

Colonoscopic Miss Rates for Right-Sided Colon Cancer: A Population-Based Analysis

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Background & Aims: Colonoscopy contains an inherent miss rate for colorectal cancer. Although miss rates from academic centers or units known for their endoscopic expertise have been previously reported, the colorectal cancer miss rate of colonoscopy performed in usual clinical practice is unknown. We conducted a population-based study to estimate the proportion of right-sided colon cancers missed during colonoscopy in Ontario. **Methods:** All persons ≥ 20 years old with a new diagnosis of right-sided colon cancer admitted to the hospital for surgical resection in Ontario from April 1, 1997, to March 31, 2001, were identified. Patients who had a colonoscopy within 3 years of their diagnosis were divided into 2 groups: detected cancers (those who had a colonoscopy up to 6 months before the diagnosis) and missed cancers (those who had a colonoscopy between 6 and 36 months before the diagnosis). Data were obtained from the Canadian Institute for Health Information Discharge Abstract Database, the Ontario Health Insurance Plan database, and the Registered Persons Database. **Results:** Between April 1, 1997, and March 31, 2001, we identified 4920 persons with a new diagnosis of right-sided colon cancer, of whom 2654 (53.9%) had had at least 1 colonoscopy within 3 years of their admission for surgical resection. Most (96.0%) had had their most recent colonoscopy up to 6 months before admission (detected cancers). However, 105 patients (4.0%) had their most recent colonoscopy between 6 and 36 months before admission to the hospital (missed cancers). **Conclusions:** Among persons undergoing resection for right-sided colon cancer, the miss rate of colonoscopy for detecting cancer in usual clinical practice was 4.0%.

Colorectal cancer is the second leading cause of cancer-related deaths in the United States and Canada. The preferred method for the diagnosis of colorectal neoplasia is colonoscopy.¹ The National Polyp Study,² a large cohort study conducted by experienced endoscopists, showed that colonoscopy and removal of adenomatous polyps effectively reduce the incidence of colorectal cancer.

Colonoscopy, however, does contain an inherent miss rate for colorectal cancer and for adenomatous polyps. Two recent studies^{3,4} of tandem colonoscopies (i.e., a patient receiving 2 colonoscopies on the same day) calculated the miss rates of colonoscopies: during the first colonoscopy, all detected polyps were removed; during the second, all detected polyps were defined as missed. These studies found that the range of miss rates between the first and second colonoscopies was 12%–13% for adenomatous polyps 6–9 mm and 0%–6% for those ≥ 1 cm. These values are probably underestimates of the true miss rates because they were calculated from the findings of the second colonoscopy, which may itself have missed lesions. Also, because very experienced endoscopists conducted these procedures, the findings may not reflect the accuracy of colonoscopy performed by physicians with less experience.

The slow growth and transformation of adenomatous polyps into cancer⁵ have been used in previous research^{6,7} to define the miss rate of colonoscopy for colorectal cancer from the percentage of colorectal cancer diagnoses soon after an apparently normal colonoscopy. For example, in one study⁶ from 20 Indiana hospitals, the miss rate of colonoscopy for colorectal cancer was 5%. However, because this estimate was not population based, it may not reflect the miss rate in usual clinical practice. We define here usual clinical practice as colonoscopies performed by physicians of all levels of experience. To our knowledge, no population-based estimates of the miss rates of colonoscopy for colorectal cancer have been published.

Compared with experienced endoscopists, physicians with less training or experience may miss more lesions

Abbreviations used in this paper: CIHI, Canadian Institute for Health Information; ICD-9-CM, International Classification of Diseases, 9th Revision, Clinical Modification; OHIP, Ontario Health Insurance Plan; RPDB, Registered Persons Database.

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0016-5085/04/\$30.00

doi:10.1053/S0016-5085(04)00924-2

Table 1. Classification of Colorectal Cancer Site According to ICD-9-CM Code and Diagnosis

ICD-9-CM code	ICD-9-CM diagnosis of colorectal cancer	Site
153.0	Hepatic flexure	Transverse
153.1	Transverse colon	Transverse
153.2	Descending colon	Left
153.3	Sigmoid colon	Sigmoid
153.4	Cecum (ileocecal valve)	Right
153.6	Ascending colon	Right
153.7	Splenic flexure	Left
153.8	Other specific site	Other
153.9	Colon, unspecified	Other
154.0	Rectosigmoid junction	Rectum
154.1	Rectum	Rectum
More than 1 code, excluding 153.8 and 153.9		Synchronous

because they are less likely to reach the cecum during the procedure.⁸ Right-sided lesions are more likely to be missed because they are less likely to be reached during an incomplete colonoscopy, which poses the critical question: what is the true miss rate for right-sided colorectal cancer when colonoscopy is performed during usual clinical practice? The primary objective of this study was to conduct a population-based study to determine the miss rate of colonoscopy for right-sided colorectal cancer. A secondary objective was to determine the completion rate of colonoscopy in usual clinical practice.

Methods

This study was approved by the ethics committee of the Institute for Clinical Evaluative Sciences in Toronto, Ontario, Canada.

Data Sources

Data for this population-based cohort study were obtained from 3 sources: the Canadian Institute for Health Information (CIHI) Discharge Abstract Database, the Ontario Health Insurance Plan (OHIP) database, and the Registered Persons Database (RPDB). The CIHI database contains information about all discharges from acute care facilities for residents of Ontario since April 1, 1988. All its diagnostic codes are recorded according to the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM).⁹ The OHIP database contains information about claims for physicians' services provided to Ontario residents since July 1, 1991. Because physicians use separate codes for each segment of the colon examined during a colonoscopy, these codes provide an indication of how far the colonoscope was inserted. The RPDB is a roster of all beneficiaries of OHIP that also includes their birth dates.

Defining the Study Population

Using electronic data from the CIHI database, we identified all patients in Ontario discharged from the hospital with a diagnosis of colorectal cancer on the basis of ICD-9-CM codes during the study period (April 1, 1997, to March 31, 2001) and classified them according to the site of their cancer (Table 1). Next, we excluded those who did not have surgical resection for colorectal cancer, on the basis of the codes for Canadian Classification of Diagnostic, Therapeutic, and Surgical Procedures recorded in the CIHI database during the hospital stay (Table 2). We excluded patients with colorectal cancer who did not have surgical resection because the date of diagnosis would have been difficult to define for these patients. For each patient with colorectal cancer who had surgical resection and was discharged within our study period, we defined the first admission with a diagnosis of colorectal cancer as the index admission. For each patient, we searched the CIHI database from April 1988 to the date of his or her index admission and eliminated all patients with a previous diagnosis of colorectal cancer, thereby selecting patients with a new diagnosis of colorectal cancer. Next, we searched the CIHI database from April 1, 1988, to the index admission and excluded all patients with ulcerative colitis (ICD-9-CM code 556: 556.0–556.9) or Crohn's disease (ICD-9-CM code 555: 555.0–555.9). We then selected those patients with right-sided colorectal cancer defined by ICD-9-CM codes for ascending-colon or cecal cancer (Table 1). We recorded the age at the time of the index admission and the sex of each patient identified with a new diagnosis of right-sided colorectal cancer and excluded those younger than 20 years by using data from the RPDB. The study cohort comprised the remaining patients.

Data Collection

Using OHIP data, we identified all members of the study cohort who had a colonoscopy or a barium enema within 3 years of their index admission (Table 3). We also identified patients who had a barium enema after their last colonoscopy and before their index admission. A colonoscopy was defined by OHIP procedure codes as an endoscopic examination to the hepatic flexure, the cecum, or the terminal ileum. We calculated the interval between the date of the last colonoscopy before admission and the date of the index admission for each patient. We classified the colonoscopy as complete or incomplete. A complete colonoscopy was defined by OHIP procedure codes that indicated that the colonoscopy was performed to the cecum or the terminal ileum (i.e., the cecum was visualized; Table 3).

Table 2. Surgical Procedure Codes Used to Define Surgical Resections for Colorectal Cancer

CCP procedure code	Procedure
575	Partial excision of large intestine
576	Total colectomy
604	Abdominoperineal resection of rectum
605	Other resection of rectum

CCP, Canadian Classification of Diagnostic, Therapeutic, and Surgical Procedures.

Defining Detected and Missed Cancers

The detected-cancer group consisted of patients who had a colonoscopy up to 6 months before the index admission. We assumed that the colonoscopy identified the cancer in this group. This interval was selected on the basis of the assumption that the time between a diagnosis of colorectal cancer during colonoscopy and admission to the hospital for surgical resection would be ≤ 6 months.

The missed-cancer group consisted of those who had a colonoscopy between 6 and 36 months before the index admission, on the basis of our assumption that the colonoscopy missed the cancer in this group. To define the missed-cancer group, we used a 3-year period as the maximum time for colonoscopy preceding the diagnosis of colorectal cancer, for 2 reasons. First, this interval was used in a previous study.⁶ Second, this interval is the estimated sojourn time (the duration of the preclinical screen-detectable period) for colorectal cancer in persons 55 to 64 years old.¹⁰

Data Analysis

We compared the mean age and proportion of men between the detected- and missed-cancer groups by using the Student *t* test and χ^2 test, respectively.

Results

Patient Characteristics

Between April 1, 1997, and March 31, 2001, we identified 19,202 patients with a new diagnosis of colorectal cancer who were admitted to the hospital for surgical resection of the lesion. The mean age \pm SD was

Table 3. Colonoscopy and Barium Enema Procedure Codes Used in the OHIP Database

OHIP procedure code	Procedure
Z555 + E740 + E741	Colonoscopy to hepatic flexure
Z555 + E740 + E741 + E747	Colonoscopy to cecum
Z555 + E740 + E741 + E747 + E705	Colonoscopy to terminal ileum
X112	Single-contrast barium enema
X113	Double-contrast barium enema

69.0 \pm 11.7 years; 53.8% were men. The distribution of the cancers, according to the site of the colorectal cancer, is shown in Figure 1. Of the 19,202 patients, 4920 (25.6%) had right-sided colorectal cancer. Our study cohort comprises these 4920 patients. The mean age of the study cohort was 71.5 \pm 11.3 years; 45.5% were men.

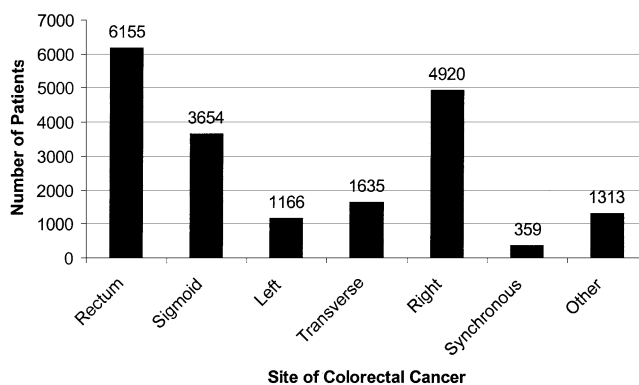
Of the 4920 patients with a new diagnosis of right-sided colorectal cancer, 2654 (53.9%) had at least 1 colonoscopy within 3 years of their index admission. Of these 2654 who had a colonoscopy, 2359 (88.9%) patients had a complete procedure (i.e., the cecum was visualized), and most (2549, or 96.0%) had their most recent colonoscopy up to 6 months before admission (Figure 2). Of these 2549 patients (the detected-cancer group), 2268 (89.0%) had a complete colonoscopy.

Of the 2654 patients who had a colonoscopy, 105 patients (4.0%) had their most recent colonoscopy between 6 and 36 months before their index admission (Figure 2). Of these 105 patients (the missed-cancer group), 91 (86.7%) had a complete procedure. There was no statistically significant difference in mean age ($P = 0.13$) or the proportion of men ($P = 0.35$) between those in the detected-cancer and missed-cancer groups.

In clinical practice, endoscopists often obtain barium enema results for patients with incomplete colonoscopies. Of the 105 patients in the missed-cancer group, 39 (37%) had a barium enema, and 6 of these had the procedure within the 6 months immediately after the colonoscopy (Figure 3).

Discussion

The results of this population-based study show that, in usual clinical practice, the miss rate of colonoscopy for a right-sided colorectal cancer among 4920

**Figure 1.** Distribution of the cancer sites in patients with a new diagnosis of colorectal cancer who were admitted to the hospital for surgical resection in Ontario (April 1, 1997, to March 31, 2001; $n = 19,202$).

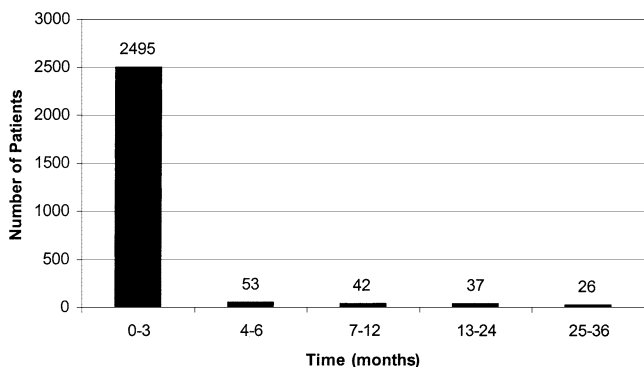


Figure 2. Interval between last colonoscopy and index admission for 2654 patients with right-sided colorectal cancer who had at least 1 colonoscopy within 3 years of their admission to the hospital for surgical resection in Ontario (April 1, 1997, to March 31, 2001; n = 2654).

patients who underwent surgical resection was 4.0%. This finding is important for 2 reasons. First, because of the marked increase in the use of screening colonoscopy, the accuracy of this procedure in usual clinical practice needed to be assessed. Second, the sensitivity of colonoscopy for detecting right-sided colorectal cancer is increasingly important because an increasing proportion of new cancers are right-sided.¹¹

Of the 105 patients in the missed-cancer group, only 6 had a barium enema within 6 months of their colonoscopies. This suggests that the endoscopists performing these procedures were satisfied with the quality of the colonoscopies in most cases and did not suspect any abnormality in the right colon.

The miss rate of colonoscopy reported here for right-sided colorectal cancer is similar to that previously reported for a retrospective study⁶ performed at 20 Indiana hospitals: 47 (5%) of 941 patients who had a colonoscopy within the 3 years before the diagnosis of colorectal cancer had reportedly normal colonoscopies. A prospective cohort study⁷ performed at 3 metropolitan teaching hospitals in Western Australia observed 1047 patients for colorectal cancer for 5 years after a reportedly normal colonoscopy to the cecum or the ileum. In that study, only 5 (0.5%) patients were subsequently diagnosed with colorectal cancer. This low rate of detection of colorectal cancer within 5 years of a normal colonoscopy may reflect a low prevalence of colorectal cancer in the study population or may be the result of highly skilled endoscopists performing the colonoscopies and reaching the cecum in all procedures. It may also indicate an incomplete ascertainment of the outcome.

Previous reports^{2,12,13} indicate that experienced endoscopists reach the cecum in more than 97% of colonoscopies. Conversely, the completion rate for procedures

performed by self-trained colonoscopists is reportedly as low as 54%.⁸ This difference in completion rates has important implications for the likelihood of missing a right-sided colorectal cancer, because the inability to reach the lesion is a major reason colorectal cancer is missed.⁶ Our study shows that in the context of usual clinical practice, approximately 89% of colonoscopies are complete. The proportion of complete colonoscopies in the missed-cancer group (86.7%) was similar to that for the entire cohort (88.9%). This suggests that there are reasons that right-sided colorectal cancers are being missed other than an inability to reach the lesion. One possibility is that the bowel preparation was not adequate and cancers were missed because the mucosa was not fully visualized. Another possibility is that the cancer was very small and located proximal to the ileocecal valve in an area that may be more difficult to examine. Finally, the endoscopist may have erroneously believed that the cecum was reached.

The results reported here must be interpreted in light of the strengths and weaknesses of the study. First, a population-based study reduces the selection bias that can occur when patients are enrolled only from centers with specialists in endoscopy. Thus, our results can be broadly generalized. Second, the codes for colonoscopy in the administrative database allowed us to determine the extent of the colonoscopy performed. This study was limited by our inability to identify the technical issues that may have led to an incomplete assessment of the right colon (i.e., a poor colonic preparation or a patient's clinical status that did not allow completion of the procedure). However, the standard of practice when this situation occurs would be to repeat the colonic preparation and repeat the colonoscopy or to proceed with an alternate method of imaging the colon, such as a barium

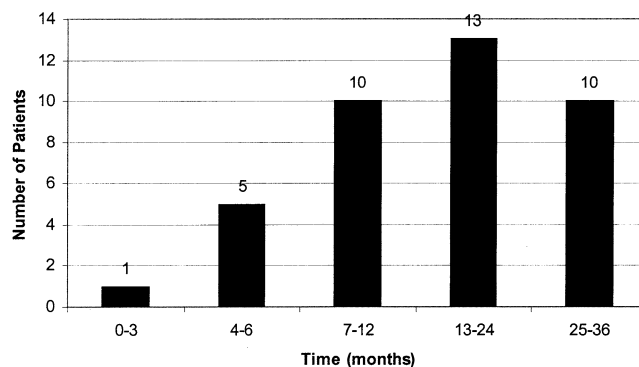


Figure 3. Interval between last colonoscopy and subsequent barium enema for patients in the missed-cancer group who had a barium enema between their last colonoscopy and the index admission for surgical resection of right-sided colorectal cancer in Ontario (April 1, 1997, to March 31, 2001; n = 39).

enema. The colonoscopies examined in this study were the last procedures performed before the index admission; therefore, repeat procedures did not occur in the missed-cancer group.

We may also have underestimated the actual miss rate. We examined only the most recent colonoscopy before the index admission, but other earlier colonoscopies may also have missed the cancers. Our estimated miss rate for right-sided colorectal cancer does not reflect the miss rate for all proximal cancers, because we excluded patients who did not have surgical resection. It is less likely that an overestimate of the miss rate may have occurred. Some rapidly progressing cancers, such as those in persons with hereditary nonpolyposis colon cancer, may have been misclassified as missed if the most recent colonoscopy before the patient's index admission was truly normal. Finally, a potential limitation is misclassification because of coding errors. However, if miscoding did occur, it should not have differentially affected the numbers in the detected- and missed-cancer groups.

Colonoscopy is in widespread use in many different clinical settings by a variety of physicians with different levels of expertise. In this population-based study of patients who underwent surgical resection for right-sided colorectal cancer, the miss rate for detection of the cancer by colonoscopy was 4%. It is important that we inform patients who are undergoing colonoscopy that if a cancer is present, there is a small chance that it will be missed.

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Received February 12, 2004. Accepted May 13, 2004.

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L.R. is a senior investigator associated with the Cancer Quality Council of Ontario. This article was prepared with the editorial assistance of Sharon Nancekivell, medical editor, Guelph, Ontario, Canada.