ 1), by the association of use of nonphysician staff with higher CRC screening rates (KQ 2), and by randomized controlled trials (RCTs) of organizational change (KQ 3) to improve screening, organizational change supported by monitoring and feedback systems (KQ 5) could have a positive effect on screening. Nonetheless, drawing conclusions on how to reduce overuse and misuse will always be difficult without adequate monitoring of these outcomes.

A second important aspect of organization is external to the primary care practice. It involves coordination of various parts of the health care system involved in CRC screening. Because these parts of the health care system are often fragmented, barriers arise that patients must navigate to complete screening. These same barriers work against monitoring the progress of patients as they move through the system or even providing assistance to those who cannot surmount the obstacles. Finally, these barriers create problems for providing consistent and timely information to patients and for establishing systems to reduce overuse and misuse.

Limitations of this Review

Limitations of the Evidence Base

Reporting. Our ability to draw conclusions on the effectiveness of CRC screening interventions is limited by the relative paucity of detail on specific elements of the interventions. Studies inconsistently adhered to reporting standards such as STROBE[218] and CONSORT,[219] making critical appraisal of internal validity and assessment of applicability challenging. In particular, many studies did not report on the intensity of the intervention (e.g., the number and length of sessions and the time period of interaction with clients), the existence of protocols governing the intensity of intervention, or fidelity to such protocols. In addition, a number of studies used multiple components of interventions (e.g., reminders paired with one-on-one interactions) to increase CRC screening but only provided overall findings. Reporting findings in this way made discerning the incremental impact of each component difficult if not impossible to assess. CRC screening interventions represent an opportunity to translate effective interventions into a variety of clinical settings; the absence of information on fidelity limits their translation.

Heterogeneity of the interventions and the intervention sites. Categorizing the interventions was complicated by the heterogeneity of approaches, even for interventions that we eventually placed in the same category. The problem of classification was also complicated by the diversity of the sites in which the interventions occurred. In a sense, for example, an intervention that would be considered a "reminder" in one location might be considered a small media intervention in a different location.

Choice of appropriate comparators. The evidence base for interventions is marked by heterogeneity in comparators in addition to appreciable diversity in the CRC screening measure itself. Although appropriate comparators can and should differ by the specific outcomes being addressed, studies often did not justify the choice of comparator(s), either on its own merits or in relation to usual care. In most cases for studies included in KQ 3, investigators did not define "usual care"; this ambiguity hampers accurate interpretation of comparisons. For that reason, our conclusions regarding the effectiveness of CRC screening interventions are necessarily limited.

We also note that a potential Hawthorne effect may exist for studies comparing CRC screening interventions with usual care as opposed to a "sham" control. In cases involving comparisons of different types of CRC screening interventions, all interventions may receive a

Hawthorne boost. This possibility makes distinguishing the different effects of the various interventions difficult.

Choice of appropriate outcomes. As with the comparators, we encountered problems assessing the studies for each key question because of the way researchers defined and operationalized CRC screening. For studies that examined factors related to screening (KQ 2), many investigators used different definitions for CRC screening, partly because of a national trend toward colonoscopy and away from FOBT and sigmoidoscopy during the period of this review. Some teams considered subjects screened if they had ever received one type of test; others were more precise in including both the test and the recommended timeframe in their calculation of up-to-date screenings; while others included any CRC test code in their analysis, regardless of whether the test was provided as a screening or diagnostic procedure, thereby increasing the challenge in determining which factors were truly related to screening..

Even with these variations in the guidelines, how researchers operationalized the outcome of being up to date was inconsistent in this body of literature. Thus, assessing both the effectiveness of interventions (KQ 3) and the factors associated with screening (KQ 2) was overly challenging, particularly with regard to assessing the appropriateness of screening.

KQ 4 also presented challenges in assessing capacity outcomes and systematically applying these to a wide range of modeling assumptions; these problems in turn made synthesizing the findings difficult. Studies pertaining to this topic were also inconsistent in how they considered the difference between screening and diagnostic colonoscopy. Some modeling studies were unclear about whether they included surveillance colonoscopy in their calculation that would result from increased number of screening tests.

Across KQs 2, 3, and 4, we observed a heavy reliance on self-reported data that are not verified through other sources; this problem, too, complicates drawing reliable conclusions. Questions to assess self-report were not standardized, despite an NCI-led effort to develop standardized survey questions that have been subsequently evaluated in validation studies.[211-214]

Study design and sample size. Most KQ 2 studies were cross-sectional rather than cohort designs; thus, we could not easily examine time relationships. For this reason, there were no studies that examined factors associated with appropriate annual or serial use of FOBT, for example, and only focused on one-time or current use. Many studies did not report *a priori* hypotheses about their primary outcomes. Limited sample sizes resulted in studies that were not powered to find differences between experimental and control or comparison groups when such differences might in fact have existed.

In addition, the time periods in which investigators followed patients during intervention implementation for KQ 3 studies or measured capacity for KQ 4 studies varied considerably. Sometimes time frames were not specified at all. Again, these deficiencies hampered our ability to draw any conclusions across the studies. For KQ 3 studies in particular, time periods for following patients ranged from 3 to 24 months. Establishing a more common time for followup would improve the overall strength of evidence for these studies.

Appropriate adjustment for confounding. The evidence base is also limited by variations in the specific confounders and effect modifiers that investigators included or controlled for in their analyses. This issue arose particularly for examining factors influencing screening (KQ 2) and for quantifying capacity and projected demand (KQ 4). Omitting important confounders and effect modifiers (e.g., patient factors known to impact test use, temporal factors such as large macro-media campaigns such as when Katie Couric had a colonoscopy on national television), especially cointerventions in comparison arms, limits the interpretability and utility of the

evidence from such investigations. Furthermore, using the studies that did account for confounders and effect modifiers is hampered by the lack of consistent definition and inclusion of key variables.

These deficiencies together appreciably limit the consistency and validity of the evidence. As a result, we found several bodies of evidence for important outcomes that we could grade only as low strength of evidence.

Limitations of the Review

We limited our search to articles published in English, primarily because the focus of this review was the United States. Issues of the use and quality of CRC screening likely vary by country. Our review does not address the nature, outcomes, or interventions developed in other countries. We excluded RCTs with samples sizes less than 30 and observational studies with samples sizes less than 100. We also limited the studies to those reporting on data collected from January 1998.

For time and resource reasons, we did not conduct dual independent, blinded review of articles for abstraction of information into evidence tables. Instead, one reviewer performed the initial review, and a second reviewer examined that input and recommended changes or corrections when needed. These two reviewers reconciled any differences by consensus discussion. We did apply dual independent review for assessing the quality of individual articles and grading the strength of evidence, and often involved a third team member to resolve disagreements about these issues. These are, generally speaking, standard approaches for the RTI-UNC EPC.

The paucity of similar articles—taking populations, patient characteristics, settings, and the heterogeneity and complexity of the interventions and the outcomes measured—precluded any efforts to pool findings statistically.

Future Research Directions

The last key question (KQ 6) is to assess “What research is needed to make the most progress and have the greatest public health impact in promoting the appropriate use of colorectal cancer screening?” We found numerous gaps in the available research that could be addressed to help us better understand and influence CRC screening rates. We summarize our suggestions for future research in Table 56.

Table 56. Suggested research agenda to improve the appropriate use and quality of CRC screening (priority areas in bold font)

Key Question	Topic	Research Agenda
1: Trends in appropriate use and quality	Underuse	Coordinate reporting from BRFSS and NHIS systems with Medicare, HEDIS, and other administrative data to provide a single national source for use and trends. Standardize questions and measures. Develop new sources of use data from medical practices.
	Overuse	**Develop monitoring systems for screening of patients unlikely to benefit because of age or comorbidities. Develop monitoring systems for polypectomy rates for diminutive polyps. Develop monitoring systems for surveillance after polypectomy.**
	Misuse	**Develop monitoring systems for use of in-office FOBT testing; nonreturn of FOBT cards; nonfollowup of positive FOBT tests; adverse events rates from colonoscopy; rates of inadequate colonoscopic insertion and too-rapid withdrawal.**
2. Factors influencing the use and quality of appropriate CRC screening	Patient characteristics	Examine patient factors associated with better understanding of screening, and with having a regular source of care after having health insurance. Examine patient preferences for receiving information about CRC screening, and preferences among CRC screening tests.
	Physician characteristics	Examine physician characteristics associated with underuse of discussion and screening; and with overuse and misuse of screening.
	Systems	Examine the interaction of various systems and different patient populations with CRC screening. Are different systems associated with underuse, overuse, or misuse in different patient populations? Consider systems within primary care practices and systems that include primary care and colonoscopy testing facilities.
3. Intervention strategies to improve appropriate screening	Underuse	**Develop and test promising interventions that need more research, especially integrated with other practice systems and especially in combinations, paying special attention to what strategies work best (and are most cost-effective) in various patient populations. Should use outcomes of CRC screening and discussions.**
	Overuse and misuse	**Develop and test strategies, including monitoring systems, to reduce overuse and misuse.**
4. Current capacity, projected demand, and projected capacity to meet screening and surveillance needs	Current capacity	Studies examining national and regional current capacity for FS and for colonoscopy.
	Projected capacity	Studies examining projected capacity under various realistic screening and training scenarios, perhaps including trained nurse endoscopists (and projections in the context of future physicians trained?).
5. Effective approaches for monitoring appropriate use and quality	Underuse Overuse Misuse	**As in KQ 1, develop and evaluate national or regional monitoring systems that provide routine data on use and quality in a useful and timely form, with feedback mechanisms to encourage improvement.**

BRFSS, Behavioral Risk Factor Surveillance Survey; CRC, colorectal cancer; FOBT. fecal occult blood test; HEDIS, Healthcare Effectiveness Data and Information Set; KQ, key question; NHIS, National Health Interview Survey,

The priority for research should be RCTs of interventions to implement appropriate CRC screening (i.e., minimizing underuse, overuse, and/or misuse) and monitoring linked to improvement initiatives. In our review, we became aware of multiple studies of the operating characteristics of potential new CRC tests. Although improving screening tests is a reasonable research agenda (especially finding ways to reduce the need for the most invasive and expensive tests), screening could be balanced with research to find ways to implement screening programs that we already know are effective, working to minimize underuse, overuse, and misuse. To

focus research primarily on developing newer screening tests without placing higher priority on implementation of the existing effective tests leaves the people of the United States with inadequate screening. At least as important as newer screening tests are improved access, improved communication, and improved organization. We present in this review results of the uses of CRC tests within the VA system, where access to health care and insurance coverage are addressed by being members of that system, demonstrating that in this system, the use of screening is greater than among the general public. We found that rates among respondents in a nationally representative sample of respondents in the 2005 National Health Interview Survey (NHIS) who reported being covered by military insurance were statistically significantly more likely to have been screened when compared to all other insured and uninsured respondents (31.6 percent of those without insurance versus as high as 43.0 percent among insured respondents, compared to 67.9 percent among those with military insurance [$P < 0.0001$]).[46] These findings indicate that when an organization is designed to provide screening to a population with consistent access to care, CRC screening rates can increase to levels seen for breast cancer screening with mammography.

Not only must we understand the organizational and system features important to increasing screening, but research also needs to examine the effectiveness of strategies that target several of the screening steps discussed above. Only when all three steps are accomplished—access to primary care, discussion and recommendation, and providing assistance and reducing barriers to complete screening—would we expect screening rates to markedly improve. The interventions of client or patient reminders, one-on-one interactions, and interventions to eliminate structural barriers seem to hold promise in increasing screening. Their impact could be increased if combined with further interventions to assist patients in traversing the health care system to complete screening. Patient reminders were an effective intervention in increasing cancer screening rates (including CRC screening) in a 2002 meta-analysis.[220] In that meta-analysis, organizational change (such as the use of separate prevention clinics, use of a planned prevention visit, designation of nonphysician staff to do specific preventive care activities) was the most potent intervention in increasing preventive care.[220] This study suggests that a combination of interventions may have the greatest impact on screening rates.

Interventions should be tested that work to optimize CRC screening together with other appropriate screening programs. Some of these interventions could target clinicians. We included two studies that examined the impact of provider-level interventions (for screening[186] or surveillance colonoscopy[188]). Considering the central place that clinicians and their staff have in the screening steps, this is a potentially promising target to improve screening rates, particularly if it increases discussions between patients and providers.

In addition, cost-effectiveness studies of successful interventions to improve screening and monitoring, and then pragmatic trials that are focused on implementation of successful strategies within actual primary care practice are urgently needed. Different intensities of interventions, and even wholly different interventions, will likely be needed for different populations. Interventions should be targeted at the specific steps that are problems for specific populations (e.g., those who speak other languages than English at home could likely benefit from more basic interventions to increase awareness and discussions, whereas those who are already obtaining screening on an irregular basis may benefit most from patient reminders).

Further, we also need continued research into measuring current volume and projected demand for screening strategies. Finally, we found little evidence that adequate monitoring systems that assess the full spectrum of appropriate CRC screening (including overuse, underuse,

and misuse) are in widespread use, and are being used to improve screening. Such monitoring systems are critically important for continued improvement of CRC screening. There is clearly a large and important research agenda for the future.

This research should target more than overcoming the underuse of CRC screening, as important as that is. We found little research interest in reducing underuse of patient-physician discussions about CRC screening, or in reducing overuse and misuse of CRC screening. This research should be a priority in that the issues of high overuse and high misuse are prevalent in today's US health care.

Conclusions

Our review suggests that the United States is yet some distance from fully realizing the promise of appropriate and high-quality CRC screening. Problems of underuse, overuse, and misuse are not being adequately addressed at present. By focusing our research effort on the issues that matter most—access to screening, communication between patient and medical staff, the organization of care—and by further researching how to implement effective and cost-effective strategies into actual primary care practice, we will have the greatest opportunity to reduce the burden of suffering of CRC for the people of the United States.

References

1. Jerant AF, Fenton JJ, Franks P. Determinants of racial/ethnic colorectal cancer screening disparities. Arch Intern Med. 2008 Jun 23;168(12):1317-24.
2. Wong ST, Gildengorin G, Nguyen T, et al. Disparities in colorectal cancer screening rates among Asian Americans and non-Latino whites. Cancer. 2005 Dec 15;104(12 Suppl):2940-7.
3. Screening for colorectal cancer: U.S. Preventive Services Task Force recommendation statement. Ann Intern Med. 2008 Nov 4;149(9):627-37.
4. Levin B, Lieberman DA, McFarland B, et al. Screening and surveillance for the early detection of colorectal cancer and adenomatous polyps, 2008: a joint guideline from the American Cancer Society, the US Multi-Society Task Force on Colorectal Cancer, and the American College of Radiology. Gastroenterology. 2008 May;134(5):1570-95.
5. Chassin MR, Galvin RW. The urgent need to improve health care quality. Institute of Medicine National Roundtable on Health Care Quality. J Am Med Assoc. 1998 Sep 16;280(11):1000-5.
6. Winawer SJ, Stewart ET, Zauber AG, et al. A comparison of colonoscopy and double-contrast barium enema for surveillance after polypectomy. National Polyp Study Work Group. N Engl J Med. 2000 Jun 15;342(24):1766-72.
7. Mandel JS, Bond JH, Church TR, et al. Reducing mortality from colorectal cancer by screening for fecal occult blood. Minnesota Colon Cancer Control Study. N Engl J Med. 1993 May 13;328(19):1365-71.
8. Hardcastle JD, Chamberlain JO, Robinson MH, et al. Randomised controlled trial of faecal-occult-blood screening for colorectal cancer. Lancet. 1996 Nov 30;348(9040):1472-7.
9. Kronborg O, Fenger C, Olsen J, et al. Randomised study of screening for colorectal cancer with faecal-occult-blood test. Lancet. 1996 Nov 30;348(9040):1467-71.
10. Lindholm E, Brevinge H, Haglind E. Survival benefit in a randomized clinical trial of faecal occult blood screening for colorectal cancer. Br J Surg. 2008 Aug;95(8):1029-36.
11. U.S. Preventive Services Task Force. Guide to clinical preventive services. Baltimore: Williams & Wilkins. 1989.
12. U.S. Preventive Services Task Force. Guide to clinical preventive services. 2nd ed. Baltimore: Williams and Wilkins. 1996.
13. Screening for colorectal cancer: recommendation and rationale. Ann Intern Med. 2002 Jul 16;137(2):129-31.
14. Pignone M, Rich M, Teutsch SM, et al. Screening for colorectal cancer in adults at average risk: a summary of the evidence for the U.S. Preventive Services Task Force. Ann Intern Med. 2002 Jul 16;137(2):132-41.
15. Pignone M, Rich M, Teutsch SM, et al. Screening for colorectal cancer in adults. Systematic Evidence Review No. 7. AHRQ Pub No. 02-S003. Rockville, MD: Agency for Healthcare Research and Quality. 2002.
16. Winawer SJ, Fletcher RH, Miller L, et al. Colorectal cancer screening: clinical guidelines and rationale. Gastroenterology. 1997 Feb;112(2):594-642.
17. Winawer S, Fletcher R, Rex D, et al. Colorectal cancer screening and surveillance: clinical guidelines and rationale--update based on new evidence. Gastroenterology. 2003 Feb;124(2):544-60.
18. Mandel JS, Church TR, Bond JH, et al. The effect of fecal occult-blood screening on the incidence of colorectal cancer. N Engl J Med. 2000 Nov 30;343(22):1603-7.
19. Use of mammograms among women aged > or = 40 years--United States, 2000-2005. MMWR Morb Mortal Wkly Rep. 2007 Jan 26;56(3):49-51.
20. Warren JL, Klabunde CN, Mariotto AB, et al. Adverse events after outpatient colonoscopy in the Medicare population. Ann Intern Med. 2009 Jun 16;150(12):849-57, W152.
21. Seeff LC, Nadel MR, Klabunde CN, et al. Patterns and predictors of colorectal cancer test use in the adult U.S. population. Cancer. 2004 May 15;100(10):2093-103.
22. Pollack LA, Blackman DK, Wilson KM, et al. Colorectal cancer test use among Hispanic and non-Hispanic U.S. populations. Prev Chronic Dis. 2006 Apr;3(2):A50.
23. Schroy PC, Heeren TC. A comparative study of patient perceptions and screening preferences for stool-based DNA testing (SBDNA), fecal occult blood testing (FOBT), or colonoscopy (CS). Gastroenterology. 2003;124(4 Suppl):A604.
24. Klabunde CN, Lanier D, Breslau ES, et al. Improving colorectal cancer screening in primary care practice: innovative strategies and future directions. J Gen Intern Med. 2007 Aug;22(8):1195-205.
25. Sheridan SL, Harris RP, Woolf SH. Shared decision making about screening and chemoprevention. a suggested approach from the U.S. Preventive Services Task Force. Am J Prev Med. 2004 Jan;26(1):56-66.
26. Green L, Kreuter M. Health program planning: an educational and ecological approach. 4th ed: McGraw Hill: NY 2004.
27. Slattery ML, Kinney AY, Levin TR. Factors associated with colorectal cancer screening in a population-based study: the impact of gender, health care source, and time. Prev Med. 2004 Mar;38(3):276-83.
28. Coughlin SS, Thompson TD. Colorectal cancer screening practices among men and women in rural and nonrural areas of the United States, 1999. J Rural Health. 2004 Spring;20(2):118-24.
29. Subramanian S, Klosterman M, Amonkar MM, et al. Adherence with colorectal cancer screening guidelines: a review. Prev Med. 2004 May;38(5):536-50.

30. Agency for Healthcare Research and Quality. Methods Guide for Comparative Effectiveness REviews, Version 1.0 [Draft posted Oct. 2007]. Rockville, MD. Available at: http://effectivehealthcare.ahrq.gov/repFiles/2007_10DraftMethodsGuide.pdf. 2007.
31. Owens DK, Lohr KN, Atkins D, et al. Grading the strength of a body of evidence when comparing medical interventions--Agency for Healthcare Research and Quality and the Effective Health Care Program. Journal of clinical epidemiology. 2009 07/13.
32. Jemal A, Siegel R, Ward E, et al. Cancer statistics, 2009. CA Cancer J Clin. 2009 Jul-Aug;59(4):225-49.
33. Jemal A, Thun MJ, Ries LA, et al. Annual report to the nation on the status of cancer, 1975-2005, featuring trends in lung cancer, tobacco use, and tobacco control. J Natl Cancer Inst. 2008 Dec 3;100(23):1672-94.
34. DeLancey JO, Thun MJ, Jemal A, et al. Recent trends in Black-White disparities in cancer mortality. Cancer Epidemiol Biomarkers Prev. 2008 Nov;17(11):2908-12.
35. Schneider EC, Nadel MR, Zaslavsky AM, et al. Assessment of the scientific soundness of clinical performance measures: a field test of the National Committee for Quality Assurance's colorectal cancer screening measure. Arch Intern Med. 2008 Apr 28;168(8):876-82.
36. Baier M, Calonge N, Cutter G, et al. Validity of self-reported colorectal cancer screening behavior. Cancer Epidemiol Biomarkers Prev. 2000 Feb;9(2):229-32.
37. Gordon NP, Hiatt RA, Lampert DI. Concordance of self-reported data and medical record audit for six cancer screening procedures. J Natl Cancer Inst. 1993 Apr 7;85(7):566-70.
38. Montano DE, Phillips WR. Cancer screening by primary care physicians: a comparison of rates obtained from physician self-report, patient survey, and chart audit. Am J Public Health. 1995 Jun;85(6):795-800.
39. Schenck AP, Klabunde CN, Warren JL, et al. Data sources for measuring colorectal endoscopy use among Medicare enrollees. Cancer Epidemiol Biomarkers Prev. 2007 Oct;16(10):2118-27.
40. Schenck AP, Klabunde CN, Warren JL, et al. Evaluation of claims, medical records, and self-report for measuring fecal occult blood testing among Medicare enrollees in fee for service. Cancer Epidemiol Biomarkers Prev. 2008 Apr;17(4):799-804.
41. Breen N, Wagener DK, Brown ML, et al. Progress in cancer screening over a decade: results of cancer screening from the 1987, 1992, and 1998 National Health Interview Surveys. J Natl Cancer Inst. 2001 Nov 21;93(22):1704-13.
42. Peterson NB, Murff HJ, Ness RM, et al. Colorectal cancer screening among men and women in the United States. J Womens Health (Larchmt). 2007 Jan-Feb;16(1):57-65.
43. Meissner HI, Breen N, Klabunde CN, et al. Patterns of colorectal cancer screening uptake among men and women in the United States. Cancer Epidemiol Biomarkers Prev. 2006 Feb;15(2):389-94.
44. Colorectal cancer test use among persons aged > or = 50 years--United States, 2001. MMWR Morb Mortal Wkly Rep. 2003 Mar 14;52(10):193-6.
45. Use of colorectal cancer tests--United States, 2002, 2004, and 2006. MMWR Morb Mortal Wkly Rep. 2008 Mar 14;57(10):253-8.
46. Shapiro JA, Seeff LC, Thompson TD, et al. Colorectal cancer test use from the 2005 National Health Interview Survey. Cancer Epidemiol Biomarkers Prev. 2008 Jul;17(7):1623-30.
47. Trends in screening for colorectal cancer--United States, 1997 and 1999. MMWR Morb Mortal Wkly Rep. 2001 Mar 9;50(9):162-6.
48. Nease DE, Jr., Ruffin MTt, Klinkman MS, et al. Impact of a generalizable reminder system on colorectal cancer screening in diverse primary care practices: a report from the Prompting and Reminding at Encounters for Prevention Project. Med Care. 2008 Sep;46(9 Suppl 1):S68-73.
49. Lafata JE, Williams LK, Ben-Menachem T, et al. Colorectal carcinoma screening procedure use among primary care patients. Cancer. 2005 Oct 1;104(7):1356-61.
50. Bao Y, Fox SA, Escarce JJ. Socioeconomic and racial/ethnic differences in the discussion of cancer screening: "between-" versus "within-" physician differences. Health Serv Res. 2007 Jun;42(3 Pt 1):950-70.
51. Ling BS, Trauth JM, Fine MJ, et al. Informed decision-making and colorectal cancer screening: is it occurring in primary care? Med Care. 2008 Sep;46(9 Suppl 1):S23-9.
52. Wackerbarth SB, Tarasenko YN, Joyce JM, et al. Physician colorectal cancer screening recommendations: an examination based on informed decision making. Patient Educ Couns. 2007 Apr;66(1):43-50.
53. Wolf MS, Baker DW, Makoul G. Physician-patient communication about colorectal cancer screening. J Gen Intern Med. 2007 Nov;22(11):1493-9.
54. Lafata JE, Divine G, Moon C, et al. Patient-physician colorectal cancer screening discussions and screening use. Am J Prev Med. 2006 Sep;31(3):202-9.
55. Berkowitz Z, Hawkins NA, Peipins LA, et al. Beliefs, risk perceptions, and gaps in knowledge as barriers to colorectal cancer screening in older adults. J Am Geriatr Soc. 2008 Feb;56(2):307-14.
56. Cairns CP, Viswanath K. Communication and colorectal cancer screening among the uninsured: data from the Health Information National Trends Survey (United States). Cancer Causes Control. 2006 Nov;17(9):1115-25.
57. Klabunde CN, Vernon SW, Nadel MR, et al. Barriers to colorectal cancer screening: a comparison of reports from primary care physicians and average-risk adults. Med Care. 2005 Sep;43(9):939-44.
58. Fenton JJ, Cai Y, Green P, et al. Trends in colorectal cancer testing among Medicare subpopulations. Am J Prev Med. 2008 Sep;35(3):194-202.

59. Schenck AP, Peacock SC, Klabunde CN, et al. Trends in colorectal cancer test use in the medicare population, 1998-2005. Am J Prev Med. 2009 Jul;37(1):1-7.
60. Harewood GC, Lieberman DA. Colonoscopy practice patterns since introduction of Medicare coverage for average-risk screening. Clin Gastroenterol Hepatol. 2004 Jan;2(1):72-7.
61. Robertson RH, Burkhardt JH, Powell MP, et al. Trends in colon cancer screening procedures in the US Medicare and Tricare populations: 1999-2001. Prev Med. 2006 Jun;42(6):460-2.
62. Prajapati DN, Saeian K, Binion DG, et al. Volume and yield of screening colonoscopy at a tertiary medical center after change in Medicare reimbursement. Am J Gastroenterol. 2003 Jan;98(1):194-9.
63. Gross CP, Andersen MS, Krumholz HM, et al. Relation between Medicare screening reimbursement and stage at diagnosis for older patients with colon cancer. JAMA. 2006 Dec 20;296(23):2815-22.
64. El-Serag HB, Petersen L, Hampel H, et al. The use of screening colonoscopy for patients cared for by the Department of Veterans Affairs. Arch Intern Med. 2006 Nov 13;166(20):2202-8.
65. Brounts LR, Lehmann RK, Lesperance KE, et al. Improved rates of colorectal cancer screening in an equal access population. Am J Surg. 2009 May;197(5):609-12; discussion 12-3.
66. Messina CR, Lane DS, Colson RC. Colorectal cancer screening among users of county health centers and users of private physician practices. Public Health Rep. 2009 Jul-Aug;124(4):568-78.
67. Benson VS, Patnick J, Davies AK, et al. Colorectal cancer screening: a comparison of 35 initiatives in 17 countries. Int J Cancer. 2008 Mar 15;122(6):1357-67.
68. DeBourcy AC, Lichtenberger S, Felton S, et al. Community-based preferences for stool cards versus colonoscopy in colorectal cancer screening. J Gen Intern Med. 2008 Feb;23(2):169-74.
69. Hawley ST, Volk RJ, Krishnamurthy P, et al. Preferences for colorectal cancer screening among racially/ethnically diverse primary care patients. Med Care. 2008 Sep;46(9 Suppl 1):S10-6.
70. Schroy PC, 3rd, Heeren TC. Patient perceptions of stool-based DNA testing for colorectal cancer screening. Am J Prev Med. 2005 Feb;28(2):208-14.
71. Weir HK, Thun MJ, Hankey BF, et al. Annual report to the nation on the status of cancer, 1975-2000, featuring the uses of surveillance data for cancer prevention and control. J Natl Cancer Inst. 2003 Sep 3;95(17):1276-99.
72. Increased use of colorectal cancer tests--United States, 2002 and 2004. MMWR Morb Mortal Wkly Rep. 2006 Mar 24;55(11):308-11.
73. VHA Office of Quality and Performance intranet website: http://vaww.oqp.med.va.gov/. NOTE: This is an internal web site and not available to the public. Accessed August 24, 2009.
74. Walter LC, Lindquist K, Nugent S, et al. Impact of age and comorbidity on colorectal cancer screening among older veterans. Ann Intern Med. 2009 Apr 7;150(7):465-73.
75. Fisher DA, Galanko J, Dudley TK, et al. Impact of comorbidity on colorectal cancer screening in the veterans healthcare system. Clin Gastroenterol Hepatol. 2007 Aug;5(8):991-6.
76. Fisher DA, Judd L, Sanford NS. Inappropriate colorectal cancer screening: findings and implications. Am J Gastroenterol. 2005 Nov;100(11):2526-30.
77. Mysliwiec PA, Brown ML, Klabunde CN, et al. Are physicians doing too much colonoscopy? A national survey of colorectal surveillance after polypectomy. Ann Intern Med. 2004 Aug 17;141(4):264-71.
78. Winawer SJ, Zauber AG, Fletcher RH, et al. Guidelines for colonoscopy surveillance after polypectomy: a consensus update by the US Multi-Society Task Force on Colorectal Cancer and the American Cancer Society. Gastroenterology. 2006 May;130(6):1872-85.
79. Boolchand V, Olds G, Singh J, et al. Colorectal screening after polypectomy: a national survey study of primary care physicians. Ann Intern Med. 2006 Nov 7;145(9):654-9.
80. Krist AH, Jones RM, Woolf SH, et al. Timing of repeat colonoscopy: disparity between guidelines and endoscopists' recommendation. Am J Prev Med. 2007 Dec;33(6):471-8.
81. Robertson DJ, Greenberg ER, Beach M, et al. Colorectal cancer in patients under close colonoscopic surveillance. Gastroenterology. 2005 Jul;129(1):34-41.
82. Laiyemo AO, Pinsky PF, Marcus PM, et al. Utilization and yield of surveillance colonoscopy in the continued follow-up study of the polyp prevention trial. Clin Gastroenterol Hepatol. 2009 May;7(5):562-7; quiz 497.
83. Collins JF, Lieberman DA, Durbin TE, et al. Accuracy of screening for fecal occult blood on a single stool sample obtained by digital rectal examination: a comparison with recommended sampling practice. Ann Intern Med. 2005 Jan 18;142(2):81-5.
84. Nadel MR, Shapiro JA, Klabunde CN, et al. A national survey of primary care physicians' methods for screening for fecal occult blood. Ann Intern Med. 2005 Jan 18;142(2):86-94.
85. Stokamer CL, Tenner CT, Chaudhuri J, et al. Randomized controlled trial of the impact of intensive patient education on compliance with fecal occult blood testing. J Gen Intern Med. 2005 Mar;20(3):278-82.
86. 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 Sep;46(9 Suppl 1):S91-6.
87. Etzioni DA, Yano EM, Rubenstein LV, et al. Measuring the quality of colorectal cancer screening: the importance of follow-up. Dis Colon Rectum. 2006 Jul;49(7):1002-10.
88. Fisher DA, Jeffreys A, Coffman CJ, et al. Barriers to full colon evaluation for a positive fecal occult blood test. Cancer Epidemiol Biomarkers Prev. 2006 Jun;15(6):1232-5.

89. Rao SK, Schilling TF, Sequist TD. Challenges in the management of positive fecal occult blood tests. J Gen Intern Med. 2009 Mar;24(3):356-60.
90. Shields HM, Weiner MS, Henry DR, et al. Factors that influence the decision to do an adequate evaluation of a patient with a positive stool for occult blood. Am J Gastroenterol. 2001 Jan;96(1):196-203.
91. Baig N, Myers RE, Turner BJ, et al. Physician-reported reasons for limited follow-up of patients with a positive fecal occult blood test screening result. Am J Gastroenterol. 2003 Sep;98(9):2078-81.
92. Levin B, Hess K, Johnson C. Screening for colorectal cancer. A comparison of 3 fecal occult blood tests. Arch Intern Med. 1997 May 12;157(9):970-6.
93. Turner B, Myers RE, Hyslop T, et al. Physician and patient factors associated with ordering a colon evaluation after a positive fecal occult blood test. J Gen Intern Med. 2003 May;18(5):357-63.
94. Klabunde CN, Riley GF, Mandelson MT, et al. Health plan policies and programs for colorectal cancer screening: a national profile. Am J Manag Care. 2004 Apr;10(4):273-9.
95. Whitlock EP, Lin JS, Liles E, et al. Screening for colorectal cancer: a targeted, updated systematic review for the U.S. Preventive Services Task Force. Ann Intern Med. 2008 Nov 4;149(9):638-58.
96. Bressler B, Paszat LF, Chen Z, et al. Rates of new or missed colorectal cancers after colonoscopy and their risk factors: a population-based analysis. Gastroenterology. 2007 Jan;132(1):96-102.
97. Leaper M, Johnston MJ, Barclay M, et al. Reasons for failure to diagnose colorectal carcinoma at colonoscopy. Endoscopy. 2004 Jun;36(6):499-503.
98. Haseman JH, Lemmel GT, Rahmani EY, et al. Failure of colonoscopy to detect colorectal cancer: evaluation of 47 cases in 20 hospitals. Gastrointest Endosc. 1997 Jun;45(6):451-5.
99. Rex DK, Cutler CS, Lemmel GT, et al. Colonoscopic miss rates of adenomas determined by back-to-back colonoscopies. Gastroenterology. 1997 Jan;112(1):24-8.
100. Pabby A, Schoen RE, Weissfeld JL, et al. Analysis of colorectal cancer occurrence during surveillance colonoscopy in the dietary Polyp Prevention Trial. Gastrointest Endosc. 2005 Mar;61(3):385-91.
101. Imperiale TF, Glowinski EA, Juliar BE, et al. Variation in polyp detection rates at screening colonoscopy. Gastrointest Endosc. 2009 Jun;69(7):1288-95.
102. Barclay RL, Vicari JJ, Doughty AS, et al. Colonoscopic withdrawal times and adenoma detection during screening colonoscopy. N Engl J Med. 2006 Dec 14;355(24):2533-41.
103. Chen SC, Rex DK. Endoscopist can be more powerful than age and male gender in predicting adenoma detection at colonoscopy. Am J Gastroenterol. 2007 Apr;102(4):856-61.
104. Barclay RL, Vicari JJ, Greenlaw RL. Effect of a time-dependent colonoscopic withdrawal protocol on adenoma detection during screening colonoscopy. Clin Gastroenterol Hepatol. 2008 Oct;6(10):1091-8.
105. Shah HA, Paszat LF, Saskin R, et al. Factors associated with incomplete colonoscopy: a population-based study. Gastroenterology. 2007 Jun;132(7):2297-303.
106. Zimmerman RK, Tabbarah M, Trauth J, et al. Predictors of lower endoscopy use among patients at three inner-city neighborhood health centers. J Urban Health. 2006 Mar;83(2):221-30.
107. Zapka JG, Puleo E, Vickers-Lahti M, et al. Healthcare system factors and colorectal cancer screening. Am J Prev Med. 2002 Jul;23(1):28-35.
108. Young WF, McGloin J, Zittleman L, et al. Predictors of colorectal screening in rural Colorado: testing to prevent colon cancer in the high plains research network. The Journal of rural health : official journal of the American Rural Health Association and the National Rural Health Care Association. 2007(3):238-45.
109. Yip MP, Tu SP, Chun A, et al. Participation in colorectal cancer screening among Chinese Americans. Asian Pac J Cancer Prev. 2006 Oct-Dec;7(4):645-50.
110. Yano EM, Soban LM, Parkerton PH, et al. Primary care practice organization influences colorectal cancer screening performance. Health Serv Res. 2007 Jun;42(3 Pt 1):1130-49.
111. Wee CC, McCarthy EP, Phillips RS. Factors associated with colon cancer screening: the role of patient factors and physician counseling. Prev Med. 2005 Jul;41(1):23-9.
112. Walsh JM, Kaplan CP, Nguyen B, et al. Barriers to colorectal cancer screening in Latino and Vietnamese Americans. Compared with non-Latino white Americans. J Gen Intern Med. 2004 Feb;19(2):156-66.
113. Trivers KF, Shaw KM, Sabatino SA, et al. Trends in colorectal cancer screening disparities in people aged 50-64 years, 2000-2005. Am J Prev Med. 2008 Sep;35(3):185-93.
114. Thorpe LE, Mostashari F, Hajat A, et al. Colon cancer screening practices in New York City, 2003: results of a large random-digit dialed telephone survey. Cancer. 2005 Sep 1;104(5):1075-82.
115. Thompson B, Coronado GD, Solomon CC, et al. Cancer prevention behaviors and socioeconomic status among Hispanics and non-Hispanic whites in a rural population in the United States. Cancer Causes Control. 2002 Oct;13(8):719-28.
116. Thompson B, Coronado G, Neuhouser M, et al. Colorectal carcinoma screening among Hispanics and non-Hispanic whites in a rural setting. Cancer. 2005 Jun 15;103(12):2491-8.
117. Thompson B, Coronado G, Chen L, et al. Celebremos la salud! a community randomized trial of cancer prevention (United States). Cancer Causes Control. 2006 Jun;17(5):733-46.
118. Sun WY, Basch CE, Wolf RL, et al. Factors associated with colorectal cancer screening among Chinese-Americans. Prev Med. 2004 Aug;39(2):323-9.
119. Shih YC, Zhao L, Elting LS. Does Medicare coverage of colonoscopy reduce racial/ethnic disparities in

cancer screening among the elderly? Health Aff (Millwood). 2006 Jul-Aug;25(4):1153-62.
120. Shih YC, Elting LS, Levin B. Disparities in colorectal screening between US-born and foreign-born populations: evidence from the 2000 National Health Interview Survey. J Cancer Educ. 2008 Jan-Mar;23(1):18-25.
121. Shah M, Zhu K, Potter J. Hispanic acculturation and utilization of colorectal cancer screening in the United States. Cancer Detect Prev. 2006;30(3):306-12.
122. Schumacher MC, Slattery ML, Lanier AP, et al. Prevalence and predictors of cancer screening among American Indian and Alaska native people: the EARTH study. Cancer Causes Control. 2008 Sep;19(7):725-37.
123. Schootman M, Jeffe DB, Baker EA, et al. Effect of area poverty rate on cancer screening across US communities. J Epidemiol Community Health. 2006 Mar;60(3):202-7.
124. Schneider EC, Rosenthal M, Gatsonis CG, et al. Is the type of Medicare insurance associated with colorectal cancer screening prevalence and selection of screening strategy? Med Care. 2008 Sep;46(9 Suppl 1):S84-90.
125. Schenck AP, Klabunde CN, Davis WW. Racial differences in colorectal cancer test use by Medicare consumers. Am J Prev Med. 2006 Apr;30(4):320-6.
126. Rosen AB, Schneider EC. Colorectal cancer screening disparities related to obesity and gender. J Gen Intern Med. 2004 Apr;19(4):332-8.
127. Pham HH, Schrag D, Hargraves JL, et al. Delivery of preventive services to older adults by primary care physicians. JAMA. 2005 Jul 27;294(4):473-81.
128. O'Malley AS, Forrest CB, Mandelblatt J. Adherence of low-income women to cancer screening recommendations. J Gen Intern Med. 2002 Feb;17(2):144-54.
129. O'Malley AS, Forrest CB, Feng S, et al. Disparities despite coverage: gaps in colorectal cancer screening among Medicare beneficiaries. Arch Intern Med. 2005 Oct 10;165(18):2129-35.
130. Nguyen BH, McPhee SJ, Stewart SL, et al. Colorectal cancer screening in Vietnamese Americans. J Cancer Educ. 2008 Jan-Mar;23(1):37-45.
131. Muus KJ, Baker-Demaray T, McDonald LR, et al. Body mass index and cancer screening in older American Indian and Alaska Native men. J Rural Health. 2009 Winter;25(1):104-8.
132. Menis M, Kozlovsky B, Langenberg P, et al. Body mass index and up-to-date colorectal cancer screening among Marylanders aged 50 years and older. Prev Chronic Dis. 2006 Jul;3(3):A88.
133. McQueen A, Vernon SW, Meissner HI, et al. Are there gender differences in colorectal cancer test use prevalence and correlates? Cancer Epidemiol Biomarkers Prev. 2006 Apr;15(4):782-91.
134. Matthews BA, Nattinger AB, Venkatesan T, et al. Colorectal cancer screening among midwestern community-based residents: indicators of success. J Community Health. 2007 Apr;32(2):103-20.
135. Ling BS, Klein WM, Dang Q. Relationship of communication and information measures to colorectal cancer screening utilization: results from HINTS. J Health Commun. 2006;11 Suppl 1:181-90.
136. Levy BT, Dawson J, Hartz AJ, et al. Colorectal cancer testing among patients cared for by Iowa family physicians. Am J Prev Med. 2006 Sep;31(3):193-201.
137. Lemon S, Zapka J, Puleo E, et al. Colorectal cancer screening participation: comparisons with mammography and prostate-specific antigen screening. Am J Public Health. 2001 Aug;91(8):1264-72.
138. Koroukian SM, Xu F, Dor A, et al. Colorectal cancer screening in the elderly population: disparities by dual Medicare-Medicaid enrollment status. Health Serv Res. 2006 Dec;41(6):2136-54.
139. Koroukian SM, Litaker D, Dor A, et al. Use of preventive services by Medicare fee-for-service beneficiaries: does spillover from managed care matter? Med Care. 2005 May;43(5):445-52.
140. Katz ML, James AS, Pignone MP, et al. Colorectal cancer screening among African American church members: a qualitative and quantitative study of patient-provider communication. BMC Public Health. 2004 Dec 15;4:62.
141. Jerant AF, Arellanes RE, Franks P. Factors associated with Hispanic/non-Hispanic white colorectal cancer screening disparities. J Gen Intern Med. 2008 Aug;23(8):1241-5.
142. Janz NK, Wren PA, Schottenfeld D, et al. Colorectal cancer screening attitudes and behavior: a population-based study. Prev Med. 2003 Dec;37(6 Pt 1):627-34.
143. Hudson SV, Ohman-Strickland P, Cunningham R, et al. The effects of teamwork and system support on colorectal cancer screening in primary care practices. Cancer Detect Prev. 2007;31(5):417-23.
144. Honda K, Kagawa-Singer M. Cognitive mediators linking social support networks to colorectal cancer screening adherence. J Behav Med. 2006 Oct;29(5):449-60.
145. Heo M, Allison DB, Fontaine KR. Overweight, obesity, and colorectal cancer screening: disparity between men and women. BMC Public Health. 2004 Nov 8;4:53.
146. Gupta S, Tong L, Allison JE, et al. Screening for colorectal cancer in a safety-net health care system: access to care is critical and has implications for screening policy. Cancer Epidemiol Biomarkers Prev. 2009 Sep;18(9):2373-9.
147. Goel MS, Wee CC, McCarthy EP, et al. Racial and ethnic disparities in cancer screening: the importance of foreign birth as a barrier to care. J Gen Intern Med. 2003 Dec;18(12):1028-35.
148. Gilbert A, Kanarek N. Colorectal cancer screening: physician recommendation is influential advice to Marylanders. Prev Med. 2005 Aug;41(2):367-79.
149. Afable-Munsuz A, Liang SY, Ponce NA, et al. Acculturation and colorectal cancer screening among older Latino adults: differential associations by national origin. J Gen Intern Med. 2009 Aug;24(8):963-70.
150. Ananthakrishnan AN, Schellhase KG, Sparapani RA, et al. Disparities in colon cancer screening in the

Medicare population. Arch Intern Med. 2007 Feb 12;167(3):258-64.
151. Ata A, Elzey JD, Insaf TZ, et al. Colorectal cancer prevention: adherence patterns and correlates of tests done for screening purposes within United States populations. Cancer Detect Prev. 2006;30(2):134-43.
152. Atlas SJ, Grant RW, Ferris TG, et al. Patient-physician connectedness and quality of primary care. Ann Intern Med. 2009 Mar 3;150(5):325-35.
153. Brawarsky P, Brooks DR, Mucci LA, et al. Effect of physician recommendation and patient adherence on rates of colorectal cancer testing. Cancer Detect Prev. 2004;28(4):260-8.
154. Carcaise-Edinboro P, Bradley CJ. Influence of patient-provider communication on colorectal cancer screening. Med Care. 2008 Jul;46(7):738-45.
155. Cardarelli R, Thomas JE. Having a personal health care provider and receipt of colorectal cancer testing. Ann Fam Med. 2009 Jan-Feb;7(1):5-10.
156. Carlos RC, Fendrick AM, Ellis J, et al. Can breast and cervical cancer screening visits be used to enhance colorectal cancer screening? J Am Coll Radiol. 2004 Oct;1(10):769-76.
157. Carlos RC, Fendrick AM, Patterson SK, et al. Associations in breast and colon cancer screening behavior in women. Acad Radiol. 2005 Apr;12(4):451-8.
158. Christman LK, Abdulla R, Jacobsen PB, et al. Colorectal cancer screening among a sample of community health center attendees. J Health Care Poor Underserved. 2004 May;15(2):281-93.
159. Coughlin SS, Thompson T. Physician recommendation for colorectal cancer screening by race, ethnicity, and health insurance status among men and women in the United States, 2000. Health Promot Pract. 2005 Oct;6(4):369-78.
160. de Bosset V, Atashili J, Miller W, et al. Health insurance-related disparities in colorectal cancer screening in Virginia. Cancer Epidemiol Biomarkers Prev. 2008 Apr;17(4):834-7.
161. Diaz JA, Roberts MB, Goldman RE, et al. Effect of language on colorectal cancer screening among Latinos and non-Latinos. Cancer Epidemiol Biomarkers Prev. 2008 Aug;17(8):2169-73.
162. Dietrich AJ, Tobin JN, Cassells A, et al. Translation of an efficacious cancer-screening intervention to women enrolled in a Medicaid managed care organization. Ann Fam Med. 2007 Jul-Aug;5(4):320-7.
163. Etzioni DA, Ponce NA, Babey SH, et al. A population-based study of colorectal cancer test use: results from the 2001 California Health Interview Survey. Cancer. 2004 Dec 1;101(11):2523-32.
164. Fenton JJ, Cai Y, Weiss NS, et al. Delivery of cancer screening: how important is the preventive health examination? Arch Intern Med. 2007 Mar 26;167(6):580-5.
165. Fenton JJ, Tancredi DJ, Green P, et al. Persistent racial and ethnic disparities in up-to-date colorectal cancer testing in medicare enrollees. J Am Geriatr Soc. 2009 Mar;57(3):412-8.
166. Ferrante JM, Ohman-Strickland P, Hudson SV, et al. Colorectal cancer screening among obese versus non-obese patients in primary care practices. Cancer Detect Prev. 2006;30(5):459-65.
167. Fox SA, Heritage J, Stockdale SE, et al. Cancer screening adherence: does physician-patient communication matter? Patient Educ Couns. 2009 May;75(2):178-84.
168. Garman KS, Jeffreys A, Coffman C, et al. Colorectal cancer screening, comorbidity, and follow-up in elderly patients. Am J Med Sci. 2006 Oct;332(4):159-63.
169. Breuer-Katschinski B, Nemes K, Marr A, et al. Helicobacter pylori and the risk of colonic adenomas. Colorectal Adenoma Study Group. Digestion. 1999;60(3):210-5.
170. Bagai A, Parsons K, Malone B, et al. Workplace colorectal cancer-screening awareness programs: an adjunct to primary care practice? J Community Health. 2007 Jun;32(3):157-67.
171. Patel P, Forjuoh SN, Avots-Avotins A, et al. Identifying opportunities for improved colorectal cancer screening in primary care. Prev Med. 2004 Aug;39(2):239-46.
172. Brawarsky P, Brooks DR, Mucci LA. Correlates of colorectal cancer testing in Massachusetts men and women. Prev Med. 2003 Jun;36(6):659-68.
173. Nash D, Azeez S, Vlahov D, et al. Evaluation of an intervention to increase screening colonoscopy in an urban public hospital setting. J Urban Health. 2006 Mar;83(2):231-43.
174. Zapka JG, Lemon SC, Puleo E, et al. Patient education for colon cancer screening: a randomized trial of a video mailed before a physical examination. Ann Intern Med. 2004 Nov 2;141(9):683-92.
175. 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 Nov 1;110(9):2083-91.
176. Costanza ME, Luckmann R, Stoddard AM, et al. Using tailored telephone counseling to accelerate the adoption of colorectal cancer screening. Cancer Detect Prev. 2007;31(3):191-8.
177. Pignone M, Harris R, Kinsinger L. Videotape-based decision aid for colon cancer screening. A randomized, controlled trial. Ann Intern Med. 2000 Nov 21;133(10):761-9.
178. Ruffin MTt, Fetters MD, Jimbo M. Preference-based electronic decision aid to promote colorectal cancer screening: results of a randomized controlled trial. Prev Med. 2007 Oct;45(4):267-73.
179. Tu SP, Taylor V, Yasui Y, et al. Promoting culturally appropriate colorectal cancer screening through a health educator: a randomized controlled trial. Cancer. 2006 Sep 1;107(5):959-66.
180. Basch CE, Wolf RL, Brouse CH, et al. Telephone outreach to increase colorectal cancer screening in an urban minority population. Am J Public Health. 2006 Dec;96(12):2246-53.
181. Dolan JG, Frisina S. Randomized controlled trial of a patient decision aid for colorectal cancer screening. Med Decis Making. 2002 Mar-Apr;22(2):125-39.
182. Denberg TD, Coombes JM, Byers TE, et al. Effect of a mailed brochure on appointment-keeping for

screening colonoscopy: a randomized trial. Ann Intern Med. 2006 Dec 19;145(12):895-900.
183. Church TR, Yeazel MW, Jones RM, et al. A randomized trial of direct mailing of fecal occult blood tests to increase colorectal cancer screening. J Natl Cancer Inst. 2004 May 19;96(10):770-80.
184. Braun KL, Fong M, Kaanoi ME, et al. Testing a culturally appropriate, theory-based intervention to improve colorectal cancer screening among Native Hawaiians. Prev Med. 2005 Jun;40(6):619-27.
185. Campbell MK, James A, Hudson MA, et al. Improving multiple behaviors for colorectal cancer prevention among african american church members. Health Psychol. 2004 Sep;23(5):492-502.
186. 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 Feb 23;169(4):364-71.
187. Potter MB, Phengrasamy L, Hudes ES, et al. Offering annual fecal occult blood tests at annual flu shot clinics increases colorectal cancer screening rates. Ann Fam Med. 2009 Jan-Feb;7(1):17-23.
188. Ayanian JZ, Sequist TD, Zaslavsky AM, et al. Physician reminders to promote surveillance colonoscopy for colorectal adenomas: a randomized controlled trial. J Gen Intern Med. 2008 Jun;23(6):762-7.
189. Jandorf L, Gutierrez Y, Lopez J, et al. Use of a patient navigator to increase colorectal cancer screening in an urban neighborhood health clinic. J Urban Health. 2005 Jun;82(2):216-24.
190. Roetzheim RG, Christman LK, Jacobsen PB, et al. A randomized controlled trial to increase cancer screening among attendees of community health centers. Ann Fam Med. 2004 Jul-Aug;2(4):294-300.
191. Roetzheim RG, Christman LK, Jacobsen PB, et al. Long-term results from a randomized controlled trial to increase cancer screening among attendees of community health centers. Ann Fam Med. 2005 Mar-Apr;3(2):109-14.
192. 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 Jan 12;169(1):47-55.
193. Dietrich AJ, Tobin JN, Cassells A, et al. Telephone care management to improve cancer screening among low-income women: a randomized, controlled trial. Ann Intern Med. 2006 Apr 18;144(8):563-71.
194. Breslow RA, Rimer BK, Baron RC, et al. Introducing the community guide's reviews of evidence on interventions to increase screening for breast, cervical, and colorectal cancers. Am J Prev Med. 2008 Jul;35(1 Suppl):S14-20.
195. Brown ML, Klabunde CN, Mysliwiec P. Current capacity for endoscopic colorectal cancer screening in the United States: data from the National Cancer Institute Survey of Colorectal Cancer Screening Practices. Am J Med. 2003 Aug 1;115(2):129-33.
196. Seeff LC, Richards TB, Shapiro JA, et al. How many endoscopies are performed for colorectal cancer screening? Results from CDC's survey of endoscopic capacity. Gastroenterology. 2004 Dec;127(6):1670-7.
197. Ballew C, Lloyd BG, Miller SH. Capacity for colorectal cancer screening by colonoscopy, Montana, 2008. Am J Prev Med. 2009 Apr;36(4):329-32.
198. Benuzillo JG, Jacobs ET, Hoffman RM, et al. Rural-urban differences in colorectal cancer screening capacity in Arizona. J Community Health. 2009 Sep 2.
199. Hur C, Gazelle GS, Zalis ME, et al. An analysis of the potential impact of computed tomographic colonography (virtual colonoscopy) on colonoscopy demand. Gastroenterology. 2004 Nov;127(5):1312-21.
200. Vijan S, Inadomi J, Hayward RA, et al. Projections of demand and capacity for colonoscopy related to increasing rates of colorectal cancer screening in the United States. Aliment Pharmacol Ther. 2004 Sep 1;20(5):507-15.
201. Ladabaum U, Song K. Projected national impact of colorectal cancer screening on clinical and economic outcomes and health services demand. Gastroenterology. 2005 Oct;129(4):1151-62.
202. Seeff LC, Manninen DL, Dong FB, et al. Is there endoscopic capacity to provide colorectal cancer screening to the unscreened population in the United States? Gastroenterology. 2004 Dec;127(6):1661-9.
203. Pickhardt PJ, Hassan C, Laghi A, et al. Is there sufficient MDCT capacity to provide colorectal cancer screening with CT colonography for the U.S. population? AJR Am J Roentgenol. 2008 Apr;190(4):1044-9.
204. Fisher JA, Fikry C, Troxel AB. Cutting cost and increasing access to colorectal cancer screening: another approach to following the guidelines. Cancer Epidemiol Biomarkers Prev. 2006 Jan;15(1):108-13.
205. Framework and tools for evaluating health surveillance systems. Prepared by Health Surveillance Coordinating Committee (HSCC) Population and Public Health Branch Health Canada. Available at http://www.phac-aspc.gc.ca/php-psp/pdf/i_Surveillance_Evaluation_Framework_v1.pdf. 2004.
206. Hall HI, Van Den Eeden SK, Tolsma DD, et al. Testing for prostate and colorectal cancer: comparison of self-report and medical record audit. Prev Med. 2004 Jul;39(1):27-35.
207. Fiscella K, Holt K, Meldrum S, et al. Disparities in preventive procedures: comparisons of self-report and Medicare claims data. BMC Health Serv Res. 2006;6:122.
208. Rauscher GH, Johnson TP, Cho YI, et al. Accuracy of self-reported cancer-screening histories: a meta-analysis. Cancer Epidemiol Biomarkers Prev. 2008 Apr;17(4):748-57.
209. Haque R, Chiu V, Mehta KR, et al. An automated data algorithm to distinguish screening and diagnostic colorectal cancer endoscopy exams. J Natl Cancer Inst Monogr. 2005(35):116-8.
210. Pignone M, Scott TL, Schild LA, et al. Yield of claims data and surveys for determining colon cancer screening among health plan members. Cancer Epidemiol Biomarkers Prev. 2009 Mar;18(3):726-31.

211. Vernon SW, Meissner H, Klabunde C, et al. Measures for ascertaining use of colorectal cancer screening in behavioral, health services, and epidemiologic research. Cancer Epidemiol Biomarkers Prev. 2004 Jun;13(6):898-905.
212. Fisher DA, Voils CI, Coffman CJ, et al. Validation of a questionnaire to assess self-reported colorectal cancer screening status using face-to-face administration. Dig Dis Sci. 2009 Jun;54(6):1297-306.
213. Partin MR, Grill J, Noorbaloochi S, et al. Validation of self-reported colorectal cancer screening behavior from a mixed-mode survey of veterans. Cancer Epidemiol Biomarkers Prev. 2008 Apr;17(4):768-76.
214. Vernon SW, Tiro JA, Vojvodic RW, et al. Reliability and validity of a questionnaire to measure colorectal cancer screening behaviors: does mode of survey administration matter? Cancer Epidemiol Biomarkers Prev. 2008 Apr;17(4):758-67.
215. Harewood GC, Wiersema MJ, Melton LJ, 3rd. A prospective, controlled assessment of factors influencing acceptance of screening colonoscopy. Am J Gastroenterol. 2002 Dec;97(12):3186-94.
216. Lieberman D, Nadel M, Smith RA, et al. Standardized colonoscopy reporting and data system: report of the Quality Assurance Task Group of the National Colorectal Cancer Roundtable. Gastrointest Endosc. 2007 May;65(6):757-66.
217. Rex DK, Petrini JL, Baron TH, et al. Quality indicators for colonoscopy. Am J Gastroenterol. 2006 Apr;101(4):873-85.
218. von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. J Clin Epidemiol. 2008 Apr;61(4):344-9.
219. Altman DG, Schulz KF, Moher D, et al. The revised CONSORT statement for reporting randomized trials: explanation and elaboration. Ann Intern Med. 2001 Apr 17;134(8):663-94.
220. Stone EG, Morton SC, Hulscher ME, et al. Interventions that increase use of adult immunization and cancer screening services: a meta-analysis. Ann Intern Med. 2002 May 7;136(9):641-51.

List of Abbreviations

ACS	American Cancer Society
AHRQ	Agency for Healthcare Research and Quality
AOR	adjusted odds ratio
BRFSS	Behavioral Risk Factor Surveillance Survey
CAD	computer-aided detection
CAHPS	Consumer Assessment of Healthcare Providers and Systems
CCME	Carolina Center for Medical Excellence
CDC	Centers for Disease Control and Prevention
CHIS	California Health Interview Survey
CI	confidence interval
CONSORT	Consolidated Standards of Reporting Trials
CORI	Clinical Outcomes Research Initiative
CPT	current procedural terminology
CRC	colorectal cancer
CT	computed tomography
CTC	computed tomographic colonography
CTS	Community Tracking Study
DCBE	double contrast barium enema
DERS	Direct Endoscopic Referral System
DNA	deoxyribonucleic acid
DRE	digital rectal examination
FAP	familial adenomatous polyposis
FIT	fecal immunochemical test
FSS	fee-for-service
FFS + SUPP	fee-for-service Medicare + supplemental insurance
FIT	fecal immunochemical test
FOBT	fecal occult blood test
FS	flexible sigmoidoscopy
gFOBT	guaiac-based fecal occult blood test
G	group
GI	gastrointestinal
GI	gastroenterologist
HEDIS	Healthcare Effectiveness Data and Information Set
HINTS	Health Information National Trends Survey
HMO	health maintenance organization
HNPCC	hereditary nonpolylposis colorectal cancer
ICD	International Classification of Diseases
iFOBT	immunochemical fecal occult blood test
KQ	key question
LHA	lay health advisors
MCA	managed care activity
MCBS	Medicare Current Beneficiary Survey
MEPS	Medical Expenditure Panel Survey
MeSH	Medical Subject Heading

MMC	Medicare managed care
MMSA	metropolitan or micropolitan statistical areas
MR	magnetic resonance
MRI	magnetic resonance imaging
MSTF	Multi-Society Task Force
MSTF	Multi-Society Task Force
NCI	National Cancer Institute
NCQA	National Committee on Quality Assurance
NHIS	National Health Interview Survey
NIH	National Institutes of Health
N	number
NR	not reported
OMAR	Office of Medical Applications of Research
OR	odds ratio
PCP	primary care physician
PET	positron emission tomography
PHE	periodic health examination
PSA	prostate-specific antigen
PSAs	public service announcements
RCTs	randomized controlled trials
RDD	random digital dialing
RR	relative risk
RTC	Randomized Control Trial
RTI-UNC EPC	RTI International–University of North Carolina Evidence-based Practice Center
SES	socioeconomic status
SI	standard intervention
STROBE	STrengthening the Reporting of OBservational studies in Epidemiology
TEP	Technical Expert Panel
TFCPS	Task Force on Community Preventive Services
TI	tailored intervention
TIP	tailored intervention plus reminder phone call
US	United States
USPSTF	US Preventive Services Task Force
VA	Veterans Administration

Glossary

Ability to meet projected demand: the ability of current capacity (or projected capacity if known) to meet the projected demand under various demand scenarios, such as screening the entire eligible US population with a specific test.

Acceptability—Willingness of persons and organizations to participate in the monitoring system

Appropriate use (of CRC screening)— minimizing overuse and misuse as well as underuse

Compliance—Degree to which a system complies with all relevant legislation, regulations, and policies

Consistency—degree to which reported effect sizes from included studies appear to go in the same direction

Cost—Indirect and direct costs

Current capacity (or current potential volume)—the sum of current volume and additional available capacity, where:

- Current volume is the estimate of the current number of FS or colonoscopy procedures conducted in the present year; and
- Additional available capacity is the number of additional FS or colonoscopy procedures that could be conducted in the current year.

Data quality—Completeness and validity of the data in the system

Directness—the extent to which evidence links the compared interventions directly to health outcomes

Discussions-- discussions of CRC screening between physicians and patients includes a conversation covering such areas as pros and cons of screening options and eliciting patient preferences and is meant as more than simply the physician recommending testing

Flexibility—Ability of the system to accommodate changes in operating conditions or information needs

Followup—clinical procedures and tracking of patients who have received an abnormal colorectal cancer screening result

Lay health advisors—people with no clinical training who serve as educators of peers for various health issues

Monitoring—tracking and data collection of the use and/or quality of colorectal cancer screening (such as with a national surveillance data system)

Overall Strength of Evidence (SOE)—reflects a global assessment that takes the required domains (i.e., risk of bias, consistency, prevision, directness) directly into account. Levels of SOE include:

- High—High confidence that the evidence reflects the true effect. Further research is very unlikely to change our confidence in the estimate of effect.
- Moderate—Moderate confidence that the evidence reflects the true effect. Further research may change our confidence in the estimate of effect and may change the estimate.
- Low—Low confidence that the evidence reflects the true effect. Further research is likely to change our confidence in the estimate of effect and is likely to change the estimate.
- Insufficient—Evidence either is unavailable or does not permit estimation of an effect.

Patient level intervention terms:

- Small media—educational materials provided as videos and/or printed materials such as letters, brochures, and newsletters to inform people about specific diseases or health issues
- Decision aids—mechanisms or interventions that have been developed to improve communication between health professionals and patients; their goal is to help involve patients in making decisions regarding their health care
- Group education—workshop or presentation conducted within a specified group setting to deliver educational information or motivation to encourage screening
- One-on-one interactions—studies in which a provider (e.g., physician, nurse, health educator) works individually with patients to educate them about CRC screening and/or aid them in making decisions about which tests to complete and when to receive screening. These interventions tend to include some concentrated time with a patient to answer questions, address concerns, and help facilitate completion of screening tests.
- Eliminating structural barriers—interventions that seek to increase screening by removing structural barriers (e.g., offer more screening times or locations, provide transportation to a service, etc.)
- Patient reminders—provided to patients (e.g., via mailed letters or phone calls) who are due for a rescreening or who have never been screened to prompt people about their need for annual screening (or for screening related to whatever period recommended for the patient)

Precision—degree of certainty surrounding an effect estimate with respect to a given outcome (i.e., for each outcome separately)

Projected capacity—future capacity to conduct FS or colonoscopy under various scenarios such as changes in workforce or changes in the number of facilities that provide procedures.

Quality (of CRC tests)-- “underuse,” “overuse,” and “misuse” of screening tests rather than test performance

Quality rating—internal validity or risk of bias (of studies)

Risk of bias—degree to which the included studies for any given outcome or comparison have a high likelihood of adequate protection against bias (i.e., good internal validity)

Simplicity—Structure and ease of operation

Stability—Reliability (ability to collect, manage and provide data properly without failure) and availability (ability to be operational when it is needed) of the monitoring system

Surveillance—in terms of data collection, we opted to replace the term ‘surveillance’ with regard to data collection with the term ‘monitoring’. In terms of surveillance of colorectal cancer screening results, because of initial abnormal results, we have used the term ‘followup’ instead.

Surveillance colonoscopy—colonoscopy for patients who have had a previous colonic polyp (and, usually, polypectomy)

Timeliness—Interval between occurrence of an event and reporting of the event.