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Abbreviation:
CI = confidence interval

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CT Colonography and Colonoscopy: Assessment of Patient Preference in a 5-week Follow-up Study[1]

PURPOSE: To prospectively evaluate short- and midterm patient preference of computed tomographic (CT) colonography relative to colonoscopy in patients at increased risk for colorectal cancer and to elucidate determinants of preference.

MATERIALS AND METHODS: Consecutive patients at increased risk for colorectal cancer underwent CT colonography prior to scheduled colonoscopy. Patient experience and preference were assessed both directly after the examinations and 5 weeks after the examinations. Differences in pain, embarrassment, discomfort, and preference were assessed with the Wilcoxon signed rank sum test or a binomial test. Potential determinants of preference were investigated with logistic regression analyses.

RESULTS: Data for 249 patients were included. Fewer patients experienced severe or extreme pain during CT colonography (seven [3%] of 245) than during colonoscopy (81 [34%] of 241) ($P < .001$). Directly after both examinations, 168 (71%) of 236 patients preferred CT colonography; 5 weeks later, 141 (61%) of 233 patients preferred CT colonography ($P < .001$). Initially, a painful colonoscopy examination (odds ratio, 0.17; 95% confidence interval [CI]: 0.08, 0.38) was a determinant of CT colonography preference. Similarly, a painful (odds ratio, 3.70; 95% CI: 1.54, 8.92) or an embarrassing (odds ratio, 4.46; 95% CI: 1.18, 16.88) CT colonography examination was a determinant of colonoscopy preference. After 5 weeks, the presence of polyps emerged as a determinant of colonoscopy preference (odds ratio, 1.94; 95% CI: 1.02, 3.70), while the role of experiences waned.

CONCLUSION: Patients preferred CT colonography to colonoscopy; however, this preference decreased in time, while outcome considerations gradually replaced temporary experiences of inconvenience.

Colorectal cancer is the second leading cause of cancer-related mortality in the Western world, accounting for an estimated 56 700 deaths in 2001 in the United States (1). There is compelling evidence that screening for colorectal cancer reduces the incidence of this disease and the disease-specific mortality (2). Thus, many organizations have established screening guidelines and recommended screening methods, such as fecal occult blood testing, flexible sigmoidoscopy, colonoscopy, and double barium enema examination (3–6).

Despite the widespread promotion of colorectal cancer screening, a recent survey demonstrated that only 23.4% of the United States population aged 50 years and older underwent a fecal occult blood test in the previous year, and only 37.4% of the population underwent sigmoidoscopy or colonoscopy in the past 5 years (6). Factors that influence adherence to established guidelines are patient attitudes toward the tests, physician recommendations, and coverage by the health care system (7).

In line with reports indicating that colonoscopy is more sensitive than double barium enema examination (8) or sigmoidoscopy (combined with a fecal occult blood test) (9), the American College of Gastroenterology currently recommends that asymptomatic individuals aged 50 years and older undergo colonoscopy once every 10 years (4). The fact that

Medicare presently reimburses persons at average risk for colorectal cancer for the cost of colonoscopy screening demonstrates the increased acceptance of colonoscopy in the prevention of colorectal cancer (10). From the patient's perspective, the drawbacks of this method are the attendant discomfort, a reason that is frequently mentioned by individuals for not undergoing colonoscopy screening (11), and the risk of complications due to its invasive nature (12).

Since several reports have demonstrated that CT colonography and colonoscopy have a similar accuracy in the detection of polyps that are 10 mm and larger (13–16), CT colonography has been considered as an alternative method in colorectal cancer screening. Inconvenience is claimed to be less with CT colonography than that associated with colonoscopy, and—to our knowledge—complications have not been reported.

The few available comparisons of patient preference of CT colonography and colonoscopy are based on measurements obtained within 3 days of an examination and might have been obtained under stressful circumstances, such as hospitalization, physical discomfort, or aftereffects of sedatives (17–22). Because adverse reactions to tests tend to temper in time (22), it might be preferable to assess patient preference some time after the examinations. To date, little is known about the preference of patients, as measured 5 weeks after CT colonography and colonoscopy.

Thus, the purpose of our study was to prospectively evaluate short- and midterm preference of CT colonography relative to colonoscopy in patients at increased risk for colorectal cancer and to elucidate the determinants of patient preference.

MATERIALS AND METHODS

Patients and Setting

The study inclusion period was between October 29, 2000, and September 25, 2002. Patients scheduled to undergo routine colonoscopy at the endoscopy departments of either the Academic Medical Center or the Slotervaart Hospital because they had a personal or familial history of colorectal polyps or cancer were included.

Patients were excluded if they were *(a)* younger than 18 years, *(b)* unable to understand the concepts of patient information and informed consent or refused to provide their written informed consent, *(c)* found to have colorectal polyps or cancer during a recent colon examination, or *(d)* underwent colostomy after colorectal surgery. Approximately 7 weeks before colonoscopy, eligible patients were called by a member of the study group (R.E.v.G., M.P.S.). The member of the study group explained the aim of the study and asked patients if they were interested in receiving information about this study. This information comprised an explanation of the CT colonography procedure and a statement of the purpose of this study, which was to investigate the accuracy and patient preference of CT colonography. This report only deals with patient preference. The patients were called 2 weeks later and invited to participate in the study if they consented.

The medical ethics committees of the Academic Medical Center and Slotervaart Hospital approved the study, and all patients provided signed informed consent.

Diagnostic Procedures

For the purpose of this study, patients underwent CT colonography; approximately 1 hour later, they underwent colonoscopy.

Bowel Preparation

All patients ingested 4–6 L of polyethylene glycol electrolyte solution (Klean-Prep; Helsinn Birex Pharmaceuticals, Dublin, Ireland) for bowel preparation on the day before and the day of the examination.

CT Colonography

First, a balloon-tipped rectal enema tube was inserted, and 20 mg of butyl scopalamine bromide (Buscopan; Boehringer-Ingelheim, Ingelheim, Germany) or 1 mg of glucagon hydrochloride (Glucagen; Novo-Nordisk, Bagsvaerd, Denmark) was administered intravenously. To distend the colon, carbon dioxide (13.4 volume percentage) was insufflated manually to maximum patient tolerance (approximately 2 L). Before a patient underwent scanning, a preview image was obtained that allowed physicians or technicians to judge distention and plan the CT examination. If distention was unsatisfactory, additional air was insufflated in consultation with the patient.

Two CT examinations, one with the patient in the supine position and one with the patient in the prone position, were performed; each examination was performed during a 22-second breath hold. The examinations were performed with a multi–detector row CT scanner (Mx8000; Philips Medical Systems, Best, the Netherlands) with the following parameters: 25–100 mAs, 120 kV, 4 × 2.5-mm collimation, 0.75-second rotation time, pitch of 1.25, 3.2-mm section thickness, and 1.6-mm reconstruction interval. Either a research fellow or a specially trained technician performed CT colonography. The median examination room time was 21 minutes 30 seconds (interquartile range, 18 minutes 40 seconds to 26 minutes 58 seconds).

Colonoscopy

Colonoscopy was performed with a standard colonoscope (CF-140L; Olympus, Tokyo, Japan). During this procedure, patients received a standard dose of sedatives (5 mg of midazolam [Dormicum; Roche, Basel, Switzerland]) and analgesics (0.05 mg of fentanyl [Fentanyl-Janssen; Janssen Pharmaceuticals, Beerse, Belgium]) at request of the patient. If sedation and analgesia were insufficient, the endoscopist increased the dose.

Colonoscopy was performed in 118 (47%) of the 249 patients by an experienced (≥5 years) gastroenterologist (J.F.B., P.S., and others) and in 131 (53%) patients by a gastroenterology fellow under direct supervision of the attending gastroenterologist (J.F.B. and others). The median colonoscopy examination time, which consisted of insertion of the colonoscope and inspection, was 30 minutes 0 seconds (interquartile range, 21 minutes 0 seconds to 49 minutes 30 seconds). Patients were brought to the recovery ward after colonoscopy, and they were discharged from the hospital 2 hours later.

Patient Preference Measurements

To elucidate background information and to evaluate experience and preference, all patients were asked to fill out a total of five questionnaires: *(a)* one questionnaire 2 weeks prior to the examinations, *(b)* three questionnaires on the day of the examinations, and *(c)* one questionnaire 5 weeks after the examinations. Note that all experience parameters were evaluated with a five-point Likert scale (none, mild, moderate, severe, extreme). Questionnaire contents will be explained later and are summarized in Table 1. Patients filled out the questionnaires, although assistance was available on request.

TABLE 1
Summary of Questionnaires and Responses at Different Times

Question	Questionnaire No.	2 Weeks prior to Examination*	Directly after Examination*	5 Weeks after Examination*
To which of the following events do you feel the most reluctance: bowel preparation or CT colonography, bowel preparation or colonoscopy, or colonoscopy or CT colonography?	1	207 (83)	NA	NA
Please indicate the burden due to bowel preparation.	2	NA	247 (99)	NA
Please indicate the degree of the following sensations you experienced during CT colonography.				
Pain	3 and 5	NA	245 (98)	234 (94)
Embarrassment	3 and 5	NA	243 (98)	234 (94)
Discomfort	3 and 5	NA	243 (98)	234 (94)
Which part of the CT colonography examination did you think was the most burdensome?	3 and 5	NA	237 (95)	226 (91)
Please indicate the degree of the following sensations you experienced during CT colonoscopy.				
Pain	4 and 5	NA	241 (97)	235 (94)
Embarrassment	4 and 5	NA	240 (96)	234 (94)
Discomfort	4 and 5	NA	240 (96)	232 (93)
Which part of the colonoscopy examination did you think was the most burdensome?	4 and 5	NA	22 (88)	223 (90)
Which of the following events was the most burdensome: bowel preparation or CT colonography, bowel preparation or colonoscopy, or colonoscopy or CT colonography?	4 and 5	NA	219 (88)	228 (92)
Which of the examinations (CT colonography or colonoscopy) would you prefer if you could choose your next examination?†	4 and 5	NA	236 (95)	233 (94)

Note.—NA = not applicable.
* Data are number of patients. Data in parentheses are percentages.
† Patients were asked to assume equal accuracy for CT colonography and colonoscopy.

Two Weeks before CT Colonography and Colonoscopy

Two weeks before the examinations, participants were asked to report background information, including whether they had any previous experience with endoscopic examinations, whether these experiences were painful, and their educational and income level. Also, patients were asked which of the following events they were most reluctant to undergo: bowel preparation, CT colonography, or colonoscopy.

Day of CT Colonography and Colonoscopy

Questionnaires were filled out *(a)* directly before CT colonography to evaluate the use of bowel preparation; *(b)* directly after CT colonography to evaluate pain, embarrassment, discomfort, and the most burdensome part of the examination; and *(c)* directly after colonoscopy to evaluate pain, embarrassment, discomfort, and the most burdensome part of the examination. In addition, patients were asked to indicate whether they would prefer CT colonography or colonoscopy if a future colon examination was indicated. This measurement was performed with a seven-point certainty scale: Patients would surely, likely, or possibly prefer CT colonography; patients were indifferent; and patients would possibly, likely, or surely prefer colonoscopy. The question regarding patient preference of CT colonography or colonoscopy was posed under two assumptions: First, we stated that accuracy for both examinations is similar. Second, we stated that if CT colonography was chosen, there was a 20% likelihood that colonoscopy would have to be performed to allow removal of polyps detected with CT colonography. Finally, patients were asked to indicate which of the following events was the most burdensome: bowel preparation, CT colonography, or colonoscopy.

Five Weeks after CT Colonography and Colonoscopy

Five weeks after CT colonography and colonoscopy, patients were mailed a questionnaire in which they were asked to evaluate the experience of both examinations and indicate which they preferred. Again, patients were asked to indicate which of the following events was the most burdensome: bowel preparation, CT colonography, or colonoscopy. We requested that patients return the questionnaires with a prepaid envelope. If patients did not respond, they were reminded twice.

Statistical Analysis

Differences in experience between CT colonography and colonoscopy were assessed with the Wilcoxon signed rank sum test. To assess differences in preference for CT colonography or colonoscopy, we dichotomized this parameter into preference (surely, likely, possibly) for CT colonography or colonoscopy and tested it with the Fisher exact test. Analysis of preference was also stratified according to the use of analgesics and sedatives during colonoscopy. Differences in experience and preference between the initial and second measurement were assessed with the Wilcoxon signed rank sum test.

In the present study, we compared experiences and preferences in patients who underwent both CT colonography and colonoscopy; therefore, we included only those patients who underwent both examinations completely. To investigate whether the exclusion of patients who underwent incomplete examinations influenced our results regarding preference,

we also analyzed the preference pattern in patients with failed CT colonography and colonoscopy.

Univariate and multivariate logistic regression was used to investigate associations between preferences (short- and midterm) and patient-related factors.

Univariate analysis was performed with patient characteristics (age ≥ 70 years, sex, personal history of colorectal polyps or cancer, previous painful endoscopy, income ≥ $27 000, and completion of academic or higher vocational education); experience parameters, as measured on the day of the examination (burdensome bowel preparation and painful or embarrassing CT colonography or colonoscopy); use of sedatives and analgesics during colonoscopy; and presence of polyps at the current colonoscopy. The income level of $27 000 or more was chosen because this level is similar to the Dutch modal income. Higher vocational education is education that students can pursue after they have completed secondary school and enables them to become higher professionals, such as technical engineers. This educational level is below the university level.

To reduce the number of potential covariates, we first performed univariate logistic regression analyses; covariates with a *P* value of .10 or less at univariate analyses were subsequently entered in the multiple logistic regression analysis. Stepwise, backward, and forward selection strategies with the same preselected covariates all provided the same multivariate result as the results presented in this study (obtained with method enter).

Both the odds ratios and 95% confidence intervals (CIs) of statistically significant independent determinants are reported. A *P* value of less than .05 was considered to indicate statistical significance. We used SPSS version 11.0 for Windows (SPSS, Chicago, Ill) to perform all statistical tests.

RESULTS

Patient Participation

Of 459 patients that were scheduled for colonoscopy during the study period, 98 (21%) were not approached for inclusion in the study because the CT scanner was not available (eg, scheduled clinical patients had priority, technical maintenance of scanner was scheduled), and 11 (2%) were not approached for inclusion because of unknown reasons. Of the 350 patients that were approached for inclusion, 62 (18%) refused because participation was inconvenient for logistical or medical reasons, or it was considered burdensome. Thus, a total of 288 (82%) patients participated in the study (Fig 1).

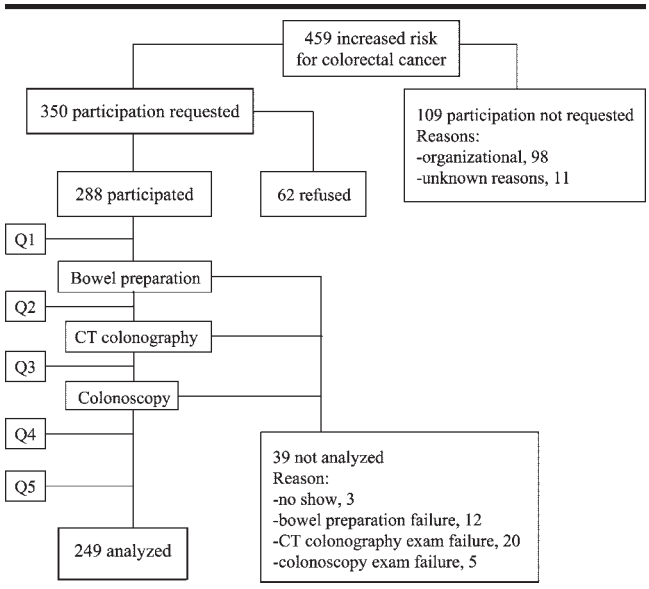

Figure 1. Flow chart shows patient participation and study design. A total of 288 patients participated; 249 patients who underwent successful bowel preparation, CT colonography, and colonoscopy were analyzed. In one patient, both unsatisfactory bowel preparation and CT colonography examination failure occurred; thus, 39 patients were not analyzed. In a 7-week time frame, patients completed five questionnaires. *Q1* = questionnaire completed 2 weeks before examination. Patient characteristics and reluctance were reported. *Q2* = questionnaire completed on the day of examination, before the examinations. Patients evaluated bowel preparation experience. *Q3* = questionnaire completed after CT colonography. Patients evaluated CT colonography experience. *Q4* = questionnaire completed after colonoscopy. Patients evaluated colonoscopy experience, and the first preference measurement was obtained. *Q5* = questionnaire completed at 5-week follow-up. Patients evaluated their CT colonography and colonoscopy experience, and the second preference measurement was obtained.

Adequate Bowel Preparation, CT Colonography, and Colonoscopy

In 12 (4%) patients, bowel preparation was insufficient and prevented evaluation with CT colonography and colonoscopy. In 20 (7%) patients, images obtained with CT colonography were inadequate because of insufficient bowel distention (*n* = 8, 3%), severe artifacts due to breathing (*n* = 3, 1%) or arthrodesis of the spine (*n* = 2, 1%), and technical problems during the examination (*n* = 7, 2%). Colonoscopy failed to reach the cecum in five (2%) patients. Three patients (1%) who initially agreed to participate did not show up for the examination. Data obtained in patients with failed bowel preparation or a failed examination or in patients who did not show up for the examinations (*n* = 39, 14%) were not analyzed. In one patient, the results of both bowel preparation and CT colonography were inadequate; therefore, data from 39 instead of 40 patients were not analyzed. Of the 249 patients with data that were analyzed, 235 (94%) returned the questionnaire they received 5 weeks after the examinations (Fig 1).

Of 249 patients, 20 (8%) had a history of mild abdominal symptoms. Of these 20 patients, eight had mild abdominal pain, two had hematochezia, and 10 had altered bowel habits.

Patient Characteristics, Responses, and Colonoscopy Results

Table 1 indicates the number of patients who responded to each question. Table 2 demonstrates the patient characteristics. Patient characteristics stratified according to the use of sedatives and analgesics during colonoscopy are available in the Appendix. In 139 (56%) of 249 patients, a polyp was diagnosed during colonoscopy. In 25 (10%) patients, a polyp of 10 mm or larger was diagnosed.

TABLE 2
Patient Characteristics

Characteristic	Data
Age (y)*	56 ± 13
Women	54 ± 13
Men	57 ± 13
Sex	
Female	103 (41)
Male	146 (59)
Previous endoscopy	189 (76)
Income ≥ $27 000	89 (51)†
Academic or higher vocational education	78 (34)‡
Indication for colonoscopy	
Personal history of colorectal polyps or cancer	158 (64)
Familial history of colorectal polyps or cancer	91 (37)
Use of sedatives and analgesics during colonoscopy	
No sedatives or analgesics used	67 (27)
Only sedatives used	61 (25)
Sedatives and analgesics used	121 (49)

Note.—Unless otherwise indicated, data are number of patients, and data in parentheses are percentages.
* Data are mean ± standard deviation.
† A total of 74 (30%) patients did not report their income.
‡ A total of 22 (9%) patients did not report their educational level.

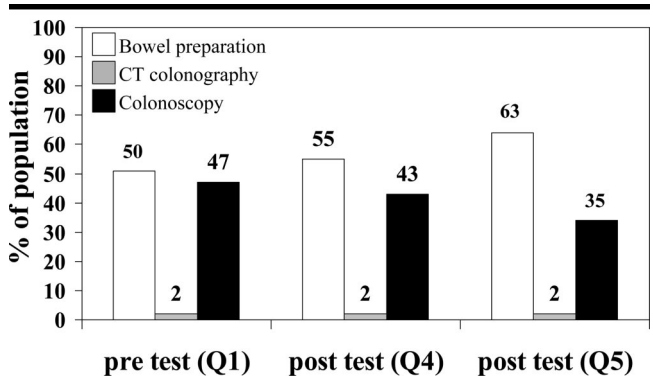

Figure 2. Graph shows pretest reluctance and posttest appraisal of the most burdensome event: bowel preparation, CT colonography, or colonoscopy. On questionnaire 1 (*Q1*), a similar percentage of patients indicated that they were most reluctant to undergo bowel preparation and colonoscopy. Patients indicated that bowel preparation was the most burdensome event after the examination on questionnaires 4 (*Q4*) and 5 (*Q5*).

Pre- and Posttest Appraisal of Bowel Preparation, CT Colonography, and Colonoscopy

Only five (2%) of 207 patients indicated that they were most reluctant to undergo CT colonography in advance and that this examination was the worst of three events directly after both examinations and 5 weeks later. Two weeks before the examinations, the number of patients that were most reluctant to undergo bowel preparation (n = 104 [50%]) and colonoscopy (n = 98 [47%]) was similar. The number of patients who indicated bowel preparation was the most burdensome event increased from 120 (55%) of 219 patients directly after both examinations to 144 (63%) of 228 patients 5 weeks after the examinations. The number of patients that indicated colonoscopy was the most burdensome event decreased from 94 (43%) of 219 patients directly after both examinations to 79 (35%) of 228 patients 5 weeks after the examinations (Fig 2).

Patient Experience of Bowel Preparation, CT Colonography, and Colonoscopy

Of 247 patients, 60 (24%) appraised the burden due to the use of bowel preparation as extreme, 85 (34%) as severe, 48 (19%) as moderate, 42 (17%) as mild, and 12 (5%) as negligible.

Directly after the examinations, fewer patients experienced severe pain during CT colonography (n = 7 [3%]) than during colonoscopy (n = 81 [34%]) ($P <$ .001). A similar significant difference was observed 5 weeks after the examinations, when eight (3%) of 234 patients appraised CT colonography as severely or extremely painful, and 67 (29%) of 235 patients appraised colonoscopy as severely or extremely painful ($P <$ .001). At both time points, patients experienced significantly less discomfort during CT colonography than during colonoscopy ($P <$ .001), but they did experience a similar level of embarrassment.

Comparison of the initial experience measurements with those obtained after 5 weeks showed that patients appraised procedural embarrassment during CT colonography and colonoscopy as slightly, but significantly, greater after 5 weeks than directly after the examinations ($P <$ .001). Procedural pain after colonoscopy was appraised as significantly less at the 5-week measurement than at the initial experience measurement (P = .003), whereas an increase in discomfort was observed for CT colonography (P = .032) (Fig 3).

Immediately after the examination, the insufflation of air and the insertion of the rectal enema tube were considered the most burdensome parts of CT colonography. After 5 weeks, the majority of patients considered the insufflation of air to be the most burdensome part of CT colonography. The insertion of the endoscope was considered the most burdensome part of colonoscopy both immediately and 5 weeks after the examination (Table 3).

Preference for CT Colonography or Colonoscopy

Of 236 patients, 168 (71%) preferred CT colonography, whereas 45 (19%) preferred colonoscopy directly after both examinations ($P <$ .001). Five weeks later, 141 (61%) of 233 patients preferred CT colonography, and 72 (31%) preferred colonoscopy ($P <$ .001). This decrease in preference for CT colonography was statistically significant ($P <$ .001) (Fig 4). Stratified according to colonoscopic premedication, the same preference patterns were observed (Table 4). Five weeks after both examinations, patients who did not receive colonoscopic premedication did not significantly prefer CT colonography to colonoscopy (P = .088).

The 25 patients who were excluded because inadequate images were obtained

with CT colonography or colonoscopy had the same preference patterns as the included patients; 14 (78%) of 18 patients who responded preferred CT colonography, three (17%) preferred colonoscopy, and one (6%) had no preference. Five weeks after the examinations, however, 13 (72%) of 18 respondents preferred CT colonography, three (17%) preferred colonoscopy, and two (11%) had no preference.

The statistically significant differences in preference and procedural experience in favor of CT colonography were found irrespective of whether endoscopy was performed by a gastroenterologist or gastrointestinal surgeon working alone or by a gastroenterology fellow working under direct supervision of an attending gastroenterologist.

Determinants of Patient Preference

A painful and embarrassing CT colonography examination (odds ratio, 3.70; 95% CI: 1.54, 8.92) was independently associated with a preference for colonoscopy (odds ratio, 4.46; 95% CI: 1.18, 16.88) directly after both examinations. Similarly, a painful colonoscopy experience was associated with a preference for CT colonography (odds ratio, 0.17; 95% CI: 0.08, 0.38). After 5 weeks, painful CT colonography (odds ratio, 2.64; 95% CI: 1.14, 6.11) and colonoscopy (odds ratio, 0.36; 95% CI: 0.19, 0.68) experiences were still associated with preference, albeit to a lesser degree. Also, after 5 weeks, the detection of a polyp with colonoscopy showed an independent association (odds ratio, 1.94; 95% CI: 1.02, 3.70) with a preference for colonoscopy. The Appendix lists the odds ratios and 95% CIs of the tested covariates.

DISCUSSION

The results of this 5-week follow-up study demonstrate that the majority of patients who have an increased risk of developing colorectal cancer have a sustained preference for CT colonography. These patients experience CT colonography as a negligible or minor burden. Patients prefer CT colonography despite a 20% chance that colonoscopy will still be required for the removal of detected polyps. Anticipated pain is an important reason for individuals to decline colonoscopic screening (11); the implementation of a less troublesome examination, such as CT colonography, in the prevention of colorectal cancer might improve attendance rates.

Although patients preferred CT colonography at both time points, the strength of that preference significantly decreased after 5 weeks. It is likely, however, that the last opinion will constitute the basis of future decisions, because this opinion is formed after immediate experiences have tempered and patients most likely have returned to normal functioning.

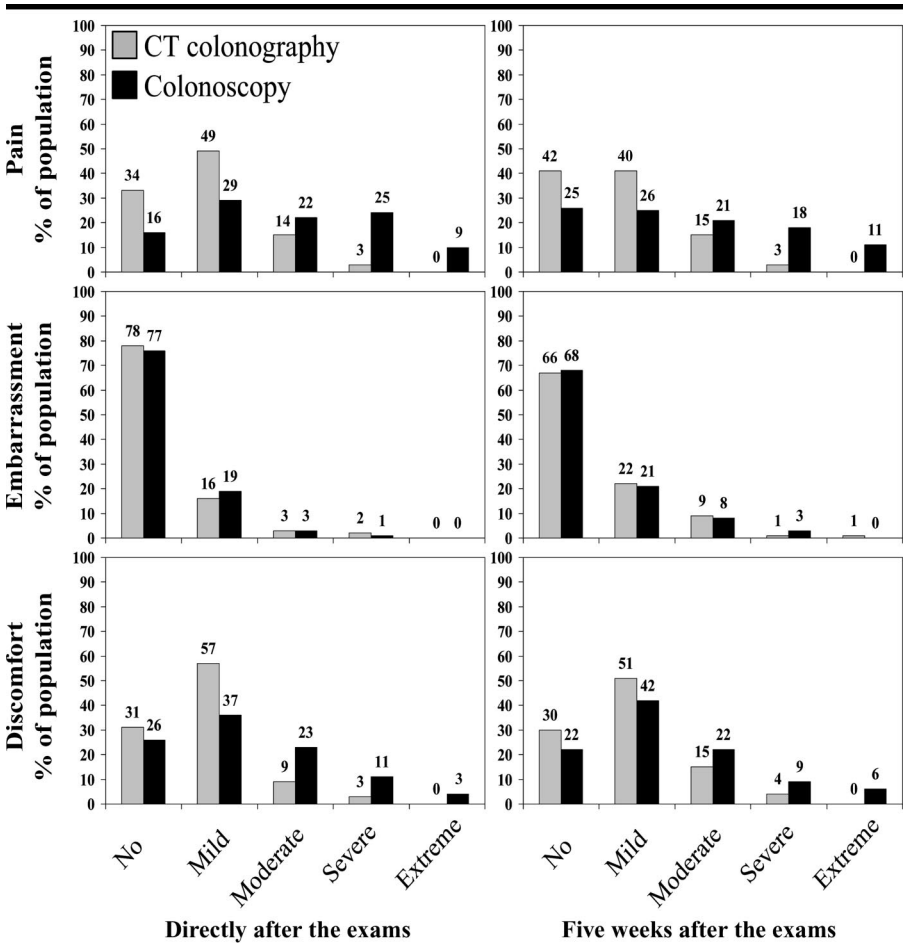

Figure 3. Graphs show patient experience with CT colonography and colonoscopy, as measured directly after both examinations and at 5-week follow-up. Differences in pain and discomfort between CT colonography and colonoscopy were statistically significant ($P < .001$) at both time points, whereas the differences in embarrassment were not. Numbers indicate percentage of the patient group.

TABLE 3
Most Burdensome Part of the Examination

Type of Examination	Directly after Examination	5 Weeks after Examination
CT colonography		
Intravenous injection	4 (2)	14 (6)
Insertion of tube	91 (38)	53 (24)
Air insufflation	91 (38)	108 (48)
Breath hold	32 (14)	31 (14)
Turning over on scanner table	7 (3)	9 (4)
Prone position	12 (5)	11 (5)
Colonoscopy		
Intravenous injection	18 (8)	12 (5)
Air insufflation	39 (18)	39 (18)
Insertion of colonoscope	157 (71)	158 (71)
Stay at recovery ward	6 (3)	14 (6)

Note.—Data are number of patients. Data in parentheses are percentages.

TABLE 4
Patient Preference according to Colonoscopic Premedication

Use of Sedation and Analgesics	Surely CT Colonography	Likely CT Colonography	Possibly CT Colonography	Indifferent	Possibly Colonoscopy	Likely Colonoscopy	Surely Colonoscopy
No sedatives or analgesics used							
Directly after examination	27 (42)	9 (14)	5 (8)	11 (17)	2 (3)	5 (8)	5 (8)
5 weeks after examination	27 (44)	6 (10)	3 (5)	4 (7)	0 (0)	12 (19)	10 (16)
Only sedatives used							
Directly after examination	29 (50)	14 (24)	1 (2)	7 (12)	1 (2)	2 (3)	4 (7)
5 weeks after examination	26 (46)	10 (18)	0 (0)	5 (9)	0 (0)	7 (12)	9 (16)
Sedatives and analgesics used							
Directly after examination	56 (49)	23 (20)	4 (4)	5 (4)	5 (4)	5 (4)	16 (14)
5 weeks after examination	42 (37)	20 (18)	7 (6)	11 (10)	2 (2)	14 (12)	18 (16)

Note.—Data are number of patients. Data in parentheses are percentages.

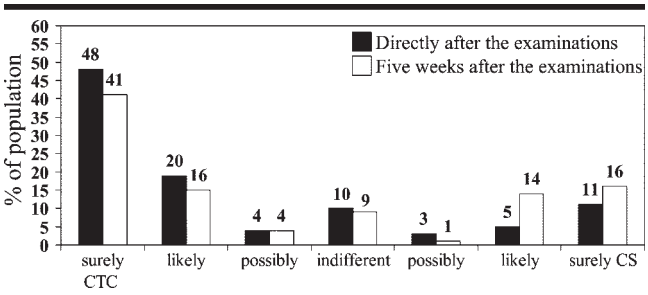

Figure 4. Graph shows preference of patients for CT colonography *(CTC)* or colonoscopy *(CS)* directly after both examinations and at 5-week follow-up and the strength of this preference. Numbers indicate percentage of the patient group. The majority of patients prefer CT colonography to colonoscopy ($P < .001$). This preference is present after 5 weeks ($P < .001$), although it decreased significantly ($P < .001$).

In time, several changes regarding the determinants of preference were noticed. First, the influence of parameters such as pain and embarrassment decreased after 5 weeks. Second, in contrast to the initial measurement, the presence of polyps at colonoscopy was associated with a preference for colonoscopy measured after 5 weeks. This observation may be explained by the patient's understanding that if polyps are present, therapeutic colonoscopy is required to remove the lesions; therefore, the patient might consider preselection by means of CT colonography to be less attractive. These changes may demonstrate that as time passes, temporary experiences wane and outcome considerations become more important.

The proportion of patients that indicated they experienced embarrassment at 5-week follow-up was greater than the proportion that indicated they experienced embarrassment immediately after both examinations. This may have been caused by the environment in which the measurement was performed. For example, thoughts of colonoscopy are normal when in the department of endoscopy, whereas thoughts of colonoscopy are surrounded by negative associations in daily life.

On the questionnaire patients received 5 weeks after the procedure, only a few patients indicated that they experienced more discomfort than they reported on the questionnaire completed directly after CT colonography; however, this finding was statistically significant ($P = .032$). The patients might have been inclined to express a more favorable opinion of CT colonography at the radiology department than at home.

The insertion of the rectal tube and insufflation of air were considered the most burdensome aspects of CT colonography. It must be noted, however, that the separate burden scores for these items were rated as severe or extreme by only 17 (7%) and 18 (7%) of 245 patients, respectively. We used rectal enema tubes for air insufflation because we thought these prevented air from escaping the rectum. It has recently been shown that use of thin rectal tubes instead of rectal balloon catheters results in clinically acceptable colon distention. Use of these thin tubes will probably improve patient acceptance of CT colonography (23).

No differences in experience between the use of room air or carbon dioxide were observed in a recent study of patient acceptance of CT colonography (22); however, the results of previous studies have shown that use of carbon dioxide reduces discomfort in patients who undergo a double contrast barium enema examination and colonoscopy because carbon dioxide is absorbed faster by the bowel wall (24,25). In the present study, we used 13.4 volume percentage carbon dioxide, but use of 100% carbon dioxide may result in less procedural pain. Pain during CT colonography clearly influenced patient preference in the present study; therefore, efforts to reduce pain may improve acceptance of CT colonography.

During colonoscopy, insertion of the endoscope was considered the most burdensome part of the examination. This finding is consistent with the findings of a recent study in which pain episodes were correlated with colonoscope configuration and air insufflation (26).

Patients were most reluctant about bowel preparation before the examinations. Bowel preparation was cited as the most severe burden after the examinations, a finding that is collaborated by previous reports (17,19,22). Early feasibility studies indicate that a bowel preparation consisting of a low-fiber diet and ingestion of contrast agents was sufficient for CT colonography (27). Implementation of these methods will further increase acceptance of CT colonography.

Performing colonoscopy without sedation is a consideration, since many of the cardiopulmonary complications associated with colonoscopy are caused by these agents. In the Netherlands and

many other countries, medication is not administered in every patient before colonoscopy (28–32). Patients who did not receive medication before colonoscopy no longer significantly preferred CT colonography at the 5-week follow-up. This may be explained by the fact that patients who do not request medication before the procedure have a more favorable view of colonoscopy. In our study, the administration of medication before colonoscopy was not randomized, which inevitably resulted in inequalities between subgroups, as reflected by differences in age, sex, and indication. Thus, no conclusions can be drawn regarding the effect of sedatives and analgesics on preference.

The present data apply to a population that may benefit from the implementation of CT colonography (eg, patients at increased risk for colorectal cancer because of a personal or familial history of colorectal polyps or cancer). Our data may also offer insight to the effects of implementation of CT colonography in colorectal cancer screening in patients with an average risk of colorectal cancer. However, several factors must be considered in this regard: First, the prevalence of large polyps in an average-risk population is lower than the prevalence observed in our study. Second, virtually all patients are asymptomatic in an average-risk population, whereas 8% of our patients had mild colorectal symptoms. Third, our patients may have been highly motivated to undergo CT colonography and colonoscopy because of their personal or familial history of colorectal polyps or cancer, whereas this is not the case in average-risk patients. Thus, the relative aspects rather than the absolute aspects of our results may apply to an average-risk population.

Several limitations of the present study must be considered. In this study, we asked patients to assume equal accuracy for CT colonography and colonoscopy. Although early reports on the accuracy of CT colonography are favorable (13–16), this assumption may be premature. As accuracy is an important criterion for patients in their choice of a screening test (33), preference patterns may be different if accuracy turns out to be lower.

Since the need for follow-up colonoscopy in patients with large polyps is considered a disadvantage of CT colonography, we are of the opinion that the likelihood of follow-up colonoscopy must be taken into account in preference research. On the basis of a 10% prevalence of polyps 10 mm or larger in patients at increased risk for colorectal cancer (34) and a sensitivity of 88% (95% CI: 84%, 93%) and a specificity of 95% (95% CI: 94%, 97%) in the detection of such lesions in patients (35), it can be expected that approximately 13% of patients will require subsequent colonoscopy. Our assumed proportion of 20% is higher than that in the aforementioned example; therefore, the preference for CT colonography in our study may even be a slight underestimation.

We assumed that experience and preference are preferably measured after a certain time because this may better reflect future behavior than if experience and preference are measured under stressful circumstances. In the present study, we chose a 5-week interval; however, it remains unknown when these opinions change and which interval should be used to optimally measure patient preference. Future studies will have to address the optimal time interval between the experience and evaluation.

The fact that the tests were performed in a fixed order might have influenced the results because residual air might have caused technical difficulties during colonoscopy, especially since we did not use 100% carbon dioxide. However, the endoscopists did not report that this was a major problem.

The fact that 62 (18%) of the 350 patients we asked to participate in the study did not grant their approval may have influenced our results, probably by reducing the number of patients that preferred colonoscopy.

Several investigators measured patient acceptance of CT colonography, all within 3 days of the actual examination (17–22). Against expectations, three reports indicated that CT colonography was considered to be more painful than colonoscopy (20–22), and patient preference was comparable for CT colonography and colonoscopy or was in favor of colonoscopy (20,21). Three other reports indicated that patients experienced less pain during CT colonography and preferred this test (17–19). These differences are most likely caused by variation in the administration of medication. In the studies in which patients indicated that CT colonography was a more painful examination, bowel relaxants were not used during the examination, and sedatives and analgesics were administered during colonoscopy in all patients (20–22). In the studies in which patients indicated that CT colonography was a less

TABLE A1
Patient Characteristics according to Use of Sedatives and Analgesics during Colonoscopy

Characteristic	No Sedatives or Analgesics Used (n = 67)	Only Sedatives Used (n = 61)	Sedatives and Analgesics Used (n = 121)
Age (y)*	59 ± 13	56 ± 14	55 ± 12
Age < 70 y	51 (76)	48 (79)	106 (88)
Female sex	16 (24)	30 (49)	56 (46)
Previous endoscopy†	55 (90)	42 (75)	92 (82)
Income ≥ $27 000‡	22 (49)	25 (56)	42 (49)
Academic or higher vocational education§	23 (37)	16 (30)	39 (35)
Indication for colonoscopy			
Personal history of colorectal polyps or cancer	52 (78)	38 (62)	68 (56)
Familial history of colorectal polyps or cancer	15 (22)	23 (38)	53 (44)

Note.—Data are number of patients, unless otherwise indicated. Data in parentheses are percentages. Patients who did not use sedatives or analgesics were significantly older than patients who did use sedatives or analgesics (Student t test, P = .018). More women than men used sedatives or analgesics (Pearson χ^2 analysis, P = .007). More patients with a personal history of colorectal polyps or cancer did not use sedatives or analgesics (Pearson χ^2 analysis, P = .014).

* Data are mean age ± standard deviation.

† Six (9%) patients in whom no sedatives or analgesics were used, five (8%) patients in whom only sedatives were used, and nine (7%) patients in whom sedatives and analgesics were used did not know if they had undergone previous endoscopy.

‡ Twenty-two (33%) patients in whom no sedatives or analgesics were used, 16 (26%) patients in whom only sedatives were used, and 36 (30%) patients in whom sedatives and analgesics were used did not report their income.

§ Five (7%) patients in whom no sedatives or analgesics were used, seven (11%) patients in whom only sedatives were used, and ten (8%) patients in whom sedatives and analgesics were used did not report their educational level.

TABLE A2
Determinants of Preference for CT Colonography or Colonoscopy

Characteristic	Directly after CT Colonography and Colonoscopy		5 Weeks after CT Colonography and Colonoscopy	
	Univariate Analysis	Multivariate Analysis	Univariate Analysis	Multivariate Analysis
Age ≥ 70 y	2.29 (1.04, 5.07)	2.09 (0.85, 5.11)	1.73 (0.83, 3.59)	NA
Female sex	1.19 (0.62, 2.31)	NA	0.96 (0.54, 1.72)	NA
Personal history	1.29 (0.65, 2.58)	NA	1.17 (0.65, 2.11)	NA
Previous painful endoscopy	0.83 (0.41, 1.67)	NA	0.86 (0.47, 1.56)	NA
Income ≥ $27 000/year	0.87 (0.40, 1.91)	NA	1.45 (0.74, 2.86)	NA
High educational level	0.77 (0.36, 1.62)	NA	1.54 (0.83, 2.87)	NA
Burdensome bowel preparation	1.11 (0.49, 2.51)	NA	1.68 (0.79, 3.57)	NA
Pain during CT colonography	2.76 (1.26, 6.08)	3.70 (1.54, 8.92)	2.40 (1.13, 5.10)	2.64 (1.14, 6.11)
Embarrassment during CT colonography	2.93 (0.88, 9.73)	4.46 (1.18, 16.88)	1.65 (0.49, 5.62)	NA
Pain during colonoscopy	0.26 (0.13, 0.52)	0.17 (0.08, 0.38)	0.43 (0.24, 0.77)	0.36 (0.19, 0.68)
Embarrassment during colonoscopy	0.82 (0.17, 3.95)	NA	0.21 (0.03, 1.69)	NA
Use of sedatives and analgesics at colonoscopy				
No sedatives or analgesics used	NA	NA	NA	NA
Only sedatives used	0.54 (0.20, 1.52)	NA	0.73 (0.33, 1.61)	NA
Sedatives and analgesics used	1.07 (0.49, 2.33)	NA	0.81 (0.41, 1.58)	NA
Polyp depicted with colonoscopy	2.24 (0.83, 6.07)	NA	1.92 (1.05, 3.51)	1.94 (1.02, 3.70)

Note.—Data are odds ratios. Data in parentheses are 95% CIs. Covariates were selected for multivariate analysis if the *P* value was not greater than .10 at the univariate analysis. Multivariate analysis was repeated with the same preselected covariates by using forward and backward conditional procedures and yielded results that were fully consistent with the enter method. An odds ratio of less than 1 indicates a positive association of the listed covariate with a preference for CT colonography.

painful examination, bowel relaxants were routinely administered, and sedatives and analgesics were administered during colonoscopy in a lower proportion of the study population (17–19). Although the claimed effect on improved bowel distention in CT colonography is controversial (23,36), there is evidence that both glucagon hydrochloride and butyl scopalamine bromide significantly reduce patient discomfort in CT colonography (37).

The results of our study add information to the existing reports. First, our results indicate that 5 weeks after undergoing CT colonography and colonoscopy, increased-risk patients prefer CT colonography. This opinion may be more predictive of future behavior than measurements obtained directly after the actual examination. Second, our results demonstrate that procedural pain and the presence of polyps at colonoscopy are important patient-related determinants of preference. The fact that pain influenced the preference for CT colonography indicates that efforts to further reduce discomfort may improve the acceptance of CT colonography. Because polyp prevalence influenced preference, which is a variable that varies with the nature of the population to be studied, this factor should be an important consideration in future preference research on CT colonography.

The results of our 5-week follow-up study demonstrate that increased-risk patients prefer CT colonography to colonoscopy; however, this preference decreases in time, while outcome considerations gradually replace temporary experiences of inconvenience. Implementation of CT colonography in colorectal cancer prevention programs may result in better attendance rates than those attained with colonoscopy because the attendant discomfort is considerably less.

APPENDIX

Data pertaining to patient characteristics according to use of sedatives and analgesics can be found in Table A1.

Data pertaining to determinants of preference for CT colonography or colonoscopy can be found in Table A2.

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