

Barriers to Colorectal Cancer Screening: Inadequate Knowledge by Physicians

MELISSA GENNARELLI, M.D.¹, LINA JANDORF, M.A.¹, CAROLINE CROMWELL, M.D.¹,
HEIDDIS VALDIMARSDOTTIR, PH.D.¹, WILLIAM REDD, PH.D.¹, AND STEVEN ITZKOWITZ, M.D.²

Abstract

Background: The rate of colorectal cancer (CRC) screening remains relatively low. One potential barrier to higher rates is the lack of physician knowledge regarding CRC screening. The purpose of this study was to assess physicians' knowledge of (a) American Cancer Society (ACS) CRC screening guidelines for average-risk and high-risk patients, and (b) general colorectal cancer facts which support these guidelines.

Methods: We administered a questionnaire to internal medicine residents, internal medicine attendings and medical students who provide care to patients in a low-income, predominantly minority community, to compare their levels of knowledge regarding CRC screening. Mean knowledge scores were calculated based on the number of correct responses.

Results: Knowledge of ACS guidelines for average-risk patients was low, although it did increase directly with level of training: medical students obtained a mean score of 32%, residents 49%, and attendings 56% ($p < 0.001$). Knowledge scores for high-risk patients were even lower, with fewer than half of the respondents offering correct answers. Mean knowledge scores of general CRC screening facts increased with level of training: medical students scored 31%, residents 38% and attendings 42% ($p < 0.001$).

Clinical Implications: Knowledge of CRC screening guidelines for both average- and high-risk patients was suboptimal among the medical students, residents and attendings studied. Lack of knowledge about CRC is one barrier to screening that may contribute to underutilization of screening for minority populations. Further educational efforts should be targeted to these health care professionals.

Key Words: Colorectal cancer, cancer screening, ethnic minorities, colonoscopy, sigmoidoscopy, fecal occult blood test, ACS guidelines.

Introduction

COLORECTAL CANCER (CRC) is the second most common cause of cancer-related deaths in the United States. Screening asymptomatic individuals for lesions predisposing to CRC reduces morbidity and mortality, and is cost effective. In recent years, studies have investigated physician practices and found that not all patients are being screened for CRC at intervals recommended by national organizations (1–5). Medical associations are aware of the appropriate clinical guidelines for CRC screening and surveillance for average- and high-risk individuals; nevertheless, screening rates remain unacceptably low. Studies show that the single most important predictor of patient compliance with CRC screening tests is physician recommendation (6, 7). Primary care physicians (PCP) in particular are in a unique

position to provide CRC screening. They also play a critical role in recommending and encouraging patient acceptance of screening tests.

Rates of CRC screening in the U.S. are relatively low despite compelling evidence that CRC screening saves lives. According to CDC data from the 1999 Behavioral Risk Factor Surveillance System (BRFSS), only 40.3% of respondents over the age of 50 reported ever having had a fecal occult blood test (FOBT) and only 43.8% reported ever having had a sigmoidoscopy (8). In 1999 the state of New York reported via the BRFSS that only 34.6% of whites, 28.6% of African Americans, and 21.3% of Hispanics had ever had a sigmoidoscopy or colonoscopy (9). These rates are unacceptably low, especially compared with screening for breast, cervical and prostate cancer. Rates of FOBT and sigmoidoscopy are even lower when evaluated for the American Cancer Society (ACS) recommended time intervals. It is particularly disconcerting that CRC screening rates are lower among African Americans despite the higher incidence and mortality of CRC in this group. For screening to be effective in reducing morbidity and mortality from CRC, it should be performed on a regular basis. However, the prevalence of repeat screening in the U.S. has been reported to be low for both flexible sigmoidoscopy and FOBT (10, 11).

From the ¹Derald H. Ruttenberg Cancer Center, and ²Department of Medicine, Mount Sinai School of Medicine, One East 100th Street, New York, NY.

Address all correspondence to: Lina Jandorf, M.A., Box 1130, Mount Sinai School of Medicine, One East 100th Street, New York, NY 10029; email: lina.jandorf@mssm.edu

This study was supported by NCI grants U01-CA86107 and R25-CA81137

Accepted for publication April 2004.

The reasons for the low rates of CRC screening include organizational, patient-related, and physician-related factors. In the present study, we examine one of the physician-related factors. Although some studies have examined physicians' knowledge base as a potential barrier to CRC screening (12–17), none have specifically surveyed medical students, residents, and attendings since the revision of the guidelines in 1997. A recent article assessing resident knowledge of colorectal cancer identified only one area of deficiency, lack of knowledge regarding proper management of a positive FOBT (13). Another article reported deficient knowledge among internal medicine residents regarding screening recommendations for high-risk groups (18). The inclusion of medical students, residents, and attendings in our study was done in an effort to assess knowledge across all stages of medical education in order to better define the population(s) and specific areas in need of intervention.

Many studies examining physician behavior with regard to CRC screening have used the terms “practice” and “knowledge” interchangeably. Such studies have found that physician practices are not consistent with the recommended guidelines, and some studies presume that this is due to inadequate physician knowledge without directly assessing this knowledge (18, 19). Physician practices may be altered by a host of barriers, only one of which is knowledge. Sharma et al. (20) assessed primary care physician (PCP) knowledge and practice of CRC screening, through the use of six hypothetical patient scenarios. The study detected some important discrepancies between self-reported PCP practices and national guidelines. The authors suggested that these inconsistencies in physician practices were a direct result of imperfect understanding and deficient knowledge on the part of the PCP (19). A second study by the same group assessed internal medicine residents' practices with regard to CRC screening. The questions in both of these studies actually assessed physician's personal practice or opinions with regard to CRC screening, but neither study directly assessed physician's knowledge and awareness of the recommended guidelines. We therefore developed a survey to directly evaluate the physician's knowledge base with regard to CRC.

Materials and Methods

Development of Physician Survey Instrument

Institutional Review Board (IRB) approval was obtained to administer the questionnaire to all eligible participants. (For participant criteria, see **Study Design**, below.) Questions were designed to elicit in-

formation regarding physicians' knowledge of: (A) CRC screening guidelines for average-risk patients; (B) CRC screening guidelines for high-risk patients; and (C) general CRC facts. The guideline questions (sections A and B) assessed physicians' knowledge of nationally accepted guidelines for CRC screening recommendations. Questions were developed to be consistent with both the American Cancer Society (ACS) and the 1997 multidisciplinary panel recommendations (21). Physicians were asked specifically to answer questions based on ACS recommendations, not on their current practices. Physicians were asked what the ACS recommendations are for both the starting age and frequency for each of the following CRC screening options: FOBT, flexible sigmoidoscopy (FS), and colonoscopy. In section B, five case vignettes were created to assess physician's knowledge of screening and surveillance guidelines for high-risk patients. High-risk patients were defined as individuals with a family history of cancer, adenomatous polyps, familial adenomatous polyposis (FAP), hereditary nonpolyposis colon cancer (HNPCC), and/or a personal history of adenomatous polyps. Section C consisted of multiple-choice questions, derived from the current literature, assessing factual knowledge that is used to support the recommended guidelines. Three national experts reviewed the questions independently for fact and content validity.

Study Design

This study was conducted at four major medical centers serving the low-income, medically underserved community of East Harlem in New York City. Participation was limited to third or fourth year medical students (n=53), internal medicine residents (n=92), or internal medicine attendings (n=23). To ensure construct validity, the survey was first administered to 7 gastroenterology fellows and 14 oncology nurses who served as positive and negative controls, respectively (Table 1). After the questionnaire was administered, we compared the knowledge scores of the three groups (medical students, residents, attendings), using analysis of variance (ANOVA). All statistical analyses were performed using SPSS, version 10.0.

Data Collection and Procedures

Participants were unaware of the subject matter addressed in the survey prior to its administration, to prevent any preparation ahead of time. The survey was voluntary and anonymous. Within each section of the questionnaire, cumulative knowledge scores based on the number of correct answers were calculated for each participant.

TABLE 1
Knowledge of CRC Screening Guidelines and Facts Among Study Participants and Controls

	Knowledge of ACS guidelines for average-risk patients		Knowledge of ACS guidelines for high-risk patients		Knowledge of general CRC screening facts	
	No. people responding	Mean Score	No. people responding	Mean Score	No. people responding	Mean Score
Oncology nurses (n=14)	9	42%	10	37%	13	20%
Medical students, Residents, attendings (n=168)	158	46% ^a	164	53% ^{a,b}	168	37% ^{a,b}
Gastroenterology fellows (n=7)	7	81%	7	83%	7	69%

^a p<0.05 for target group (medical students, residents and attendings) knowledge compared to gastroenterology fellows

^b p<0.05 for target group knowledge compared to oncology nurses

ACS = American Cancer Society, CRC = colorectal cancer

Results

A total of 400 surveys were distributed, with a response rate of 48%. Of the 195 respondents, 27 did not meet study criteria (18 specialists, 4 nurse practitioners, and 5 physician assistants) and were excluded from the analysis. The demographics of the three groups are shown in Table 2. Because the survey was anonymous, we do not know the demographics of the nonresponders.

Comparison of Knowledge Scores by Training

Knowledge scores on all sections were progressively higher as level of training increased (Table 3). Indeed, within each group, scores also increased with level of training (e.g., years of medical school and from postgraduate year one (PGY-1) to PGY-2 to PGY-3, such that PGY-3 and PGY-4 residents had knowledge levels equivalent to those of attendings (data not shown).

Knowledge of Average-Risk Patient Guidelines (Section A)

Fig. 1 depicts the percentage of correct responses regarding the recommended starting age for the three major colon cancer screening tests. The correct re-

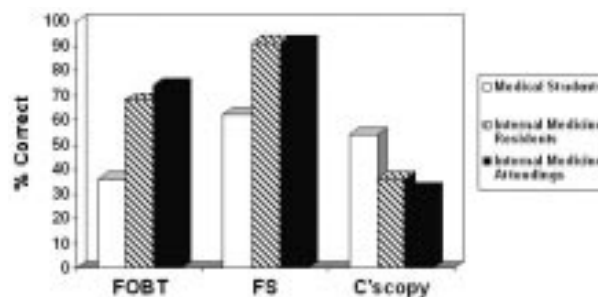


Fig. 1. Participants were asked at what age does the American Cancer Society (ACS) recommend to begin screening for patients who have no family history of colorectal cancer (CRC).

C'scopy = colonoscopy, FOBT = fecal occult blood test, FS = flexible sigmoidoscopy.

sponse (age 50) was identified by the following percentage of internal medicine residents: FOBT (68%), FS (91%), and colonoscopy (36%). The responses of residents more closely approached those of the attendings than those of the medical students.

With respect to knowing the frequency for performing screening tests according to ACS guidelines, 84% of residents correctly indicated FOBT should be done annually and 71% knew that FS is recommended for every 5 years, but only 24% were aware that colonoscopy is recommended for every 10 years (Fig. 2). For all three tests, the rate of cor-

TABLE 2
Demographics

	Age (Mean Years / SD)	Gender (% Male)	Ethnicity (% White)
Medical students (n=53)	25.8 / 1.7	36%	56%
Internal medicine residents (n=92)	29.6 / 4.0	65%	59%
Internal medicine attendings (n=23)	39.4 / 10.2	61%	61%

TABLE 3
Knowledge of CRC Screening Guidelines and Facts Among Study Participants

	Knowledge of ACS guidelines for average-risk patients		Knowledge of ACS guidelines for high-risk patients		Knowledge of general CRC screening facts	
	No. people responding	Mean Score	No. people responding	Mean Score	No. people responding	Mean Score
Medical students (n=53)	52	37% ^{a,b}	53	53%	53	31% ^{a,b}
Internal medicine residents (n=92)	83	49%	90	52%	92	38%
Internal medicine attendings (n=23)	23	56%	23	54%	23	42%

^a p<0.05 for medical students compared to residents

^b p<0.01 for medical students compared to attendings

ACS = American Cancer Society, CRC = colorectal cancer

rect responses by residents was somewhere between that of medical students and internists.

Knowledge of High-Risk Patient Guidelines (Section B)

Physicians were provided with five vignettes to test knowledge of recommended guidelines for screening high-risk patients (Table 4). The first vignette described an asymptomatic patient with a single first-degree relative diagnosed with CRC at an age less than 55. All participants scored high on this vignette, knowing the correct age to begin screening (40 years old), with an overall correct response rate of 60%. The second vignette described an asymptomatic patient with a single affected first-degree relative diagnosed with an adenomatous polyp of the colon at age less than 60. Only 28% of residents correctly chose age 40 as the recommended screening age. The third vignette tested knowledge of what age to begin screening of an asymptomatic patient with a known family history of FAP. Only 36% of residents

knew to begin screening at age 12, and the vast majority (88%) chose colonoscopy rather than the recommended FS (11%) as the screening test.

The fourth vignette was of an asymptomatic patient with a known family history of HNPCC. Of the residents, 43% would correctly begin screening for CRC while the patient was in his twenties. Medical students and attendings had a slightly lower correct response rate on this case. The fifth vignette was of a 65-year-old man who had removal of a 1.5 cm polyp. Forty-eight percent (48%) of residents knew that surveillance colonoscopy should be performed 3 years after the procedure, compared with 27% of the medical students and 65% of the attendings.

Knowledge of General Cancer Facts (Section C)

Results of selected questions (for the residents) that test knowledge of the screening tests which form the basis of the ACS guidelines are presented in Figs. 3 and 4. Fact one: FOBT performed annually for asymptomatic patients has been shown to decrease mortality by 30–35% (22). Only 18% of res-

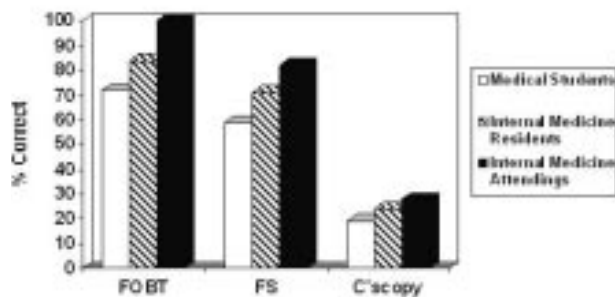


Fig. 2. Participants were asked at what frequency does the ACS recommend each of these screening tests for patients who are due for CRC screening and who have no family history of CRC. For explanation of abbreviations, see Fig.1.

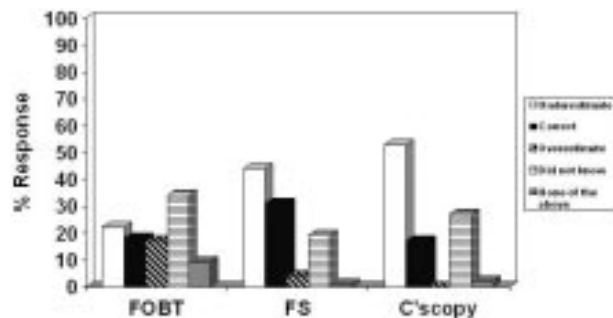


Fig. 3. Internal medicine residents' responses to efficacy rates of different procedures. For explanation of abbreviations, see Fig.1.

TABLE 4

Vignettes Evaluating Physician Knowledge of Screening and Surveillance Guidelines for High-Risk Patients. Physicians Were Asked to Answer Questions on the Following Cases with Regard to the American Cancer Society (ACS) Screening Recommendations.

Vignette	Question	Medical Students	Internal Medicine Residents	Internal Medicine Attendings
		No. correct respondents / No. people responding	No. correct respondents / No. people responding	No. correct respondents / No. people responding
An asymptomatic patient with a single affected first degree relative diagnosed with CRC at age less than 55.	At what age should this patient begin screening for CRC? Answer: 40	29/52 (56%)	56/89 (63%)	14/23 (61%)
An asymptomatic patient with a single affected first degree relative diagnosed with an adenomatous polyp of the colon at age less than 60.	At what age should this patient begin screening for CRC? Answer: 40	26/51 (51%)	25/90 (28%)	9/23 (39%)
An asymptomatic patient has a family history of familial adenomatous polyposis (FAP).	At what age should this patient begin screening for CRC? Answer: 12	25/51 (49%)	32/88 (36%)	7/22 (32%)
An asymptomatic patient has a family history of hereditary nonpolyposis colon cancer (HNPCC).	At what age should this patient begin screening for CRC? Answer: 25	21/50 (42%)	38/89 (43%)	7/23 (30%)
A 65-year-old man has just had a colonoscopy which revealed a single 1.5 cm adenomatous polyp.	When should you recommend that this patient have a repeat test? Answer: 3 years	12/44 (27%)	40/84 (48%)	15/23 (65%)

CRC = colorectal cancer

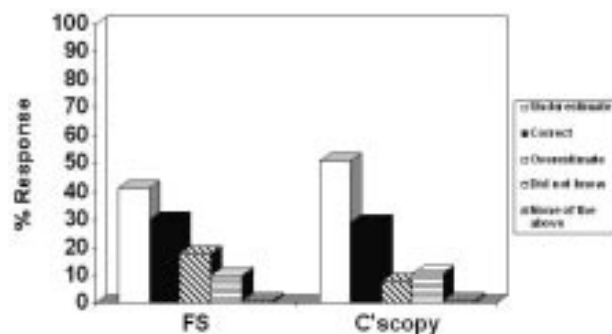


Fig. 4. Internal medicine residents' responses to risks of different procedures.
For explanation of abbreviations, see Fig.1.

idents knew the correct answer, 22% underestimated, 17% overestimated, and the remainder either did not know the efficacy or chose "none of the above." Fact two: Sigmoidoscopy has been shown to decrease mortality from distal CRC by 65–70% (23, 24). Only 31% of residents correctly chose this re-

sponse, while 44% underestimated the efficacy of sigmoidoscopy, 4% overestimated, and the remainder either did not know or chose "none of the above." Fact three: Colonoscopy with polypectomy has been shown to decrease the expected incidence of CRC by over 85% (25). Only 17% of the residents correctly chose this answer, 53% underestimated the efficacy of colonoscopy, 27% did not know, and 2% chose "none of the above." Two questions assessed the risk of FS and colonoscopy. Best estimates of the risk of colonic perforation from these tests are 1/10,000 from FS and 1/1,000 from colonoscopy (21). Thirty percent (30%) and 29% of residents correctly estimated the risk of FS and of colonoscopy, respectively. As shown in Table 2, resident overall factual knowledge with regard to CRC was somewhere between that of medical students and attendings.

Discussion

The present study showed that knowledge of CRC screening guidelines among medical profes-

sionals is low for both average-risk and high-risk patients. Colorectal cancer is a major preventable public health problem in the United States. Data from the 1999 BRFSS demonstrate low CRC screening rates in the general population for FOBT, FS, and colonoscopy (26). CRC screening rates appear to be even lower nationally among minority groups, including African-Americans and Hispanic-Americans, as compared to Caucasians (26). Although important efforts are underway to enhance public awareness of CRC screening, attention must also be given to enhancing physician knowledge and awareness. Since internists are often on the frontlines of CRC screening, we chose to investigate the knowledge of primary care physicians at all levels of training.

Average-Risk Patients (Section A)

Section A assessed physicians' knowledge of available screening options as recommended by the ACS. The ACS recommendations were used as the standard for comparison, since prior studies have indicated that the majority of physicians follow or agree with these guidelines as compared to those of other national organizations (27–29). In addition, the ACS guidelines are consistent with those of the 1997 multidisciplinary panel (21). At the time of this survey, the ACS recommended as suitable screening options for average-risk patients: (a) FOBT annually and FS every 5 years; (b) colonoscopy every 10 years; and (c) double contrast barium enema every 5–10 years.

As reported in the results section, physicians at all levels of training demonstrate low levels of knowledge of the screening guidelines for average-risk patients. Although knowledge scores increased incrementally according to level of training, they did not exceed 56% for any group. This lack of knowledge is likely to have a direct impact on physicians' screening practices. If physicians are unaware of the acceptable and alternative options for CRC screening, they may not select the appropriate, individualized test for the patient. Physicians should be knowledgeable about all available screening methods for CRC so that patients can be informed about their options and make educated medical decisions. In one study assessing internal medicine residents' practices, 71% of residents would begin screening for CRC at age 50 (20). In our study, the percentage of correct responses to this issue among the residents was even lower; approximately one third of residents did not know that 50 is the recommended age to begin FOBT testing. While the majority of residents knew the correct age to begin recommending FS, almost half of all residents did not know that colonoscopy is recommended as a CRC screening option for average-risk patients.

Although most residents knew the recommended frequency for FOBT (80%), approximately one third of residents did not know the frequency for FS and less than one third correctly identified the frequency for colonoscopy. Similar rates were obtained for medical students and attendings, with resident correct response rates being intermediate. Although it is true that physicians may be following the recommendations of other national organizations for CRC screening, we have chosen to assess knowledge of the most widely accepted guidelines. Furthermore, physicians should also be aware of recommendations put forth by other nationally recognized organizations in order to make informed decisions about which one they will follow in practice.

Knowledge of High-Risk Patient Guidelines (Section B)

We also aimed to assess physicians' knowledge of ACS guidelines for high-risk patients, since primary care providers are often the first to encounter and identify patients with a family history of CRC or other risk factors for CRC and subsequently refer them to a specialist.

Family history of CRC. Persons who are at a higher risk of developing CRC should be screened more aggressively. The higher an individual's risk of disease, the greater the potential benefit from screening for that person and the lower the cost of screening per cancer detected (21). Individuals with a family history of CRC are defined as those who have one or more first-degree relatives with CRC, excluding people with FAP and HNPCC. First-degree relatives of persons with CRC have consistently been found to have a 2–3-fold increased risk of CRC compared to control populations (30), and there is good evidence that cancers arise at an earlier age in these people than in average-risk persons. The risk of developing CRC for a 40-year-old person with a family history of CRC is comparable to that of an average-risk 50-year-old person (21, 30). A 5–10% reduction in mortality is predicted if individuals with a positive family history begin screening at age 40 rather than 50. For these reasons, it is recommended that CRC screening begin at age 40 or at ten years before the youngest case in patients with a first-degree relative who had CRC before the age of 55 years. Other groups have recommended guidelines for screening those with familial risk, but they also support the age criteria recommended by the ACS (9, 21, 31). In our study, more than one third of medical students, residents and attendings did not correctly identify the age at which screening should begin for patients who have a first-degree relative with CRC. This is somewhat worse than the 21% in-

correct response rate among internal medicine residents reported by others (18).

There is also evidence that patients who have first-degree relatives with adenomatous polyps are at increased risk for CRC when the polyp is diagnosed before the age of 60 (21, 32, 33). These patients should also begin screening at age 40 or ten years younger than the index case. However, about two thirds of residents and attendings, and half of medical students did not know this. It is possible that physicians do not routinely ask patients about these risk factors because they are unaware that the information may lead to a change in medical management.

Genetic syndromes. Internal medicine physicians should also be aware of the screening recommendations for high-risk patients with a family history of genetic syndromes. The identification of a first-degree relative with FAP and/or HNPCC has direct implications for the patient's risk of developing CRC and for the physician's management of the patient and the patient's family members. According to recommended guidelines, FAP gene carriers and indeterminate cases should be offered FS every year beginning at puberty, or around age 12, to see if they manifest the phenotype. Although participants surveyed in our study thought that it is recommended to begin screening before the age of 50 for a patient with a family history of FAP, only one third of residents and attendings, and half of medical students knew the correct age to begin screening for FAP. Most participants chose an age over 25 (9, 21, 34).

HNPCC is also inherited in an autosomal dominant fashion and is characterized by an 80% risk of CRC. Risk of CRC increases by age 21 and is very high by age 40. Patients with a family history of CRC in multiple close relatives and across generations should receive genetic counseling and/or testing for HNPCC between the ages of 20 and 30. This age criterion is accepted by most national organizations, including ACS and the 1997 Multidisciplinary Task Force. Yet fewer than 45% of medical students, residents and attendings knew the correct age to begin screening for patients with a family history of HNPCC. Internal medicine attendings in our study had correct response rates similar to those of physicians in a study by Schroy et al. (12). It is unclear whether this lack of knowledge regarding high-risk patients reflects physician unfamiliarity with the actual diseases or with the recommendations for CRC screening.

Surveillance for patients with history of adenomatous polyps. One vignette was used to assess physician knowledge of optimal surveillance intervals, as recommended by the ACS, for patients with a history of adenomatous polyps. The National Polyp Study directly addressed the question of opti-

mal surveillance intervals (35). The data from this study supports the ACS recommendation that follow-up surveillance colonoscopy need not be performed until 3 years after the removal of adenomas at the initial examination. Most physicians in our study knew that the surveillance test of choice for a patient with personal history of polyps > 1 cm is colonoscopy, but were not sure about the recommended frequency of future surveillance. Attendings were more familiar with this recommendation than were residents or medical students.

General Knowledge of CRC Facts (Section C)

This is the first study to date to assess actual physician knowledge of facts such as test efficacy and risk. Overall, physicians were unaware of screening test efficacy. Less than one third of residents chose the correct response when asked about the ability of each of these screening tests to decrease mortality from and incidence of CRC based on the current literature. In a study by Montano et al., physician belief in the efficacy of sigmoidoscopy positively correlated with rates of providing sigmoidoscopy (35). Similarly, perceived ineffectiveness of FOBT has been identified as a reason for physician not complying with the test (17). Low level of knowledge of actual test efficacy can be expected to affect perceived efficacy on the part of the physician and may partially account for the low usage of both FS and colonoscopy as screening procedures for average-risk patients. Interestingly, in our study, a larger percentage of physicians underestimated the efficacy of FS and colonoscopy than that of FOBT. This is consistent with the lower rates of screening endoscopy than FOBT which exist in this community.

Prior studies (36) have indicated that physicians' perception of the risks of sigmoidoscopy are also a barrier to its implementation. Surprisingly, residents in our study underestimated the actual risk of flexible sigmoidoscopy and colonoscopy. Perhaps even the underestimated risk rates are unacceptable to this group of physicians. Approximately two thirds of residents did not know the risk of perforation associated with FS and colonoscopy, as estimated in the current literature. An inadequate knowledge base in these crucial areas will lead to an incorrect estimation of risk-benefit ratio, which is necessary for selecting any screening or diagnostic test for a patient.

Implications

Overall, the knowledge level of CRC screening guidelines and medical facts is low among medical

students, residents and attendings serving the medically underserved minority community of East Harlem. Scores assessing knowledge of guidelines for high-risk patients were similar, yet low, across all levels of training. This suggests a need for educational interventions with regard to CRC, beginning early in medical education. Increasing physician knowledge of current guidelines and clinical trial results will provide practicing physicians and physicians in training with the appropriate foundation for decision making and patient care with regard to CRC prevention and detection. Thus, as a next step, an intervention geared toward increasing physician knowledge of CRC guidelines should be explored.

There were several limitations to our study. First, although our response rate is similar to that of other physician-based surveys, we do not have data regarding the nonresponders (13). This may serve as a limitation to the external validity of our study. Second, although physicians were specifically asked about their knowledge of the ACS guidelines, they may have answered according to personal practices or to other guidelines that would falsely lower the obtained knowledge results. Lastly, we can report on level of physician knowledge, but cannot predict how this knowledge actually influences practice without some measure of physician compliance. Further studies could investigate whether knowledge is a significant predictor of practice.

Reference

- 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; 85(6):795–800.
- Lee MM, Lee F, Stewart S, McPhee S. Cancer screening practices among primary care physicians serving Chinese Americans in San Francisco. *West J Med* 1999; 170(148):155.
- Gemson DH, Elinson J, Messeri P. Differences in physician preventive practice patterns for white and minority patients. *J Community Health* 1988; 13(1):53–64.
- Wong MD, Hollenberg JP, Charlson ME. A comparison of clinical performance of primary care and traditional internal medicine residents. *Med Care* 1999; 37(8):773–784.
- Peterson SK, Vernon SW. A review of patient and physician adherence to colorectal cancer screening guidelines. *Seminars in Colon and Rectal Surgery* 2000; 11(1):58–72.
- Holt WS Jr. Factors affecting compliance with screening sigmoidoscopy. *J Fam Pract* 1991; 32(6):585–589.
- Bejes C, Marel MK. Attempting the improbable: offering colorectal cancer screening to all appropriate patients. *Family Practice Research Journal* 1992; 12:83–90.
- CDC data from web, 2001. www.cdc.org (accessed 7/29/04)
- Centers for Disease Control and Prevention (CDC). Behavioral Risk Factor Surveillance System Survey Data. Atlanta, Georgia: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2001. www.cdc.gov/brfss (accessed 7/29/04)
- Ries LAG, Wingo PA, Miller DS, et al. The annual report to the nation on the status of cancer, 1973–1997, with a special section on colorectal cancer. *Cancer* 2000; 88(10):2398–2424.
- Vernon SW. Participation in colorectal cancer screening: a review. *J Natl Cancer Inst* 1997; 89(19):1406–1422.
- Schroy PC 3rd, Barrison AF, Ling BS, et al. Family history and colorectal cancer screening: a survey of physician knowledge and practice patterns. *Am J Gastroenterol* 2002; 97(4):1031–1036.
- Zack DL, DiBaise JK, Quigley EM, Roy HK. Colorectal cancer screening compliance by medicine residents: perceived and actual. *Am J Gastroenterol* 2001; 96(10):3004–3008.
- Dietrich AJ, Barrett J, Levy D, Carney-Gersten P. Impact of an educational program on physician cancer control knowledge and activities. *Am J Prev Med* 1990; 6(6):346–352.
- Turner BJ, Day SC, Borenstein B. A controlled trial to improve delivery of preventive care: physician or patient reminders? *J Gen Intern Med* 1989; 4(5):403–409.
- Sheinfeld GS, Gemson D, Ashford A, et al. Cancer education among primary care physicians in an underserved community. *Am J Prev Med* 2000; 19(1):53–58.
- Schroy PC III, Geller AC, Wood MC, et al. Utilization of colorectal cancer screening tests: a 1997 survey of Massachusetts internists. *Prev Med* 2001; 33:381–391.
- Barrison AF, Smith C, Oviedo J, et al. Colorectal cancer screening and familial risk: a survey of internal medicine residents' knowledge and practice patterns. *Am J Gastroenterol* 2003; 98(6):1410–1416.
- Moser RM, McCance KL, Smith KR. Results of a national survey of physicians' knowledge and application of prevention capabilities. *Am J Prev Med* 1991; 7(6):384–390.
- Sharma VK, Vasudeva R, Howden CW. Colorectal cancer screening and surveillance practices by primary care physicians: results of a national survey. *Am J Gastroenterol* 2000; 95(6):1551–1556.
- Sharma VK, Corder FA, Raufman JP, et al. Survey of internal medicine residents' use of the fecal occult blood test and their understanding of colorectal cancer screening and surveillance. *Am J Gastroenterol* 2000; 95(8):2068–2073.
- Winawer S, Fletcher R, Miller L, et al. Colorectal cancer screening: clinical guidelines and rationale. *Gastroenterology* 1997; 112:594–642.
- Hardcastle JD, Chamberlain JO, Robinson MH, et al. Randomized controlled trial of faecal-occult-blood screening for colorectal cancer. *Lancet* 1996; 348(9040):1472–1477.
- Selby JV, Friedman GD, Quesenberry CP Jr, Weiss NS. A case-control study of screening sigmoidoscopy and mortality from colorectal cancer. *N Engl J Med* 1992; 326:653–702.
- Newcomb PA, Norfleet RG, Storer E, et al. Screening sigmoidoscopy and colorectal cancer mortality. *J Natl Cancer Inst* 1992; 84:1572–1575.
- Winawer SJ, Zauber AG, Ho MN, et al. Prevention of colorectal cancer by colonoscopic polypectomy. *N Engl J Med* 1993; 329:1977–1981.
- Healthy People 2010. www.cdc.gov/nchs/hphome.htm (accessed 7/20/04)
- McPhee SJ, Richard RJ, Solkowitz SN. Performance of cancer screening in a university general internal medicine practice: comparison with the 1980 American Cancer Society Guidelines. *J Gen Intern Med* 1986; 1(5):275–281.
- Czaja R, McFall SL, Warnecke RB, et al. Preferences of community physicians for cancer screening guidelines. *Ann Intern Med* 1994; 120(7):602–608.
- Gemson DH. Prevention in primary care: variability in physician practice patterns in New York City. *Am J Prev Med* 1986; 2(4):226–234.

31. Fuchs CS, Giovannucci EL, Colditz GA, et al. A prospective study of family history and the risk of colorectal cancer. *N Engl J Med* 1994; 331:1669–1674.
32. Colonoscopy in the screening and surveillance of individuals at increased risk for colorectal cancer. American Society for Gastrointestinal Endoscopy. *Gastrointest Endosc* 1998; 48(6):676–678.
33. Ahsan H, Neugut AI, Garbowski GC, et al. Family history of colorectal adenomatous polyps and increased risk for colorectal cancer. *Ann Intern Med* 1998; 128(11):900–905.
34. Bonelli L, Martines H, Conio M, et al. Family history of colorectal cancer as a risk factor for benign and malignant tumours of the large bowel: a case-control study. *Int J Cancer* 1988; 41(4):513–517.
35. Montano DE, Phillips WR, Kasprzyk D. Explaining physician rates of providing flexible sigmoidoscopy. *Cancer Epidemiol Biomarkers Prev* 2000; 9(7):665–669.
36. Burt RW. Colon cancer screening. *Gastroenterology* 2000; 119:837–853.