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# Impact of a colonoscopic screening examination for colorectal cancer on later utilization of distal GI endoscopies

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**Background:** Colonoscopic screening for colorectal cancer is being implemented in an increasing number of countries. This might lead to a demand for colonoscopies that could outstrip supply.

**Objective:** We wanted to investigate whether undergoing a colonoscopic examination for colorectal cancer would affect the utilization of later distal GI endoscopies for other indications than follow-up of the findings at the screening examination (usual-care endoscopies).

**Design:** Prospective case control study.

**Patients:** In 1996, a screening group of 634 individuals, aged 63 to 72 years, randomly drawn from the official population registry, was invited to a "once only" colonoscopic screening examination for colorectal cancer. A total of 451 individuals (71%) attended. An age- and sex-matched control group of 634 individuals was enrolled from the same registry. Both groups belonged to the encatchment area of a single hospital.

**Main Outcome Measurements:** Distal endoscopies performed in the 2 groups from January 1996 to November 2004 were registered by investigating medical records.

**Results:** A total of 1268 individuals (52.4% women) were followed for 9 years. Sixty-three individuals (9.9%) in the screening group and 110 (17.4%) individuals in the control group (odds ratio 0.53, 95% confidence interval 0.38-0.73) had had a total of 85 and 169 usual-care distal endoscopies, respectively ( $P < .001$ ).

**Conclusions:** Undergoing a colonoscopic examination for colorectal cancer seems to reduce the utilization of later usual-care endoscopic examinations. This finding could have an impact on the estimation of endoscopic resources needed for colorectal cancer screening. (*Gastrointest Endosc* 2006;64:948-54.)

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Colorectal cancer (CRC) is one of the leading causes of cancer mortality in the Western world. Several studies have indicated that sigmoidoscopic and colonoscopic screening, with the removal of polyps, may reduce the incidence of CRC and CRC-related mortality.<sup>1-3</sup> An increasing number of countries, therefore, are offering colonoscopic screening examinations. Concerns have been raised whether a sufficient number of screening and follow-up examinations can be provided with the current endoscopic capacity.<sup>4-8</sup> It has been estimated that colonoscopy screening every 10 years would require 4.8 million procedures per year, with a 70% attendance in the U.S. population from ages 50 to 80 years.<sup>7</sup> The volume of colonoscopies in the United States in 2000 was estimated to be 1.6 million screening and 2.4 million diagnostic procedures.<sup>7</sup> In a British study,

it was concluded that there is a serious underutilization of colonoscopy in most hospitals, necessitating a dramatic increase in manpower and resources to meet national colorectal screening programs.<sup>8</sup> A change in the utilization of lower-GI examinations by individuals who had been screened may be important in calculating cost-benefit and demand for endoscopic resources when implementing population-based colonoscopic screening for CRC.

We wanted to investigate, through a case-control study, whether undergoing a colonoscopic screening examination for CRC would affect the utilization of distal endoscopies for indications other than follow-up of the findings at the screening examination.

## PATIENTS AND METHODS

In 1983, 400 individuals, aged 50 to 59 years, were randomly drawn from the official Norwegian population

**TABLE 1. Norwegian guidelines for follow-up colonoscopies after polypectomy \*†**

No follow-up indicated

1 or 2 resected tubular adenomas <10 mm in diameter

Finding of only diminutive hyperplastic polyps

Age of patient >75 years

Follow-up within 1 y

Finding a malignant polyp, moderately to well differentiated, resected with free margins, no affection of blood and lymph vessels, and polyp removed in 1 piece

Follow-up after 5 y

3 or more adenomas resected

Small adenomas only biopsied, not resected

Earlier endometrial cancer

First-degree relative with CRC

Follow-up after 10 y

Adenoma with severe dysplasia and/or villous components resected

Adenoma with diameter  $\geq 10$  mm resected

\*From Ref. 11.

†The guidelines are based on a complete colonoscopy (intubation of the cecum) with adequate bowel cleansing and histologic verification of detected polyps. Polyps should be snare resected in 1 piece with free margins.

registry of Telemark County and offered a screening examination for CRC by flexible sigmoidoscopy.<sup>9</sup> An age- and sex-matched group of controls ( $n = 399$ ), not being offered screening examination, was also drawn from the same registry. Three hundred twenty-three individuals (81%) attended the screening examination; 76 (19%) refused to attend after 1 postal reminder. A total of 112 (35%) in the screening group had polyps detected at the screening examination, and they received 1 to 3 follow-up colonoscopies during the next 6 years.<sup>10</sup> From 1983 to 1996, 10 individuals among the controls and 2 screenees had been diagnosed with CRC ( $P = .02$ ).<sup>3</sup> The frequency of polyps and CRC in the 2 groups has previously been reported.<sup>3,10</sup>

In 1996, a "once-only" colonoscopic screening examination with polypectomy was offered to the survivors among the screenees and the controls from 1983. This screening examination was a part of the follow-up of the sigmoidoscopic screening study started in 1983. It was also the start of a new study of the effect of a colonoscopic screening examination with polypectomy on the incidence of CRC. The invitations were mailed, and a written reminder was sent to those who did not answer the invitation. Survivors among the 76 nonattenders from 1983 were

## Capsule Summary

### What is already known on this topic

- Utilization of lower-GI examinations by individuals who previously were screened by colonoscopy would be a factor in calculating the cost-benefit ratio and the demand for endoscopic resources when implementing population-based colonoscopic screening for CRC.

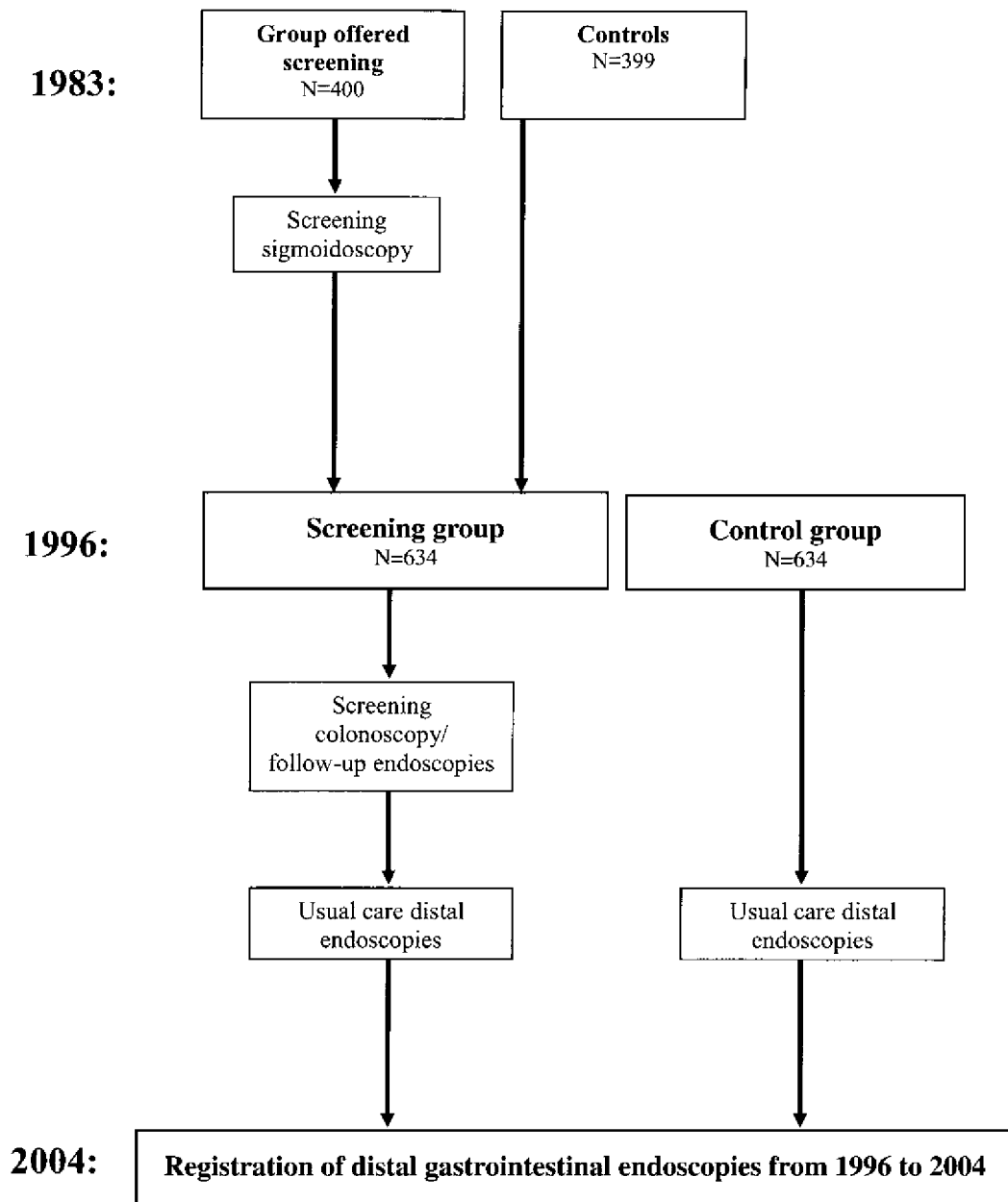
### What this study adds to our knowledge

- In a single-center case-control study of 1268 individuals followed for 9 years, 9.9% of subjects in the colonoscopy screening group and 17.4% in the control group underwent one or more distal endoscopic examinations; after correction for multiple comparisons, no significant differences were seen between the groups in terms of the indications for distal endoscopy.

excluded for ethical reasons, because this group had explicitly rejected participation in 1983 after 1 invitation and 1 reminding letter. This rendered altogether 634 individuals eligible for the new screening group in 1996, and 451 (71%) attended.<sup>3</sup> Follow-up colonoscopies were scheduled according to the Norwegian guidelines for follow-up after polypectomy (Table 1).<sup>11</sup> An age- (year and month of birth) and sex-matched control group was established by randomly drawing from the same population registry as the screening group. These individuals were not informed of being enrolled as a control group. They received the usual care through the local health service. None of the referring clinicians in the area knew about the study. Only a single hospital performed endoscopic examinations in the area from which the study groups were drawn. The endoscopist had no knowledge about which individuals belonged to which study group. The population of the geographical area from which the study groups were drawn is quite homogenous, and the socioeconomic differences are small.

The Norwegian health system covers almost all expenses for medical examinations and treatments. Patients need no specific health insurance; all have equal rights and access to the health service. The patient has to pay a fee, equaling about 50 U.S. dollars per usual care and per follow-up examination. The referring physicians had no economical benefit from referring patients to an endoscopic procedure. The screening examinations in 1996 were free of charge.

All contacts and the type of contact with the hospital were electronically registered, and medical records were electronically stored. In December 2004, the medical records of all study individuals were investigated, and all distal endoscopies (colonoscopies and flexible sigmoidoscopies) were registered, giving an observation period of 9 years. The endoscopic examinations were grouped



**Figure 1.** Flowchart of the study from 1983 to 2004.

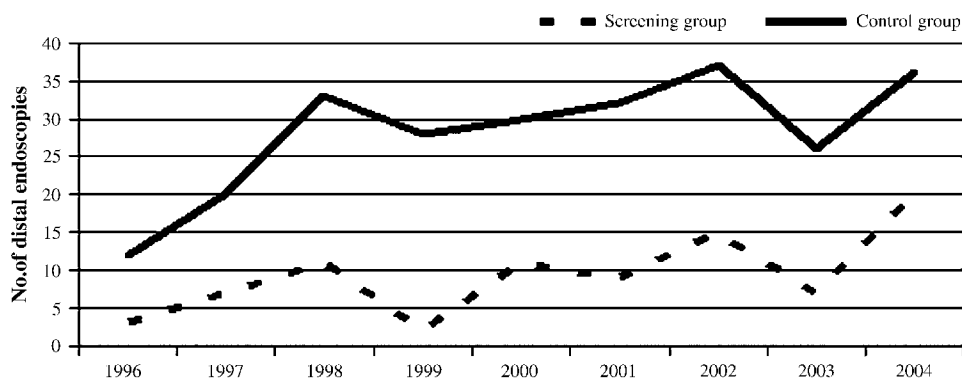
as “screening-related” and “usual-care” examinations. Screening-related examinations were defined as follow-up and surveillance initiated as a consequence of findings at the screening examination in 1996. All other examinations after 1996, whether these were because of symptoms, relatives with cancer, or other reasons (including spontaneous screening), were defined as usual-care examinations.

Deaths and present addresses were traced through the official Norwegian population registry. A flowchart of the study is presented in Figure 1.

### Statistical analyses

The Yates  $\chi^2$  test and Fisher’s exact test were used to determine statistical significance of the differences between proportions in frequency tables. The Mann-Whitney  $U$  test was used to compare means. The log-rank test was used to analyze the difference in survival. A 2-sided  $P$  value of .05 or less was considered statistically significant. The Bonferroni method was used to correct for multiple comparisons.<sup>12</sup>

No power calculations were done in 1983 when the study was initiated. Retrospectively, the present study



**Figure 2.** Number of usual-care distal endoscopies in the screening and control groups from 1996 to December 2004.

had a power of 0.95 to detect as statistically significant ( $P \leq .05$ ), a reduction of 40% in the number of individuals undergoing usual-care distal endoscopies in the screening group compared with the control group. For computing the data SPSS 12.0 software (SPSS Inc, Chicago, Ill) was used. For power analysis SamplePower Release 2.0 software (SPSS) was used.

### Ethics

The study was approved by the regional ethics committee and was performed in accordance with the Helsinki declaration.

### RESULTS

A total of 1268 individuals, 634 in each group, were studied for 9 years. In each group, 332 were women (52.4%). The mean age in the 2 groups at the start of the observation period in 1996 was 67.5 years (range, 63-72 years).

In the screening group, 63 individuals (9.9%), and, in the control group, 110 individuals (17.4%) attended 1 or more usual-care distal endoscopies during the observation period (odds ratio 0.53, 95% confidence interval 0.38-0.73,  $P < .001$ ). The total number of usual-care distal endoscopies in the screening and control groups were 85 and 169, respectively ( $P < .001$ ). In the screening group, 14 (17%), and, in the control group, 24 (14%) of the examinations were flexible sigmoidoscopies ( $P = .6$ ). The numbers of usual-care distal endoscopies per year in the 2 groups are shown in Figure 2. When the screening group was divided into attenders ( $n = 451$ ) and nonattenders ( $n = 183$ ) to the screening examinations in 1996, 46 (10.2%) and 17 (9.3%), respectively, had usual-care endoscopies ( $P = .7$ ). In the screening group, 50 individuals (8%) had a total of 64 follow-up colonoscopies after findings of adenomas or CRC at the screening examinations in 1996.

The screening group had, from the start of the screening in 1996, a total of 610 lower-GI endoscopies (screen-

**TABLE 2. Indications for usual-care distal endoscopies in the screening and control groups**

	No. indications (%)*		P value†
	Screening group (N = 63)	Control group (N = 110)	
Change in bowel habits	25 (40)	55 (50)	.2
Abdominal pain	25 (40)	36 (33)	.4
Blood in the stools	23 (37)	28 (26)	.1
Anemia	13 (20)	13 (12)	.1
Neoplasia follow-up‡	10 (16)	36 (33)	.02
Relatives with CRC	0	11 (10)	.008
Other§	17 (27)	18 (16)	.09

\*Some individuals had more than 1 indication.

†No corrections for multiple comparisons are made.

‡Follow-up of adenomas and CRC detected at previous usual-care distal endoscopies.

§Workup of suspected malignant disease, rectal prolapse, and defecation problems; follow-up of inflammatory bowel and diverticular disease.

ing, screening related, and usual-care examinations), compared with 169 in the control group.

After correction for multiple comparisons, there were no statistically significant differences between the screening and control groups regarding indications for usual-care distal endoscopies. There was, however, a trend toward fewer distal endoscopies in the screening group because of follow-up of adenomas and CRC detected at usual-care distal endoscopies and because of relatives with CRC (Table 2).

From January 1996 to November 2004, 113 individuals (18%) in the screening group and 130 (21%) in the control group had died ( $P = .16$ ). Fifty-eight (76%) of the 76 nonattenders to the screening sigmoidoscopy in 1983 were

alive in 1996. Of these, 21 (36%) were registered as dead by November 2004.

Nineteen individuals (0.03%) in the screening group and 8 (0.01%) in the control group were, by November 2004, registered with an address outside the area from which the study population was drawn and were lost to follow-up. Thirteen of those in the screening group had moved in the period from the study start in 1983 to 1996, and 8 had moved from 1996 to December 2004. In the control group, 8 (0.01%) had moved from the area from 1996 to December 2004.

## DISCUSSION

Implementing a population-based colonoscopic screening program will inevitably increase the utilization of procedures. One will, however, expect that those who receive colonoscopy screening will have fewer lower-GI investigations over the next few years. This assumption was confirmed in the present study where the screening group had 50% fewer usual-care distal endoscopic examinations than the control group during 9 years after a screening colonoscopy. Such an effect of screening on the utilization of usual-care distal endoscopies was addressed in a theoretical analysis of the ability of the U.S. health care system to meet the demand for these procedures<sup>6</sup>; however, to our knowledge, no previous studies have demonstrated this effect.

Our findings have some limitations. Even though there has been no tradition in Norway for using health services outside the area in which one lives, some of the individuals in the study may have attended distal endoscopic examinations at hospitals in other areas. These examinations would not be registered in our study. One would, however, presume that there would be no difference between groups with regard to the number of examinations done at other hospitals. Likewise, we have no information about endoscopies performed in other regions for those who had moved.

There was a difference in the selection of individuals to the 2 study groups. The survivors among the nonattenders to the screening examination in 1983 (58 individuals) were not invited to the screening examination in 1996 and, therefore, were not included in the present study. Hence, the screening group consisted of a slightly different population than the control group. The mortality from 1996 to 2004 was higher among these nonattenders compared with the included attenders (36% vs 18%). This might explain some of the observed nonstatistically significant difference in mortality between the screening and control groups. Increased all-cause mortality among nonattenders to screening programs is a known phenomenon.<sup>13-15</sup> Nonattenders to screening programs seem to be different from attenders in several aspects. They also have fewer contacts with the health service.<sup>16-19</sup> This dif-

ference in behavior was confirmed in the present study. Proportionally fewer of those in the screening group who refused to attend the screening examination in 1996 had distal endoscopies in the observation period compared with the control group: 9.3% versus 17.4%. If survivors of the nonattenders from 1983 had been included in the screening group of 1996, the difference between the study groups in the number of distal endoscopic examinations would probably have been even larger.

Implementing a screening study could raise the awareness of CRC screening in the study area. This could again increase the demand for examinations among those not invited to a screening examination. Such an effect could increase the demand for examinations, outstripping the reducing effect observed in this study. Our study was not designed to detect such an effect, but the observed increase in examinations among controls from 1996 to 1998 was greater than those observed during the following years (Fig. 2). Such an "awareness-effect" would, however, not be of any importance if the screening examinations were offered to the whole population as a part of the health service.

The attendance rate for the screening examination in 1996 was high (71%). A lower attendance rate would probably reduce the observed absolute difference in nonscreening-related distal endoscopies between the groups.

Because older age groups tend to have more contact with the health service and more endoscopic examinations done, the effect on younger age groups of the observed reduction in nonscreening-related endoscopies might be in the same proportion, but the absolute difference in the number of examinations would probably be smaller. The findings in this study, with a mean age of 67.4 years in 1996, nevertheless, is interesting, because several investigators have suggested that a "once-only" colonoscopic screening examination would be most cost effective when done at the age of 65 to 70 years.<sup>20-21</sup> In screening guidelines advocating a colonoscopic examination every 10 years from the age of 50, no upper age limit for attendance was suggested.<sup>22,23</sup> Our study population, being otherwise healthy, would probably be advised to attend screening examinations.

If corrected for multiple comparisons, then there were no statistically significant differences in indications for nonscreening-related endoscopies between the study groups. There were, however, trends toward fewer endoscopies in the screening group for 2 indications: follow-up of adenomas and CRC detected at usual-care distal endoscopies and having relatives with CRC. Studies have shown that having a family history of cancer increases the attendance rate to screening programs.<sup>24,25</sup> It could be speculated that most individuals in the screening group with a positive family history attended the screening in 1996 and felt reassured and did not need further distal endoscopies for this indication.

It is not possible to use the number of follow-up examinations observed in the screening group of the present study to calculate the total need for distal endoscopic examinations after screening in other countries. Both United States<sup>22</sup> and British<sup>26</sup> guidelines for postpolypectomy surveillance advocate more frequent follow-up examinations after findings of adenomas than do the Norwegian guidelines,<sup>11</sup> thus creating more follow-up examinations.

The study was performed in a country where the national health system covers most of the expenses for the patients. We believe that the relative reductions in usual-care procedures observed would also be found in a fee-for-service health system, given that referring physicians have no personal economical benefits from referring patients to endoscopic procedures. Whether an endoscopist in a fee-for-service health system would schedule more frequent follow-up examinations, regardless of official guidelines, than an endoscopist in Norway, would be based on speculations. Any differences in scheduling of follow-up examinations would probably affect both the screening group and the control group to the same extent, and the relative differences between usual-care procedures in the 2 groups would persist.

One important aspect of screening, however, is not addressed in the present study. We do not know whether the reduced demand for distal endoscopies shown in this study reflect a truly reduced demand or only a change in health care-seeking behavior. Theoretically, one could fear that attenders feeling healthy after a negative screening examination would have a higher threshold for contacting the health service if new abdominal symptoms occurred. This could delay diagnosis and treatment of interval cancers or a cancer missed at the screening examination. To investigate this possible effect, the patient delay would have to be compared in diagnosing CRC in the 2 groups. Such an analysis was not possible in the present study.

In conclusion, undergoing a colonoscopic screening examination for CRC seems to substantially reduce the later utilization of distal endoscopic examinations because of causes other than follow-up of findings at the screening examination.

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## DISCLOSURE

*None of the authors have any disclosures to make.*

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