ORIGINAL ARTICLE

Incidence of interval colorectal cancer attributable to an endoscopist in clinical practice

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Background and Aims: Endoscopists who encounter an interval colorectal cancer (I-CRC) may be concerned about the implications because I-CRCs may represent a lapse in colonoscopy quality and a missed opportunity for prevention. We wanted to determine the I-CRC rate per colonoscopy examination and to examine the effect of colonoscopy volume and adenoma detection rate (ADR) on the number of I-CRCs attributable to an endoscopist.

Methods: We determined the rate of I-CRC diagnosis per outpatient colonoscopy examination by measuring the incidence of CRC diagnosis in practice and by assessing, via literature review, the percentage of cancers that are interval. We also estimated the number of attributable I-CRCs as a function of ADR and colonoscopy volume.

Results: Among 93,562 colonoscopies performed in 2013 to 2015 by 120 physicians in 4 diverse U.S. medical centers, 526 CRCs were diagnosed (.6%). Of 149,556 CRCs in the published literature, 7958 were I-CRCs (5.25% ± .94%). With rates of .6% (CRC per colonoscopy) and 5.25% (I-CRC per CRC), the rate of I-CRC is 1 per 3174 colonoscopies (95% confidence interval, 1 per 2710 to 1 per 3875). An endoscopist at the median of outpatient colonoscopy volume (316/year) in the lowest ADR quintile of detection (7%-19%) would have an I-CRC attributed every 8.2 years, or 4.2 I-CRCs in a 35-year career, versus every 16.7 years, or 2.0 I-CRCs in a 35-year career, for an endoscopist in the highest ADR quintile (33%-52%).

Conclusions: An average-volume endoscopist will have 2 to 4 attributable I-CRCs in a 35-year career, but the frequency will vary depending on colonoscopy volume and ADR. (Gastrointest Endosc 2018;■:1-7.)

Colorectal cancer (CRC) is the fourth most common cancer and the second leading cause of cancer death in the United States.[1] Screening for CRC with flexible sigmoidoscopy[2,3] and colonoscopy[4,5] reduces CRC incidence, presumably through the removal of adenomatous and sessile serrated polyps, precursor lesions that have the potential to evolve to CRC. Endoscopic screening with colonoscopy is the most common means of CRC screening in the United States,[5] but the efficacy of colonoscopy depends on the quality of the examination. An endoscopist's adenoma detection rate (ADR), or the prevalence of adenomas detected on colonoscopy, is inversely associated with that endoscopist's patients' risk of developing a subsequent cancer. Patients of practitioners with a lower ADR at colonoscopy[6,7] or at flexible sigmoidoscopy[8] have higher subsequent rates of CRC. From a pathophysiologic perspective, the presumption is that patients of practitioners who leave behind significant

Abbreviations: ADR, adenoma detection rate; CI, confidence interval; CIE, Central Illinois Endoscopy; I-CRC, interval colorectal cancer.

DISCLOSURE: *Dr Robert Schoen was supported by the National Cancer Institute (5R01CA168959). Dr Crockett was supported in part by a grant from the NIH (5KL2TR001109). All other authors disclosed no financial relationships relevant to this publication. Research support for this study was provided by the National Cancer Institute (grant 5R01CA168959).*

0016-5107/$36.00
https://doi.org/10.1016/j.gie.2018.05.012

Received March 14, 2018. Accepted May 15, 2018.

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numbers of precursor lesions are at greater risk for one of those lesions to subsequently evolve into CRC.

CRCs that occur subsequent to testing have been classified as interval CRCs (I-CRCs) and are defined as cancers "diagnosed after a screening or surveillance examination in which no cancer is detected, and before the date of the next recommended examination."[9] I-CRCs are a focus of attention because they may represent a missed opportunity to prevent a subsequent cancer. Among practitioners in the Kaiser Northern California healthcare system in the highest quintile of ADR, there was a 50% lower incidence of interval cancer compared with practitioners in the lowest quintile of ADR detection.[7] Although a higher ADR was associated with a significantly lower rate of I-CRC, interval cancers did occur even in the highest ADR performance quintile.

Although I-CRC may seem like an appealing quality metric, I-CRCs are rare in an endoscopist's practice.[10] I-CRCs are also difficult to measure because of the long risk period after a patient's last colonoscopy and a fragmented healthcare system in the United States that may lead to CRC diagnosis and treatment at a different facility, without the knowledge of the original endoscopist. The aim of our investigation is to determine the expected rate of an I-CRC in outpatient clinical practice and to examine the effect of an endoscopist's colonoscopy volume and ADR on the number of I-CRCs attributable to that endoscopist to provide context for endoscopists regarding an I-CRC they might encounter in routine clinical practice.

METHODS

We determined the frequency of CRC diagnosis in clinical practice by analyzing CRC diagnoses in a sample of 93,562 outpatient colonoscopy examinations in 4 clinical sites. Using literature review, we determined the percentage of CRCs that are I-CRC. Using the rate of CRC diagnosis in clinical practice and the average percentage of I-CRCs among all CRCs, we calculated the rate of I-CRC diagnosis per outpatient colonoscopy examination. Because the rate of I-CRC for an individual endoscopist will vary by colonoscopy volume, we assessed colonoscopy volumes of individual endoscopists in our clinical practice sample. To estimate the effect of ADR on the rate of I-CRC attributable to an endoscopist, we applied the unadjusted relative risk of interval cancer as a function of ADR reported by Corley et al.[7] I-CRCs may be diagnosed by an endoscopist who is different from the endoscopist who performed the initial examination. We have used the term "attributable" to reflect the overall expected incidence after initial examinations by a given practitioner, but this does not necessarily reflect the I-CRCs diagnosed personally by that particular practitioner.

I-CRC rate among reported CRCs

To estimate the percentage of CRCs that are I-CRCs, we conducted a literature search on PubMed and Cochrane databases with search terms including "interval colorectal cancer," "post-colonoscopy interval cancer," and "post-colonoscopy colorectal cancer." Searches were limited to the English language and to within the years January 2006 to January 2017. Studies that reported the incidence of I-CRCs among total number of CRCs were included and were used to calculate the average percentage of I-CRCs among all CRCs. Studies that reported I-CRC rates based on person-year observation were excluded (Supplementary Table 1, available online at www.giejournal.org).

CRC diagnosis in clinical practice

To determine the frequency of CRC diagnoses in contemporary endoscopic practice, we examined a large cross-sectional sample of outpatient colonoscopy examinations from October 1, 2013 to September 30, 2015 using a previously validated natural language processing system.[11-14] Four health systems were studied: a staff model health maintenance organization (Kaiser Permanente Washington) in Seattle, Washington (16 physicians); a private practice (Central Illinois Endoscopy [CIE]) in Peoria, Illinois (11 physicians); an academic medical center (University of North Carolina) in Chapel Hill, North Carolina (23 physicians); and a mixed academic-community health system (University of Pittsburgh Medical Center) in western Pennsylvania (70 physicians). This study was approved by the Institutional Review Board at the University of Pittsburgh.

We restricted the analysis to endoscopists performing at least 200 colonoscopy examinations over 2 years to exclude part-time physicians or those for whom colonoscopy was a small component of clinical practice. Inpatient colonoscopies, procedures for adults less than 40 years old, and patients with inflammatory bowel disease were excluded. All pathology reports that contained text including the words "carcinoma," "carcinoma in-situ," or "cancer" were reviewed manually to confirm the diagnosis of invasive CRC. We assessed the rate of CRC by colonoscopy indication (screening vs not) and calculated colonoscopy volumes per endoscopist.

Frequency of CRC diagnosis by specialty and colonoscopy volume

We also examined whether the frequency of CRC diagnosis in clinical practice differed by endoscopist specialty (gastroenterology vs nongastroenterology) and by colonoscopy volume (low volume [below median] vs high volume [above median]).

I-CRC diagnosis in clinical practice

Based on the incidence of CRC per colonoscopy and the fraction of CRCs that are I-CRCs, we determined the number of colonoscopy examinations to diagnose an I-CRC. We then examined the time to reach this number of colonoscopy examinations depending on the colonoscopy volume of an individual endoscopist.