

Colorectal Cancer Screening with Double-Contrast Barium Enema: A National Survey of Diagnostic Radiologists

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OBJECTIVE. This article describes diagnostic radiologists' colorectal cancer screening activities and beliefs about screening effectiveness and future capacity for screening with double-contrast barium enema, and compares radiologists' opinions about colorectal cancer screening with those of primary care physicians.

MATERIALS AND METHODS. We surveyed a nationally representative sample of diagnostic radiologists. Of 381 eligible radiologists, 312 (82%) responded. Descriptive statistics and chi-square tests were used to assess radiologists' opinions about double-contrast barium enema volume and capacity and to compare radiologists' beliefs about colorectal cancer screening with those of primary care physicians. Logistic regression was used to identify characteristics of radiologists who receive referrals for or perform a higher volume of screening double-contrast barium enema and of those who expect the volume of double-contrast barium enemas to increase.

RESULTS. Seventy-five percent of radiologists said that double-contrast barium enema is a "very effective" colorectal cancer screening procedure compared with 33% of primary care physicians. Although 86% of radiologists reported performing one or more screening double-contrast barium enema procedures during a typical month, only 27% indicated that they did so 11 or more times. Fifteen percent of radiologists said that their double-contrast barium enema volume had increased over the past 3 years, and 50% expect an increase over the next 3 years. Only 8% said that the capacity of facilities and personnel to meet the demand for double-contrast barium enemas in their geographic area of practice is inadequate. Geographic region and belief in double-contrast barium enema efficacy were predictors of double-contrast barium enema volume and referrals.

CONCLUSION. Most diagnostic radiologists perform colorectal cancer screening with double-contrast barium enema, but procedure volumes are modest. Because primary care physicians view double-contrast barium enema less positively than do radiologists, radiologists' expectations for an increased volume of double-contrast barium enemas over the next few years may not be realized.

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Screening for colorectal cancer is more complicated than for other conditions, largely because of the multiple modalities that are available to providers and patients as screening options. The fecal occult blood test, sigmoidoscopy, colonoscopy, and double-contrast barium enema are the colorectal cancer screening procedures most commonly mentioned in published guidelines [1-3]. Of these procedures, perhaps the least is known about the usefulness and utilization of double-contrast barium enema.

Unlike sigmoidoscopy, double-contrast barium enema has the advantage of permit-

ting examination of the entire colon. Compared with sigmoidoscopy and colonoscopy, double-contrast barium enema is believed to have lower rates of such major complications as bowel perforation, hemorrhage, and death [3]. Simulations using mathematic models also have shown double-contrast barium enema to be a cost-effective colorectal cancer screening procedure [4-6]. Data on the performance characteristics, effectiveness, and adverse events associated with double-contrast barium enema are sparse, however. No controlled trial has been conducted to directly assess the impact of double-contrast barium enema on colorectal cancer mortality. Sup-

port for double-contrast barium enema as a colorectal cancer screening modality is predicated on indirect evidence from other modalities showing that detection and removal of polyps and early-stage cancers reduce colorectal cancer incidence and mortality. The sensitivity of double-contrast barium enema for detecting polyps 1 cm or larger has been estimated to range from 50% to 90% [3, 7, 8]. Sensitivity declines with decreasing lesion size, however, and double-contrast barium enema appears to be less sensitive than colonoscopy for identifying small lesions [9]. Although a multidisciplinary panel charged with establishing a set of clinical guidelines for colorectal cancer screening concluded that "performance of double-contrast barium enema is sufficient to detect the majority of clinically important lesions" [3], and Medicare covers double-contrast barium enema as a colorectal cancer screening modality [10], the sparse and inconsistent data about this procedure may limit its clinical appeal as a screening strategy [11].

Despite growing recognition of the importance of screening asymptomatic average-risk patients for colorectal cancer and documentation of low rates of screening for this disease among adults 50 years old and older in the United States [12, 13], few nationally representative analyses of health care providers' colorectal cancer screening knowledge, attitudes, and practices have been conducted. Furthermore, no prior study of diagnostic radiologists' colorectal cancer screening opinions and practices has been undertaken.

To address these gaps, the National Cancer Institute, in collaboration with the Centers for Disease Control and Prevention and the Centers for Medicare and Medicaid Services, fielded the Survey of Colorectal Cancer Screening Practices in Health Care Organizations. This survey is a comprehensive study of primary care and specialty physicians and health plan medical directors that is designed to obtain nationally representative data on how colorectal cancer screening is being conducted in the United States and to identify barriers to delivery of screening in community practice [14]. In this report, we describe diagnostic radiologists' beliefs about the efficacy of colorectal cancer screening modalities in current use, their self-reported colorectal cancer screening activities in their clinical practices, and their opinions about current and future capacity for colorectal cancer screening with double-contrast barium enema. In addition, because

primary care physicians are an important referral source for colorectal cancer screening procedures, we compare radiologists' opinions about colorectal cancer test effectiveness, recommended screening strategy, and published guidelines with those of the primary care physicians who participated in this national survey.

Materials and Methods

Sampling Methodology

Using the American Medical Association's Physician Masterfile [15] as the sampling frame, we surveyed a nationally representative sample of diagnostic radiologists in 1999–2000. The masterfile contains demographic and practice-related data on all allopathic and virtually all osteopathic physicians in the United States. Eligible respondents were diagnostic radiologists 75 years old and younger who were listed in the database as having an active license to practice medicine and whose major professional activity involves patient care. Physicians who were retired, in residency training, or involved in full-time teaching, research, or administration were excluded. We selected a systematic random sample of 467 diagnostic radiologists using a fractional sampling interval. The sample size was selected to provide point estimates of population proportions within $\pm 5\%$ at a 95% confidence interval. Sample selection was accomplished after the sampling frame database had been sorted by United States census region (Northeast, North Central, South, West), urban versus rural practice location, and physician sex to ensure adequate representation of rural and female radiologists and each census region in the sample. Of the initial sample, 86 radiologists subsequently were determined to have retired or died, to not be currently practicing medicine, or to be impossible to locate after an extensive search for current contact information. Exclusion of these physicians left 381 eligible radiologists.

Survey Methodology

Sampled radiologists were sent an advance mailing in the fall of 1999 that contained a cover letter describing the objectives of the survey, letters of support from several medical societies and the United States Surgeon General, and a postcard with a stamped return envelope on which they were asked to verify their specialty and status as a practicing physician and to indicate their preferred mode of response to the survey (i.e., mail, fax, telephone, or secure Internet Web site). Radiologists who responded to the advance mailing were sent a subsequent mailing that included the mail or fax version of the questionnaire or instructions on how to complete the survey by telephone or Internet, depending on their stated preference, and a \$50 honorarium check. Approximately 6 weeks later, radiologists who did not respond to the ad-

vance mailing were sent a follow-up mailing containing the mail version of the questionnaire and a \$50 honorarium check. A second follow-up questionnaire mailing was sent by express mail to eligible nonrespondents in February 2000. Telephone follow-up of nonrespondents was undertaken in March and early April 2000.

The survey took approximately 15 min to complete and was organized into two sections: cancer screening beliefs and practices, and practice and other characteristics. Items inquiring about diagnostic radiologists' colorectal cancer screening beliefs, opinions, and practices were specific to asymptomatic, average-risk patients and encompassed the four colorectal cancer screening modalities most commonly mentioned in published guidelines: fecal occult blood test, sigmoidoscopy, colonoscopy, and double-contrast barium enema, although the focus of the questionnaire was primarily on double-contrast barium enema. Definitions of screening and diagnostic follow-up were provided. Radiologists were asked to rate the effectiveness of each screening modality using a three-point Likert scale that included the categories "very effective," "somewhat effective," and "not effective." Radiologists also were asked to identify the test or test combination with which they believe most average-risk adults should be screened for colorectal cancer and to rate the influence of published guidelines on their practice of colorectal cancer screening using the categories "very influential," "somewhat influential," and "not influential." A separate set of items inquired about whether radiologists routinely receive patient referrals from other providers to perform colorectal cancer screening procedures and the frequencies with which radiologists order or perform fecal occult blood testing and perform or supervise screening and diagnostic double-contrast barium enemas. Finally, radiologists were asked whether the volume of colorectal cancer screening or diagnostic procedures they perform or supervise had increased, stayed the same, or decreased over the past 3 years; whether they expect demand for double-contrast barium enema in the geographic area in which they practice to increase, stay the same, or decrease over the next 3 years; and whether they believe the capacity of facilities and personnel for performing double-contrast barium enemas in their geographic area of practice is more than enough, just about right, or inadequate to meet anticipated demand over the next 3 years.

Linkage to the Area Resource File

To obtain socioeconomic and health personnel data for each respondent's county of medical practice, we extracted several variables from the February 1999 version of the Area Resource File [16] and merged them with the diagnostic radiologists' survey data set using the state and county Federal Information Processing Standards code [17] as the linkage variable. Variables obtained from the Area Resource File included whether the respondent's

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county of practice had been designated in whole or in part a primary care health professions shortage area; the proportion of the county population self-identified as white; the proportion of the county's population of adults 25 years old and older holding a college degree; the number of patient care gastroenterologists; the number of patient care diagnostic radiologists; and an estimate of the county population for 1997.

Survey of Primary Care Physicians

The sampling and survey methodologies for the survey of primary care physicians were analogous to those described for the diagnostic radiologists. Eligible respondents for the primary care physician survey were general practitioners, family practitioners, general internists, and obstetrician-gynecologists. We selected a systematic, stratified random sample of 2098 primary care physicians, with physician specialties as the sampling strata and selection proportional to the specialty's representation in the total United States physician population. This sample size was selected to provide point estimates of population proportions within $\pm 3\%$ at a 95% confidence interval. Of the initial sample, 380 primary care physicians subsequently were determined to be ineligible, leaving a final sample of 1718 primary care physicians.

A separate questionnaire was developed for primary care physicians. This questionnaire was lengthier than the diagnostic radiologists' questionnaire and was organized into four sections: cancer screening beliefs and practices, attitudes toward and training in colorectal cancer screening, recommendations for and use of colorectal cancer screening modalities, and practice and other characteristics. Items asking primary care physicians to rate the effectiveness of colorectal cancer screening modalities and the influence of published guidelines on their practice of colorectal cancer screening were identical to those previously described for the diagnostic radiologists' survey. Primary care physicians also were asked to identify the test or test combination that they most often recommend to their asymptomatic, average-risk patients for colorectal cancer screening. Additional detail on the primary care physician survey is available elsewhere [18].

Statistical Analysis

A sample weight that accounts for the probability of selection into the sample and nonresponse was assigned to each respondent. We used descriptive statistics to assess diagnostic radiologists' opinions about current and future double-contrast barium enema volume and capacity. We used descriptive statistics and contingency tables with chi-square tests to compare diagnostic radiologists' opinions about colorectal cancer screening strategies, test effectiveness, and the influence of published guidelines with those of primary care physicians. We used multivariate logistic regression analysis to identify characteristics of diagnostic radiologists who reported performing a high

volume of screening double-contrast barium enemas, expectations for performing a greater volume of double-contrast barium enemas, and receiving referrals from other providers to perform screening double-contrast barium enemas.

Because of sample size limitations, we used a sequential approach to fitting each of the logistic regression models. Independent variables were grouped into three categories: physician characteristics, practice characteristics, and environmental characteristics. In each of these categories, the bivariate association of each independent variable with the dependent variable of interest was assessed using the chi-square test for categorical variables and *t* tests of differences in means for continuous variables. Independent variables that showed a statistically significant association at a *p* value of less than 0.20 were then entered into separate logistic regression models examining physician characteristics, practice characteristics, and environmental characteristics with the dependent variable of interest. Independent variables that were statistically significant in these models at a *p* value of less than 0.20 were included in three final logistic regression models to identify important predictors of diagnostic radiologists who reported a high volume of screening double-contrast barium enemas, expectations for performing an increased volume of double-contrast barium enemas, and receiving referrals to perform screening double-contrast barium enemas. Sampling weights were applied in all statistical analyses to permit generalization of the results to the United States population of practicing diagnostic radiologists.

Results

Description of Respondents

A total of 312 diagnostic radiologists responded to the survey, a response rate of 82%. Seventy-six percent of diagnostic radiologists responded by mail, 13% by telephone, 9% by Internet, and 2% by fax. Most were male, white, board-certified, and graduates of United States medical schools (Table 1). Their mean age was 47.7 years (range, 32–75 years). Eighty-four percent reported that they routinely receive patient referrals to perform screening double-contrast barium enema. Fewer than 2% indicated that they order or perform fecal occult blood testing for colorectal cancer screening during a typical month.

Perceived Test Effectiveness and Recommended Screening Strategy

Three quarters or more of diagnostic radiologists reported the belief that colonoscopy and double-contrast barium enema are "very effective" screening procedures for reducing colorectal cancer mortality in patients 50 years old and older (Fig. 1). Fewer than 25%

TABLE 1 Characteristics of Responding Diagnostic Radiologists and Practice Settings (n = 312)	
Physician Characteristics	%
Male	84.2
Age (yr)	
30–39	17.3
40–49	43.0
50–59	31.7
≥60	8.0
White, non-Hispanic	80.4
Board-certified	93.6
Medical school affiliation	34.1
International medical graduate	11.3
Receives referrals to perform screening barium enema	83.6
Believes most average-risk adults should be screened with barium enema	47.1
Practice Characteristics	%
Setting	
Solo	5.6
Single-specialty group	67.6
Multispecialty group	23.6
Unknown	3.3
No. of physicians in practice	
1–5	32.4
6–15	35.1
16–49	20.8
≥50	10.4
Full or part owner of practice	54.8
≥50% of patients covered by managed care	34.1
Employed by health maintenance organization	2.7
Urban location	64.7
Health professions shortage area	72.9
Geographic region	
Northeast	22.7
North Central	22.4
South	37.0
West	17.9
Environment Characteristics	Mean
County population	
≥25 yr old with college degree	23.4%
White	80.7%
No. per 100,000 county population	
Gastroenterologists and surgeons	n = 22.1
Diagnostic radiologists	n = 9.6

Note.—Data are from the Survey of Colorectal Cancer Screening Practices, 1999–2000.

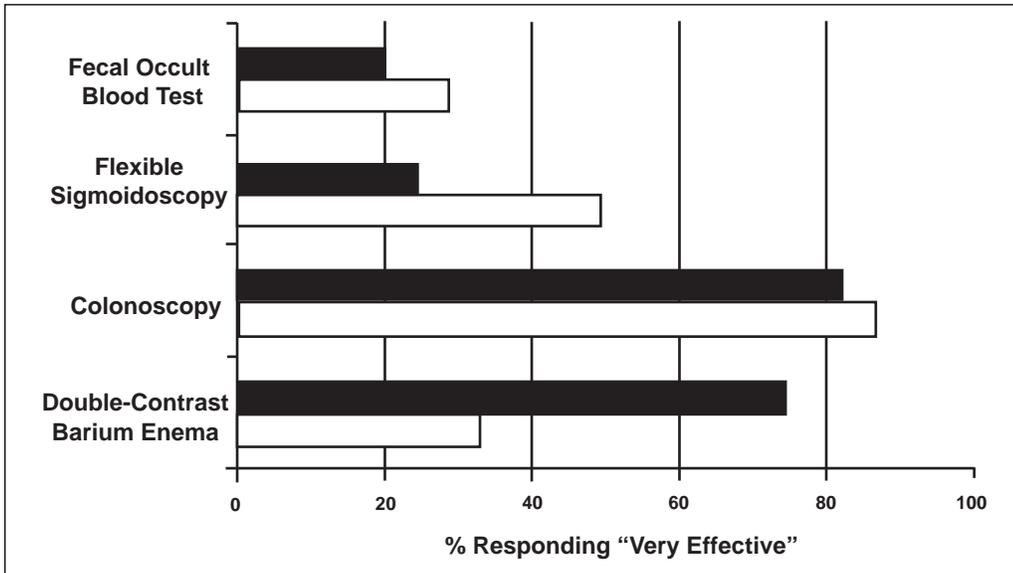


Fig. 1.—Graph shows physicians’ perceived effectiveness of colorectal cancer screening tests for average-risk adults 50 years old and older. Black bars represent diagnostic radiologists; white bars represent primary care physicians. Differences are statistically significant at $p < 0.0001$ for fecal occult blood test and barium enema and at $p < 0.005$ for flexible sigmoidoscopy.

of radiologists, however, rated flexible sigmoidoscopy and fecal occult blood testing as “very effective.” Primary care physicians also were most likely to rate colonoscopy as “very effective.” Although their assessment of this modality was similar to that of radiologists, primary care physicians differed significantly from radiologists in their ratings of the effectiveness of the other three modalities. Differences between radiologists and primary care physicians were most striking for double-contrast barium enema, with 75% of radiologists but only 33% of primary care physicians rating this modality as “very effective.” Differences between the two physician groups were smaller but still statistically significant for flexible sigmoidoscopy and fecal occult blood testing. Primary care physicians were more likely than radiologists to rate these modalities as “very effective.”

When asked to specify the testing approach with which most average-risk adults should be screened for colorectal cancer, nearly half the radiologists indicated that double-contrast barium enema, either alone or combined with flexible sigmoidoscopy, should be used (Table 2). In contrast, 85% of primary care physicians reported that they most often recommend fecal occult blood testing and flexible sigmoidoscopy, either alone or in combination, to their average-risk patients, and only about 2% said that they most often recommend double-contrast barium enema, either alone or combined with flexible sigmoidoscopy. Furthermore, despite the high ratings of colonoscopy effectiveness by both physician groups, fewer than 10% of radiologists responded that colonoscopy was the testing approach with which most average-risk adults should be screened, and

fewer than 10% of primary care physicians reported that colonoscopy was the screening approach that they most often recommend to their average-risk patients.

Influence of Published Guidelines on Screening Practice

When asked to rate the influence of published guidelines on their colorectal cancer screening practices, 30% of diagnostic radiologists reported that the 1997 American Cancer Society guidelines [1] were “very influential” compared with other specialty society guidelines (25%), the 1997 G. I. (Gastrointestinal) Consortium guidelines [3] (10%), or the 1996 United States Preventive Services Task Force guidelines [2] (5%) (Fig. 2). Primary care physicians also were more likely to note American Cancer Society guidelines as being “very influential” compared with these other guidelines. However, a greater proportion of primary care physicians rated each type of guideline as “very influential” than did radiologists, with the exception of the guidelines of other specialty societies. For all guideline types, differences between the two physician groups were statistically significant. Between one quarter and one half of radiologists and between one quarter and one third of primary care physicians indicated that they were unfamiliar with the United States Preventive Services Task Force, G. I. (Gastrointestinal) Consortium, or other specialty society guidelines. In contrast, only 17% of radiologists and 8% of primary care physicians reported that they were unfamiliar with American Cancer Society guidelines.

Screening Test or Combination	Diagnostic Radiologists (%)	Primary Care Physicians (%)
Double-contrast barium enema and flexible sigmoidoscopy	29.0	1.7
Fecal occult blood test and flexible sigmoidoscopy	25.6	47.2
Double-contrast barium enema alone	18.1	0.5
Fecal occult blood test alone	9.2	26.8
Colonoscopy	7.6	5.1
Flexible sigmoidoscopy alone	0.3	2.5
Either fecal occult blood test or flexible sigmoidoscopy	0.0	8.9
Other	10.2	7.1
Total	100.0	99.8

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Opinions About Current and Future Double-Contrast Barium Enema Volume and Capacity

Radiologists reported performing or supervising a smaller volume of screening than diagnostic double-contrast barium enema procedures (Fig. 3). Nearly half the respondents indicated that they perform or supervise five or fewer screening double-contrast barium enema procedures during a typical month, whereas 40% said that they perform or supervise five or fewer diagnostic double-contrast barium enema procedures during a typical month. Furthermore, 45% reported that they typically perform or supervise six

to 20 diagnostic double-contrast barium enema procedures per month, compared with 39% who said they perform or supervise this volume of screening procedures. Only for the highest volume category were the proportions of radiologists equivalent, with 11% reporting that they perform or supervise more than 20 screening double-contrast barium enema procedures per month and 10% indicating that they perform or supervise more than 20 diagnostic procedures per month. Although 15% of radiologists indicated that the volume of double-contrast barium enema procedures they performed or

supervised over the past 3 years had increased, 54% reported that their procedure volume had stayed the same, and 23% said that it had decreased (Fig. 4). Of the minority of radiologists who said that the volume of double-contrast barium enema procedures they performed or supervised had increased, a greater volume of referrals for diagnostic follow-up procedures was mentioned more often as the reason for the increase (91%) than were more referrals for screening (84%) or for surveillance (79%) procedures.

One half of radiologists, however, reported that they expect the demand for colorectal

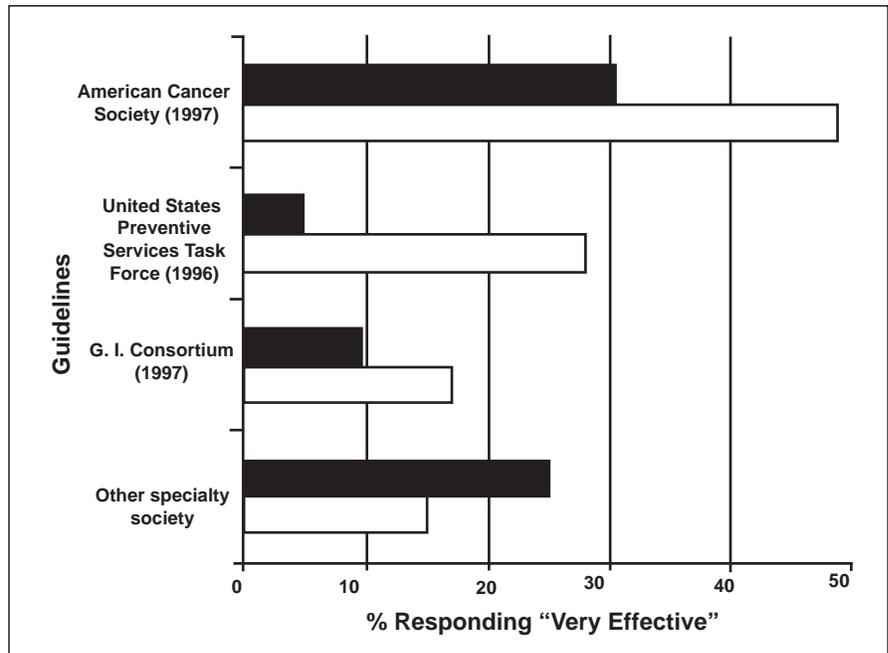


Fig. 2.—Graph shows self-reported influence of published guidelines on physicians' colorectal cancer screening practice. Black bars represent diagnostic radiologists; white bars represent primary care physicians. Differences are statistically significant at $p < 0.0001$ for the American Cancer Society and the United States Preventive Services Task Force, and at $p < 0.005$ for the G. I. (Gastrointestinal) Consortium and other specialty societies.

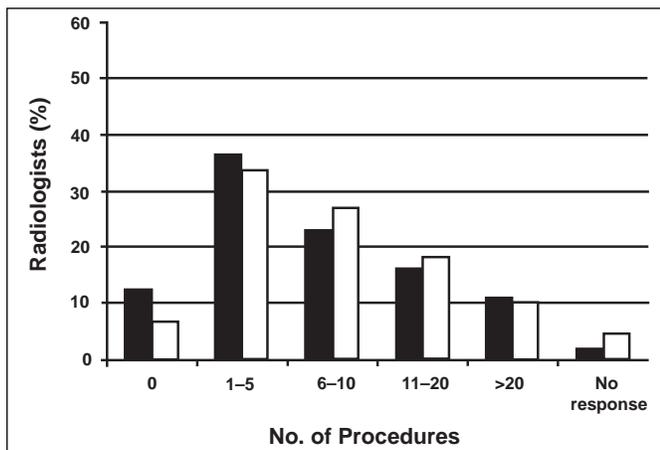


Fig. 3.—Graph shows self-reported volume of double-contrast barium enema procedures during typical month. Black bars indicate screening and white bars indicate diagnostic procedures.

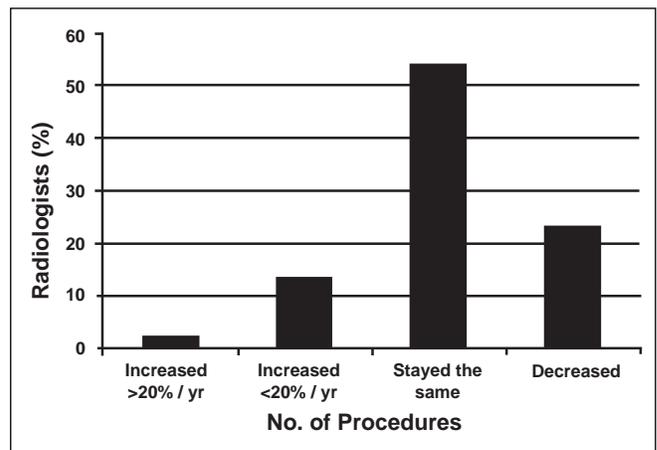


Fig. 4.—Graph shows diagnostic radiologists' self-reported change in colorectal cancer screening and diagnostic procedure volume during past 3 years.

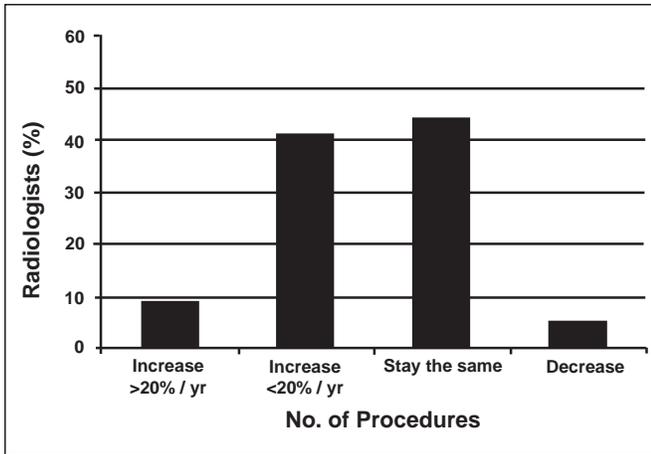


Fig. 5.—Graph shows diagnostic radiologists' expectations for double-contrast barium enema screening and diagnostic procedure volume during next 3 years.

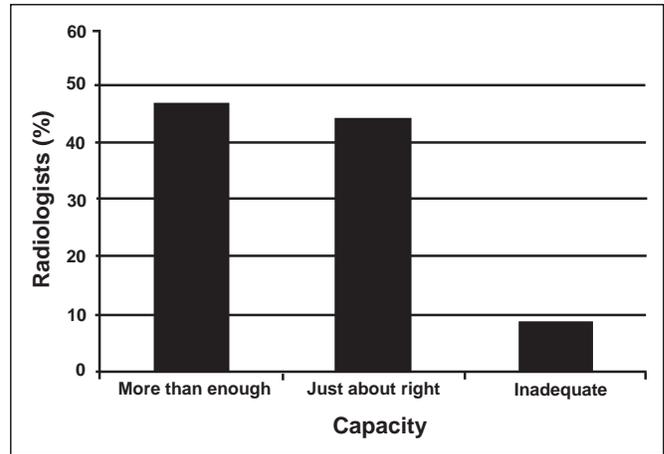


Fig. 6.—Graph shows diagnostic radiologists' perceived adequacy of capacity of facilities and personnel to meet double-contrast barium enema demand over next 3 years.

cancer screening and diagnostic procedures with double-contrast barium enema in their geographic area of practice to increase during the next 3 years, with 9% indicating that they expect an increase in procedure volume of more than 20% per year (Fig. 5). Forty-four percent said they expect demand to stay about

the same, and 5% reported the belief that it would decrease. Finally, more than 90% of respondents said that the capacity of facilities and personnel for performing colorectal cancer screening and diagnostic procedures with double-contrast barium enema in their geographic area was either just about right (44%)

or more than adequate (47%) to meet anticipated demand; only 8% reported the belief that that capacity was inadequate (Fig. 6).

Predictors of Screening Double-Contrast Barium Enema Volume and Referrals

With the exception of board certification and employment in a health maintenance organization, each of the physician, practice, and environmental characteristics displayed in Table 1 was examined as a potential predictor of performing a high volume of screening double-contrast barium enemas, the expectation that the volume will increase in the radiologist's geographic area of practice, and receiving referrals from other providers to perform screening double-contrast barium enema. Relatively few of these characteristics were statistically significant in multivariate modeling, however. In the final logistic regression model comparing diagnostic radiologists who reported performing 11 or more screening double-contrast barium enema procedures per month with radiologists reporting a lower volume of this procedure, having referral arrangements with other providers to perform screening examinations, having a high proportion of patients covered by managed care, and practicing in the North Central census region were significant predictors (Table 3) at a *p* value of less than 0.05. In the final model comparing radiologists who indicated that they expect demand for double-contrast barium enemas to increase in their geographic area of practice during the next 3 years with those not expecting an increase in demand, being a graduate of a United States medical school and

Characteristic	Odds Ratio	95% CI
Physician		
Age (yr)		
30–39	1.00	
40–49	0.90	0.41–1.98
50–59	1.51	0.68–3.35
≥60	0.65	0.18–2.41
Receives referrals to perform screening examination		
No	1.00	
Yes	3.64	1.08–12.34
Believes most average-risk adults should be screened with double-contrast barium enema		
No	1.00	
Yes	1.58	0.91–2.75
Practice		
Patients covered by managed care		
<50%	1.00	
≥50%	2.16	1.17–3.97
Geographic region		
Northeast	1.00	
North Central	2.66	1.13–6.28
South	1.37	0.61–3.04
West	1.17	0.46–2.95

Note.—High volume is defined as performing or supervising ≥11 procedures during a typical month. Comparison was performed using logistic regression model. CI = confidence interval.

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believing that most average-risk adults should be screened for colorectal cancer with double-contrast barium enema were significant predictors of the opinion that demand will increase (Table 4). Finally, being a full or part owner of a physician practice, practicing in the North Central census region, and believing that most average-risk adults should be screened for colorectal cancer with double-contrast barium enema were significant predictors of diagnostic radiologists who reported receiving referrals from other providers to perform screening double-contrast barium enemas (Table 5).

Discussion

Double-contrast barium enema is a cost-effective colorectal cancer screening modality that is recommended as a screening option in the published guidelines of at least two major groups and covered as a screening benefit under current Medicare regulations [1, 3, 5, 6, 10, 19, 20]. Compared with sigmoidoscopy and colonoscopy, double-contrast barium enema has fewer complications; and compared with colonoscopy, it is less costly [21]. Nevertheless, there recently has been debate about the relative merits of each of the colorectal cancer screening modalities in current use (e.g., the fecal occult blood test, sigmoidoscopy, colonoscopy, double-contrast barium enema), with some individuals and groups advocating colonoscopy as the superior screening strategy [22–24]. However, others have pointed out that each modality has benefits as well as costs and that the colorectal cancer screening test that is preferable is the one the patient will follow through to obtain [18, 25]. At least one investigation of patient preferences for colorectal cancer screening has shown high acceptance rates for screening when recommended to patients by their physicians, but no dominant preference for a specific screening modality [26]. Furthermore, issues about the adequacy of the national capacity to perform screening endoscopy, particularly colonoscopy, cannot be ignored [27].

The results of our study show that most diagnostic radiologists in the United States view colorectal cancer screening with double-contrast barium enema as a very effective strategy for reducing colorectal cancer mortality in average-risk older adults, and most reported performing this procedure in their clinical practices. However, only slightly more than 25% said that they perform the

procedure 11 or more times during a typical month (i.e., roughly three or more procedures per week). The low double-contrast barium enema volumes reported by many diagnostic radiologists in this survey may have implications for procedure quality, especially given the findings of some studies suggesting that physicians who perform low volumes of a particular procedure have less favorable outcomes than do those who perform high volumes [28–32]. The volume–outcome relationship for radiologic procedures has received little attention and is an area that may merit further investigation.

Although the double-contrast barium enema procedure volumes reported in our study were modest, one half of diagnostic radiologists expressed their belief that the volume of double-contrast barium enemas will increase in their geographic area of practice over the next few years. This expectation may derive from recent and ongoing public health efforts to improve colorectal cancer screening rates, which are considerably lower than screening rates for cervical, breast, and pros-

tate cancer [33]. Whether these expectations will be realized is debatable, given that primary care physicians view double-contrast barium enema less positively than do radiologists, and primary care physicians indicated that they most often recommend fecal occult blood testing and sigmoidoscopy as colorectal cancer screening modalities to their average-risk patients. However, even though radiologists reported primary care physicians to be their main referral source for screening double-contrast barium enema procedures, limited sigmoidoscopy and colonoscopy capacity in certain geographic areas may result in greater double-contrast barium enema volume for some radiologists. In addition, as previously mentioned, some patients will choose double-contrast barium enema when presented with a menu of options for colorectal cancer screening [26]. Also, increased use of screening colonoscopy may lead to an increase in the number of double-contrast barium enema procedures because not all colonoscopic examinations successfully reach the cecum, and patients with incom-

TABLE 4 Comparison of Diagnostic Radiologists Expecting Versus Not Expecting an Increase in Demand for Double-Contrast Barium Enemas in Next 3 Years

Characteristic	Odds Ratio	95% CI
Physician		
Age (yr)		
30–39	1.00	
40–49	0.87	0.44–1.71
50–59	1.02	0.49–2.11
≥60	2.45	0.81–7.42
Affiliated with medical school		
No	1.00	
Yes	1.62	0.95–2.76
International medical school graduate		
U. S. medical school graduate	2.71	1.13–6.50
Believes most average-risk adults should be screened with double-contrast barium enema		
No	1.00	
Yes	1.85	1.13–3.04
Practice		
Located in		
Urban area	1.00	
Rural area	0.65	0.38–1.12
Geographic region		
Northeast	1.00	
North Central	1.97	0.92–4.21
South	1.54	0.79–3.01
West	1.58	0.73–3.42

Note.—Comparison was performed using logistic regression model. CI = confidence interval.

plete colonoscopy are often referred for a barium enema procedure [34]. The results of our logistic regression analyses suggest that screening double-contrast barium enema may be more sustainable when there are existing referral relationships for diagnostic double-contrast barium enema, when health care payers place a premium on cost, and in locations in which access to alternative modalities may be difficult.

Fewer than 10% of radiologists indicated the belief that the capacity of facilities and personnel to meet the demand for double-contrast barium enema procedures over the next few years in their geographic area of practice was inadequate. This finding, coupled with the low and static or decreasing double-contrast barium enema procedure volumes reported in our study, lends support to prior work showing that colonoscopy has been replacing barium enema as an initial colorectal examination since the mid 1980s [35]. Our survey did not ascertain diagnostic

radiologists' levels of training or interest in performing an increased volume of screening double-contrast barium enema examinations, however. With new colorectal cancer screening technologies such as CT colonography on the horizon [36], radiologists who view double-contrast barium enema as an older and potentially soon-to-be-obsolete technology may have little interest in investing, or incentive to invest, more time and resources in the procedure.

To date, fecal occult blood testing is the only colorectal cancer screening modality that is supported by evidence from randomized, controlled trials [3]. The effectiveness of double-contrast barium enema as a colorectal cancer screening strategy has received very little study. Moreover, data on the use of double-contrast barium enema at the population level is extremely limited because the surveys such as the National Health Interview Survey [37] that are the basis for monitoring screening utilization nationally do not in-

clude double-contrast barium enema as a screening modality. Although it is possible to study colorectal cancer screening with double-contrast barium enema using Medicare claims, this type of analysis would exclude individuals not covered under the Medicare program, as well as individuals who are enrolled in health maintenance organizations.

Our study is limited by the self-reported nature of its data. However, to our knowledge, it is the first nationally representative assessment of diagnostic radiologists' colorectal cancer screening opinions and practices. With increasing emphasis on colorectal cancer control as a public health priority, the need for comprehensive data to monitor and understand colorectal cancer screening practices is acute. Diagnostic radiologists potentially have an important role to play in colorectal cancer control. Their challenge is to obtain the data necessary to document that the technologies within their scope of practice—double-contrast barium enema and, in the future, CT colonography—can be appropriately applied in a screening context.

Characteristic	Odds Ratio	95% CI
Physician		
International medical school graduate	1.00	
U. S. medical school graduate	2.23	0.93–5.37
Believes most average-risk adults should be screened with double-contrast barium enema		
No	1.00	
Yes	1.97	1.01–3.86
Practice		
Full or part owner of physician practice		
No	1.00	
Yes	2.09	1.08–4.06
No. of physicians in practice		
1–5	1.00	
6–15	1.50	0.67–3.35
≥16	1.13	0.52–2.45
Geographic region		
Northeast	1.00	
North Central	2.88	1.02–8.15
South	1.49	0.64–3.45
West	1.50	0.55–4.06
Environment		
County population white		
<70%	1.00	
70–80%	2.37	0.84–6.68
80–90%	1.88	0.80–4.46
≥90%	2.09	0.85–5.15

Note.—Comparison was performed using logistic regression model. CI = confidence interval.

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