Yield and Practice Patterns of Surveillance Colonoscopy Among Older Adults: An Analysis of the GI Quality Improvement Consortium

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OBJECTIVES: **There is little guidance regarding when to stop surveillance colonoscopy in individuals with a history of adenomas or colorectal cancer (CRC). We evaluated both yield and recommendations for follow-up colonoscopy in a large cohort of older individuals undergoing colonoscopy, using the GI Quality Improvement Consortium registry.**

METHODS: **We analyzed the yield of colonoscopy in adults aged ≥75 years, comparing those who had an indication of surveillance as opposed to an indication of diagnostic or screening, stratified by 5-year age groups. Our primary outcome was CRC and advanced lesions. We also evaluated recommended follow-up intervals by age and findings.**

RESULTS: **Between 2010 and 2017, 376,686 colonoscopies were performed by 3,976 endoscopists at 628 sites, of which 43.2% were for surveillance. Detection of CRC among surveillance patients increased with age from 0.51% (age 75–79 years) to 1.8% (age ≥ 90 years); however, these risks were lower when compared with both the diagnostic and screening for the same age band ($P < 0.0001$). Yield of advanced lesions also increased by every 5-year interval of age across all groups by indication. Even at the most advanced ages and in those with nonadvanced findings, only a minority of patients were recommended for no further colonoscopy. For example, in patients aged 90 years and older with only low risk findings, 62.9% were recommended to repeat colonoscopy.**

DISCUSSION: **Surveillance colonoscopy is frequently recommended at advanced ages even when recent findings may be clinically insignificant. Further work is needed to develop guidelines to inform best practice around when to stop surveillance in older adults.**

SUPPLEMENTARY MATERIAL accompanies this paper at http://links.lww.com/AJG/B299, http://links.lww.com/AJG/B300, and http://links.lww.com/AJG/B301

Am J Gastroenterol 2019;114:1811–1819. https://doi.org/10.14309/ajg.0000000000000430

INTRODUCTION

The US population is rapidly aging, with the number of adults older than 65 years estimated to reach 78 million by 2035 (1). Because colonoscopy is a frequently performed procedure in older adults, having guidance on when to stop is important. For those considering undergoing initial or further screening, the 2016 US Preventive Services Task Force recommends that screening between ages 76–85 be individualized, taking into account overall health, screening history, and patient preferences (2).

Surveillance of previous colon adenomas and other preneoplastic polyps is the most common indication for colonoscopy in older adults. Given the increasing age and longevity of the population, wider adoption of colorectal cancer (CRC) screening (3), and higher polyp detection rates with improved technology, an estimated 5.6 million adults aged >75 years will undergo surveillance colonoscopy annually by 2024 (4). Yet, despite the increasing use of surveillance colonoscopy, there is no clear guidance on how to manage surveillance in older adults, except for the US Multi-Society's Task Force on CRC's recommendation that the "decision … be individualized" (5). Decision making around surveillance in older adults may not directly parallel that of screening because of the perceived heightened risk of CRC in adults with a history of polyps. In the absence of guidelines on when to stop surveillance, older adults may be exposed to the unnecessary burdens and harms of colonoscopy with little to no benefit (6).

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Received May 23, 2019; accepted September 6, 2019; published online October 24, 2019

Overall, there is a need for more evidence to help inform decision making in older adults considering surveillance colonoscopy. This study aims to quantify incident CRC and advanced lesions among older adults undergoing surveillance colonoscopy and to characterize recommendations by endoscopists to stop surveillance.

METHODS

GI Quality Improvement Consortium

The GI Quality Improvement Consortium (GIQuIC) is a large, national clinical data registry designed for quality improvement which was developed by the American College of Gastroenterology and the American Society of Gastrointestinal Endoscopy (http://giquic.gi.org/). Participation in the GIQuIC facilitates data collection and electronic reporting on quality indicators for colonoscopy, and sites are provided with benchmarking reports to support peer-based performance evaluation and quality improvement initiatives. GIQuIC has been collecting data since July 2010. Currently, there are approximately 4,500 endoscopists participating at >650 unique sites with >7 million colonoscopies captured.

Sites voluntarily choose to participate in the GIQuIC. Each participating site assigns a specified data manager responsible for exporting data from the endowriter and uploading data to the registry, running quality measure reports, sharing reports with their endoscopists, and troubleshooting. Data managers participate in a required onboard training session and have access to additional materials (e.g., manuals through the GIQuIC dashboard, workflow documentation, training tutorials). Dedicated GIQuIC support staff are available to provide ongoing training and support.

GIQuIC uses a data collection form to collect information on patient demographics, procedure, pathology, and follow-up recommendations, with certain required variables (bolded variables at http://giquic.gi.org/data-collection-form.asp; see Figure 1, Supplementary Digital Content 1, http://links.lww.com/AJG/B299). The form is completed in one of two ways, depending on site capability. Most sites (95%) use 1 of 14 GIQuIC-certified endowriters. The data manager uploads the demographic information from the electronic health record and procedure information that has already been entered by the endoscopist into the GIQuIC-certified endowriter. A few sites (5%) use manual entry, such that the endoscopist or staff manually enters data from the endoscopist-generated colonoscopy procedure report and medical record into a web-based version of the data collection form. Sites are trained to export their data after pathology results are available, and at that time, they enter the pathology results and final follow-up interval, which should reflect what is in the medical record. Pathology results and follow-up intervals may be entered directly by the endoscopist or by a staff member (e.g., nurse) under the direction of the endoscopists.

GIQuIC takes multiple approaches to ensure data completeness and accuracy, including (i) error and warning checking functionality on data submission, (ii) empowering users with tools and training to monitor the accuracy of their data in real time, and (iii) conducting audits, in which an independent reviewer compares registry data with the medical record for agreement.

Study population

We included colonoscopy reports in adults aged ≥75 years within the GIQuIC between January 1, 2010, and December 31, 2017. We excluded those with inflammatory bowel disease, serrated polyposis syndrome, or a personal or family history of a genetic CRC syndrome based on set fields in the GIQuIC because of the increased risk for colonic neoplasia and need for frequent surveillance (see Table 1, Supplementary Digital Content 2, http://links.lww.com/AJG/B300). We also excluded incomplete colonoscopies defined as lack of photo-documentation of the cecum or inadequate bowel preparation (as defined by the endoscopist).

Outcomes

Our primary outcome was the absolute risk of advanced colonic neoplasia (CRC and advanced lesions). Advanced lesions were defined as adenomas ≥10 mm in size, or with high-grade dysplasia, or villous features; or significant serrated polyps defined as size ≥10 mm or with dysplasia (e.g. traditional serrated adenomas) on the current colonoscopy. A secondary outcome was the follow-up interval recommended provided on the data collection form by the performing endoscopist. We classified available choices of "none" (no follow-up recommended), discrete months (<3, 3, 6, or 9 months), discrete years (1, 2, 3, 5, or 10 years), or "other" with a field for free text as none, 1 year, between 1 and 3 years, and 5 years or longer.

Variables

The main exposure variables were age in 5-year groups and indication for colonoscopy, with surveillance due to a history of colonic neoplasia as our primary interest. To provide context, we compared neoplastic yield in surveillance colonoscopies with both screening and diagnostic colonoscopies. Categorization of screening, surveillance, and diagnostic colonoscopies in the GIQuIC was based on the *colonoscopy type* field of the data collection form. GIQuIC has several certified vendors that enable their software to be compatible with the registry. There may be variation in how this field is populated between vendors, but generally, colonoscopy type was initially populated from the endoscopy software-generated report using the indication provided by the endoscopist, based on predefined mapping definitions. In other cases, colonoscopy type is initially selected by the endoscopist. In all cases, the colonoscopy type may be modified by the endoscopist based on clinical judgment.

We had access to sex, self-reported race (white, black, Asian, other), and the American Society of Anesthesiology (ASA) physical status classification (I, II, III, other) as assessed by the endoscopist, practice setting (ambulatory surgical center [ASC], hospital, office), and region of the country as defined by the US Census Bureau (Midwest, Northeast, South, West; see Table 2, Supplementary Digital Content 2, http://links.lww.com/AJG/B300) (7). Provider specialty as determined by National Provider Identifier taxonomy code was also available and categorized into gastroenterology (GI) vs non-GI.

Statistical analysis

We used descriptive statistics, Pearson's χ^2 tests, and analysis of variance tests to describe and compare characteristics of the study population across colonoscopy indications. Within each indication category, we compared the absolute risk of detecting CRC and advanced lesions by age using descriptive statistics, Pearson's χ^2 test, and the Cochran-Armitage test for trend across the increasing age groups. We created unadjusted followed by multivariable logistic regression models, separate for CRC and advanced lesions during surveillance accounting for age, sex, ASA class, and region of the country. Potential interactions were tested

by including relevant interaction terms (i.e., age and region, age and ASA) as covariates in the multivariable models but not included as they were not statistically significant. To evaluate follow-up recommendations after surveillance colonoscopy based on findings, we used descriptive statistics and test for trend across age groups. We evaluated follow-up recommendations based on provider specialty (GI vs non-GI). We also evaluated follow-up recommendations after surveillance colonoscopy based on the region of the country for both CRC and advanced lesions. In the analysis of recommended timing of next colonoscopy, colonoscopies in which the follow-up interval recommended was "other" (8.9% of colonoscopies told to return) were excluded. SAS 9.4 (Cary, NC) was used for all analyses.

Human subjects protection

The de-identified GIQuIC research database is stored on a secure server and is exempt from Institutional Review Board oversight per the Western Institutional Review Board. This study was deemed non-human subject research by the Dartmouth College Committee for the Protection of Human Subjects on August 8, 2017.

RESULTS

Study cohort

Between 2010 and 2017, there were 5,356,603 colonoscopies in the GIQuIC research database, of which 450,488 were in adults aged ≥75 years (Figure 1). After exclusions, 376,686 colonoscopies performed by 3,976 physicians at 628 sites remained, of which the most common indication was surveillance at 43.2% (162,526). Most physicians were gastroenterologists (85%). Table 1 shows the characteristics of the surveillance cohort compared with the screening and diagnostic groups. Most patients were between ages 75 and 79 and were white. There were more male patients in the surveillance cohort compared with the screening and diagnostic groups, consistent with the higher age-specific incidence of colon polyps among men compared with women (8,9). Most colonoscopies occurred in ASCs. Gastroenterologists performed most of the colonoscopies (53.9%), although the specialty of the performing endoscopist was frequently unspecified (45.7%) (data not shown).

Overall findings

Table 2 shows the findings during colonoscopy by indication and age. Among surveillance colonoscopies, there was an increase in the risk of CRC from 0.51% in those ages 75–79 to 1.8% in those ages ≥90 (P for trend < 0.0001). There was a similarly significant increase in the risk of CRC by 5-year age group for the indication of screening (0.70%–4.4%; P for trend < 0.0001) and diagnostic colonoscopy (2.1%–8.2%; P for trend < 0.0001). For each age band, the finding of CRC was highest for diagnostic colonoscopies and lowest for surveillance (all Ps < 0.0001; Table 2, footnote b). There was a statistically significant increase in the prevalence of advanced lesions by age for each indication ($P < 0.0001$ for surveillance and diagnostic and $P = 0.0005$ for screening). For each age band (i.e., 75–79, 80–84, and 85–89 years), there was a statistically significant difference in the risk of advanced lesions across the 3 different indications (Table 2, footnote d).

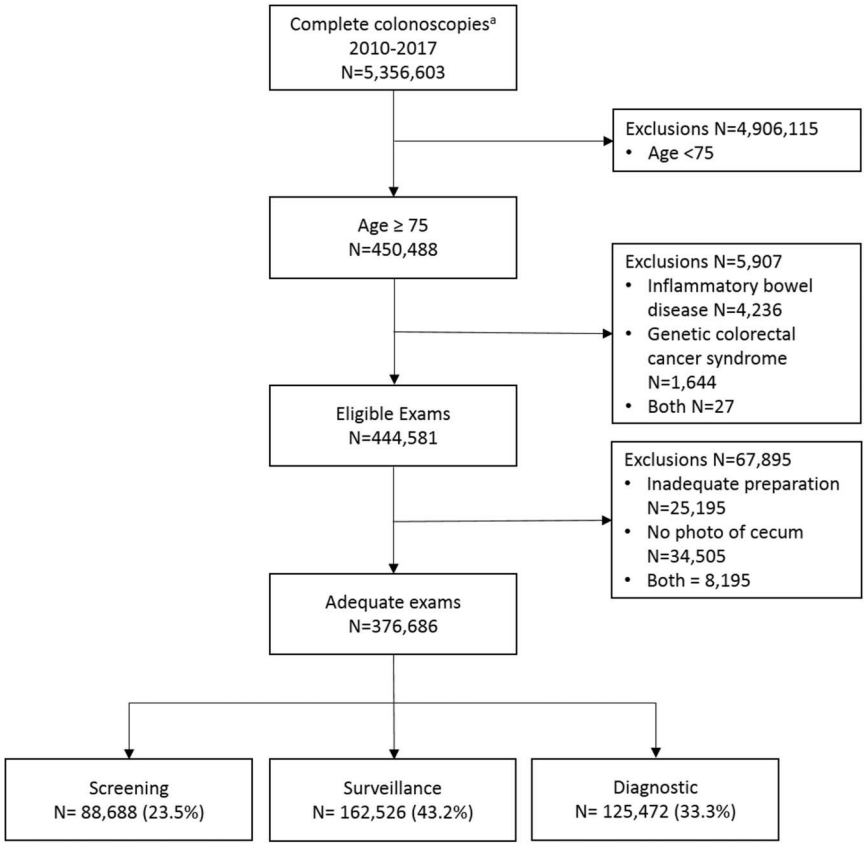

Figure 1. Flow diagram of colonoscopies included in this study. [a]Complete colonoscopy defined as containing all required fields and using discrete fields for entering pathology results where applicable.

Table 1. Characteristics of adults aged 75 years and older by colonoscopy indication (i.e., surveillance, screening, or diagnostic)

Characteristic	Surveillance, n (%)	Screening, n (%)	Diagnostic, n (%)	*P* value
Total N	162,526 (43.2)	88,688 (23.5)	125,472 (33.3)	
Age (yr)				<0.0001
75–79	118,025 (72.6)	71,932 (81.1)	72,656 (57.9)	
80–84	37,815 (23.3)	14,562 (16.4)	37,687 (30.0)	
85–89	6,231 (3.8)	2,011 (2.3)	12,981 (10.4)	
≥90	455 (0.3)	183 (0.2)	2,148 (1.7)	
Mean ± SD[a]	78.2 ± 2.9	77.5 ± 2.6	79.3 ± 3.6	<0.0001
Median[a]	77	77	79	
Sex				<0.0001
Male	87,266 (53.7)	39,235 (44.2)	52,845 (42.1)	
Female	75,260 (46.3)	49,453 (55.8)	72,627 (57.9)	
Race				<0.0001
White	117,190 (72.1)	58,715 (66.2)	86,382 (68.9)	
Black	9,327 (5.7)	6,218 (7.0)	8,192 (6.5)	
Asian	3,415 (2.1)	2,468 (2.8)	3,041 (2.4)	
Other	2,602 (1.6)	2,391 (2.7)	2,815 (2.2)	
Unknown/declined	29,992 (18.5)	18,896 (21.3)	25,042 (20.0)	
ASA classification				<0.0001
I	3,475 (2.1)	2,931 (3.3)	1,789 (1.4)	
II	104,008 (64.0)	62,014 (69.9)	69,241 (55.2)	
III	54,497 (33.5)	23,533 (26.5)	52,803 (42.1)	
IV	542 (0.3)	206 (0.2)	1,526 (1.2)	
V	1 (0)	1 (0)	3 (0)	
E	3 (0)	3 (0)	110 (0.1)	
Geographic location				<0.0001
Midwest	28,054 (17.3)	12,939 (14.6)	22,045 (17.6)	
Northeast	27,154 (16.7)	18,096 (20.4)	25,190 (20.1)	
South	71,321 (43.9)	38,889 (43.9)	54,308 (43.3)	
West	35,653 (21.9)	18,534 (20.9)	23,588 (18.8)	
Other/unknown	344 (0.2)	230 (0.3)	341 (0.3)	
Endoscopy suite type				<0.0001
Hospital	15,274 (9.4)	8,621 (9.7)	21,553 (17.2)	
ASC	133,333 (82.0)	72,158 (81.4)	95,118 (75.8)	
Office based	1,904 (1.2)	1,459 (1.7)	1,667 (1.3)	
Unknown	12,015 (7.4)	6,450 (7.3)	7,134 (5.7)	

ASA, American Society of Anesthesiology; ASC, ambulatory surgical center.
[a]Excluding those aged 90 years and older, where exact age was unknown due to privacy issues.

Models of risk of CRC and advanced colonic neoplasia during surveillance colonoscopy

The relationships between the risk of CRC during surveillance colonoscopy and age, sex, ASA classification, and the region of the country were similar in both unadjusted and adjusted models (Table 3). In adjusted models, the risk of CRC during surveillance colonoscopy increased for every 5-year increase in age.

Age was also associated with the risk of advanced lesions during surveillance; however, the magnitude of effect was smaller (Table 4). Men were more likely than women to have an advanced adenoma (odds ratio [95% confidence interval]: 1.08 [1.05–1.12]). ASA and West region of the country were also statistically significant in the adjusted models.

Follow-up recommendations after surveillance colonoscopy

Among surveillance colonoscopies, increasing age increased the likelihood of a recommendation for no further colonoscopy across all categories of findings; however, this recommendation

Table 2. Yield of colonoscopy (i.e., risks of adenocarcinoma, advanced lesions, multiple adenomas) by colonoscopy indication (i.e., surveillance, screening, or diagnostic) and age

	Risk of each finding (%) within 5-year age cohorts according to colonoscopy indication													
	Surveillance n = 162,526 (43.2%)					Screening n = 88,688 (23.5%)					Diagnostic n = 125,472 (33.3%)				
Finding	75–79 yr	80–84 yr	85–89 yr	≥90 yr	*P* value trend[a]	75–79 yr	80–84 yr	85–89 yr	≥90 yr	*P* value trend[a]	75–79 yr	80–84 yr	85–89 yr	≥90 yr	*P* value trend[a]
Adenocarcinoma[b]	0.51	0.70	1.4	1.8	<0.0001	0.70	1.2	2.3	4.4	<0.0001	2.1	3.2	5.3	8.2	<0.0001
Advanced lesion[c,d]	9.3	10.2	12.1	13.4	<0.0001	7.9	8.4	9.8	10.9	0.0005	8.8	9.6	11.0	12.3	<0.0001
≥3 adenomas	13.4	14.3	15.5	14.2	<0.0001	8.3	8.9	10.9	17.3	<0.0001	8.4	8.6	9.1	8.2	0.08
Sessile serrated polyp < 10 mm (no dysplasia)	5.5	5.5	4.8	4.8	0.12	4.1	3.8	3.0	4.7	0.02	3.6	3.5	3.3	3.2	0.05
1 or 2 adenomas <10 mm	46.9	48.0	47.8	48.7	0.002	37.6	38.8	40.3	43.9	0.0006	37.9	37.7	37.0	31.9	0.0004
Hyperplastic	22.9	21.0	18.7	17.9	<0.0001	17.5	16.0	14.6	15.9	0.0003	18.7	15.9	13.1	8.6	<0.0001

[a]*P* value is for the trend for each pathology category across the 4 age groups within the specific indication for colonoscopy.
[b]Within each age group (i.e., ages 75–79 or 80–84 or 85–89 or ≥90), there was a significant difference in the risk of adenocarcinoma across the 3 indications of surveillance, screening, and diagnostic, with all *P*s < 0.0001.
[c]Advanced lesion was defined as adenomas ≥10 mm in size, or with high-grade dysplasia, or villous features; or significant serrated polyps defined as size ≥10 mm or with dysplasia (e.g. traditional serrated adenomas).
[d]For the age group of 75–79, 80–84, and 85–89 years, there was a statistically significant difference in the risk of advanced lesions across the 3 indications of surveillance, screening, and diagnostic, with $P < 0.0001$, $P < 0.0001$, and $P = 0.009$, respectively. For the age group ≥90 years, there was no significant difference in the risk of advanced lesions across the 3 indications; $P = 0.66$.

was given infrequently (Figure 2). Regardless of age, very few individuals with CRC were recommended for no further colonoscopy (6.9% for ages 75–79, 10.9% for ages 80–84, 14.9% for ages 85–89, and 12.5% for ages ≥90; *P* for trend = 0.004). Only a small percentage of individuals with advanced lesions were recommended for no further colonoscopy (3.8% for ages 75–79 up to 25.0% for ages ≥90; *P* for trend < 0.0001). These recommendations did not vary meaningfully by the region of the country (data not shown). Similarly, a minority of individuals with 1–2 small adenomas were recommended for no further colonoscopy. Among individuals with no findings at surveillance, only 30.5% of individuals aged 75–79 years and only 50.7% of individuals aged ≥80 years were recommended for no further colonoscopy. For all categories of findings other than CRC, GIs were significantly more likely than non-GIs to recommend no further colonoscopy. For example, for surveillance colonoscopies in which advanced lesions are found, GIs recommended no further colonoscopy 6.8% of the time compared with non-GIs (4.8%; $P = 0.006$), and for surveillance colonoscopies with no findings, GIs recommended no further colonoscopy 36.7% of the time compared with non-GIs (31.2%; $P < 0.05$) (see Table 3, Supplementary Digital Content 2, http://links.lww.com/AJG/B300). Recommendations for follow-up did not vary by ASA classification (see Figure 2, Supplementary Digital Content 3, http://links.lww.com/AJG/B301).

When recommendations to return for future surveillance were given, the recommended follow-up intervals were generally guideline concordant; yet, those at advanced ages were more likely to be asked to return sooner than guidelines (Figure 3) (5). The vast majority of those with CRC were recommended to return for surveillance colonoscopy in 1 year across all ages. This recommendation was consistent across the different regions of the country (data not shown). Most patients with advanced lesions and ≥3 adenomas were recommended to return in 2–3 years; adults at advanced ages were more frequently recommended to return within 1 year (39.1% for ages 85–89 and 38.2% for ages ≥90) compared with those ages ≤84. Most individuals aged ≤84 years with 1–2 small adenomas were told to return in ≥5 years (68.4% for ages 75–79 and 62.7% for ages 80–84); however, 2–3 years was increasingly recommended at older ages (32.1% for ages 85–99 and 35.1% for ages ≥90).

DISCUSSION

In this study, using a large, national colonoscopy quality registry (GIQuIC), we found that in an older population, the risk of CRC increased with patient age across all indications of colonoscopy and was lower for surveillance compared with both screening and diagnostic indications. The decrease in CRC risk observed among those undergoing a surveillance colonoscopy relative to other indications is plausibly related to the benefit conferred by previous polypectomy. We also found that the frequency of the recommendation to stop surveillance was higher with increasing patient age but that most patients receive recommendations to return for a future colonoscopy. Gastroenterologists were more likely to recommend no further colonoscopy among older adults with advanced polyps or less clinically significant findings at surveillance compared with nongastroenterologists, a finding consistent with the existing literature that endoscopist specialty predicts the likelihood of cessation of screening colonoscopy in older adults (10). Among those recommended to return for future colonoscopy, most of the recommended intervals were

Table 3. Unadjusted and adjusted risks of colorectal cancer among surveillance colonoscopy patients, accounting for age, sex, ASA, and the region of the country

Characteristic	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Age (yr)		
75–79	Ref	Ref
80–84	1.36 (1.18–1.57)	1.34 (1.16–1.55)
85–89	2.74 (2.19–3.43)	2.66 (2.12–3.34)
≥90	3.46 (1.71–7.00)	3.31 (1.64–6.69)
Sex		
Female	Ref	Ref
Male	0.90 (0.80–1.02)	0.88 (0.77–1.00)
ASA classification		
I	Ref	Ref
II	0.85 (0.55–1.32)	0.83 (0.53–1.28)
III	1.23 (0.79–1.90)	1.14 (0.73–1.77)
IV, V, E	1.83 (0.74–4.55)	1.65 (0.66–4.11)
Geographic region[a]		
Northeast	Ref	Ref
Midwest	1.15 (0.93–1.43)	1.15 (0.92–1.43)
South	1.16 (0.96–1.40)	1.15 (0.96–1.39)
West	0.98 (0.79–1.21)	0.99 (0.80–1.23)

ASA, American Society of Anesthesiology; CI, confidence interval; OR, odds ratio.
[a]We excluded colonoscopies where the region was unknown or listed as "other region"; however, the models did not change with their inclusion.

Table 4. Unadjusted and adjusted risks of advanced colonic neoplasia[a] among surveillance colonoscopy patients, accounting for age, sex, ASA, and the region of the country

Characteristic	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Age (yr)		
75–79	Ref	Ref
80–84	1.13 (1.09–1.18)	1.10 (1.06–1.14)
85–89	1.43 (1.33–1.54)	1.36 (1.26–1.47)
≥90	1.63 (1.26–2.11)	1.53 (1.18–1.99)
Sex		
Female	Ref	Ref
Male	1.11 (1.08–1.15)	1.08 (1.05–1.12)
ASA classification		
I	Ref	Ref
II	1.22 (1.07–1.38)	1.27 (1.12–1.44)
III	1.61 (1.42–1.83)	1.68 (1.48–1.91)
IV, V, E	1.84 (1.40–2.42)	1.94 (1.47–2.56)
Geographic region		
Northeast	Ref	Ref
Midwest	1.04 (0.98–1.10)	1.03 (0.98–1.09)
South	0.86 (0.82–0.90)	0.84 (0.80–0.88)
West	1.12 (1.06–1.18)	1.13 (1.08–1.19)

ASA, American Society of Anesthesiology; CI, confidence interval; OR, odds ratio.
[a]Advanced colonic neoplasia was defined as any adenocarcinoma or any advanced lesion (adenoma ≥10 mm in size, or with high-grade dysplasia, or villous features; or significant serrated polyp defined as size ≥10 mm or with dysplasia (e.g. traditional serrated adenoma).

concordant with existing guidelines; however, older adults tended to be recalled at shorter intervals (5,11). While the rationale for earlier surveillance recall recommendations was not available, potential factors could include the desire to repeat colonoscopy before a significant change in health status with advancing age or concern over more aggressive neoplastic transformation in older adults. It is also possible that during surveillance colonoscopy, polyps are incompletely removed more frequently in the oldest adults compared with those who are younger; however, whether polyps are partially removed is not captured consistently in this GIQuIC data set and therefore cannot be evaluated reliably within our study.

Previous studies evaluating the incidence of CRC in older adults undergoing surveillance colonoscopy have showed a similar pattern of an increase in the risk of CRC with advancing age (see Table 4, Supplementary Digital Content 2, http://links.lww.com/AJG/B300). Pinksy and Schoen (12) found that the incidence of CRC increased by age (70–74 vs 75–80 years: 9.5 vs 11.4 per 10,000 person-years). Similarly, Martínez et al. (13) found that the incidence of CRC increased with age (≤59 vs ≥80 years: 0.2% vs 1.6%). Of note, in this study, there were few adults aged ≥80 years (n = 62). By contrast, van Heijningen et al. (14) found that the risk of CRC decreased at older ages (70–79 vs 80–89 years: 2.4% vs 1.8%). A retrospective study within a single health system found that the incidence of CRC in adults decreased at older ages (50–74 vs ≥75 years: 36.1 vs 2.4 per 10,000 person years) (6). While this study included older adults aged ≥80 years, it did not show results by 5 year decades, which may be why their study results differ.

Other studies evaluating the incidence of CRC in older adults have been limited by consideration of all colonoscopy indications together (15), lack of inclusion of indication or past exposure to colonoscopy (16), or absence of a comparator group for reference (17). Several other studies focusing on the risk of neoplasia after polypectomy did not consider age (18) or did not include older adults in their studies (19–21).

In terms of advanced lesions, we found a small increase in yield by 5-year age group for all indications, with a similar magnitude of yield across all indications. These findings are consistent with those of Martínez et al. (13), who found increasing risk of advanced lesions by every decade of age. van Heijningen et al. (14) described an increase in advanced adenomas from ages 40–49 (10.9%) to 60–69 (35.2%); however, these risks decreased thereafter (ages 70–79 [23.0%] and ages 80–89 [7.9%]).

A second major finding of our work is the frequency with which the ongoing surveillance is recommended despite very advanced age. Very few studies have evaluated the use of surveillance colonoscopy in older adults. Cooper et al. (22) analyzed Medicare claims data among patients aged ≥70 years, finding that advancing age was associated with a lower cumulative exposure to surveillance colonoscopy at 5 years. A study of recommendations after colonoscopy in adults aged 18–85 years

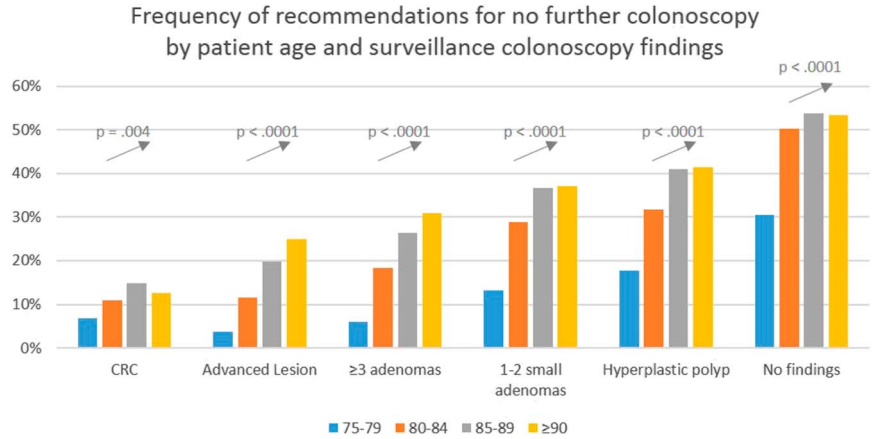

Figure 2. Percentage of individuals attending surveillance colonoscopy who received a recommendation for no further colonoscopy by age and most recent surveillance finding. CRC, colorectal cancer.

(mean age: 58 years) found that recommendations were guideline concordant in 81% of adults aged ≥65 years compared with 76.2% in younger adults. Of note, the sample of adults aged ≥75 years was quite small (n = 85, 4.7%). Other existing literature is largely limited to younger populations (22–30).

Our findings of an association between higher ASA classification and advanced colonic neoplasia are consistent with Tran's study, in which higher Charlson comorbidity index was associated with increased CRC risk (6). Although we did not have information on specific comorbidities of the patients in our study, there are many possible considerations related to this association, including diet, exercise, and diseases including both obesity and the metabolic syndrome that could affect both ASA and our outcome of advanced neoplasia (31).

The strengths of our study include the use of a large, national registry that uses discrete fields for indication and findings and includes many practices throughout the country which is likely broadly representative of US practice. Because of the registry's large size, we had the power to study CRC as an outcome and were also able to evaluate advanced lesions with even greater precision. The large number of colonoscopy examinations also enables evaluation of adults aged ≥75 years, for which there is little existing literature. Finally, one of our key primary outcomes (i.e., postprocedure surveillance recommendation) was a required data field and our results appear to make intuitive sense. For example, our analysis of recommendations for stopping colonoscopy and also intervals when follow-up is recommended seem internally consistent and valid. Older adults and those with less advanced findings are less

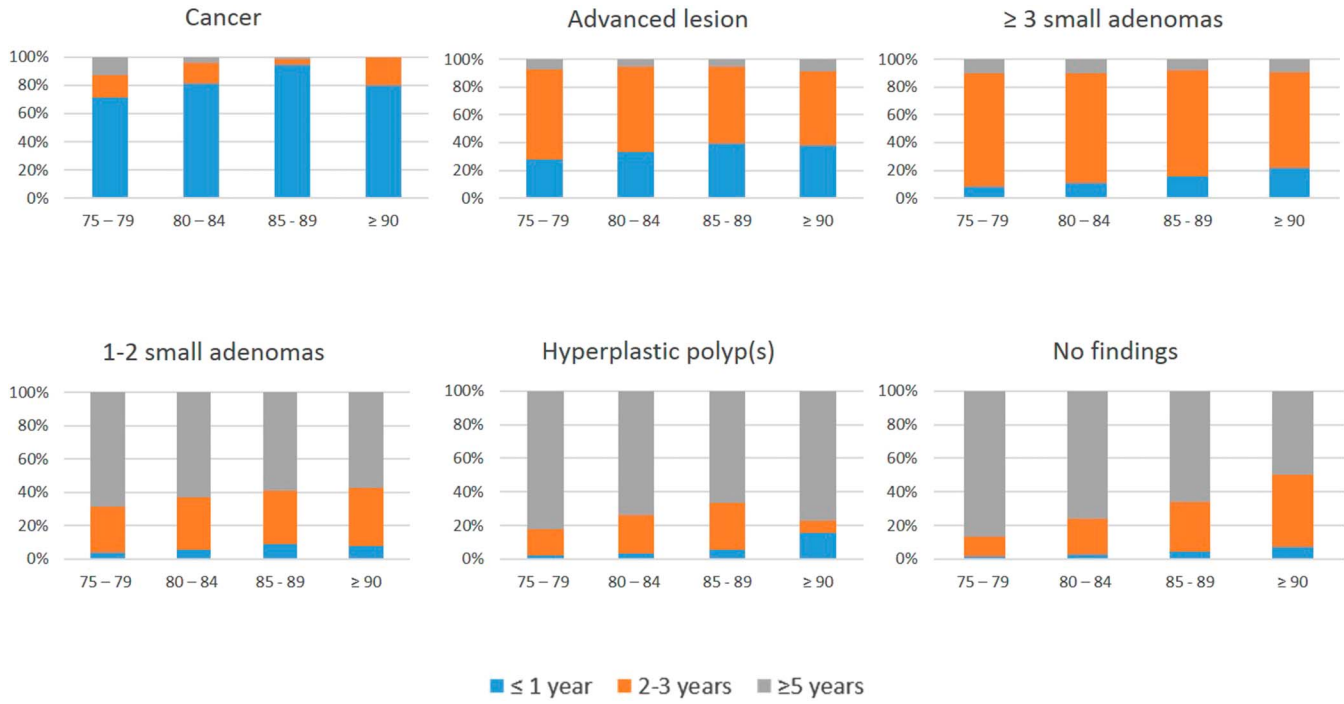

Figure 3. Among those attending surveillance colonoscopy who were told to return for future colonoscopy, the follow-up intervals provided by age and most recent surveillance finding.

likely to get a follow-up recommendation to return for future colonoscopy, which is expected.

Still, we acknowledge certain limitations. While this is a national database, it is not entirely representative of the US population as demonstrated by the high percentage of white patients and ASCs represented; however, it does well reflect the experience of those treated in most GI practices across the country. We had no information on health status or comorbidities other than the ASA classification. Data within the GIQuIC are subject to continuous auditing; however, a systematic-level validation has not been performed such that misclassification of some data fields is certainly possible. For example, the indications for colonoscopy are not validated. However, the site data manager is responsible for the integrity of the data uploaded into the GIQuIC, and sites are aware that these data directly feed into quality reporting and must be an accurate reflection of their practice. GIQuIC trains sites to input recommendations after review of pathology findings, although it is possible that some recommendations might be provided before review. These recommendations are not abstracted from the site electronic health record. In addition, these recommendations may not accurately reflect subsequent practice for recall for subsequent colonoscopy procedures. For example, practices may have individual rules for recalling patients outside what is collected in GIQuIC. However, our findings likely parallel what patients learn postprocedure about the need and timing for follow-up colonoscopy, leaving the impression of the need for ongoing surveillance. Endoscopist specialty was unspecified in many colonoscopies, and we did not have information on endoscopist-level variables such as age, sex, experience, years in practice that might also affect detection. Because insurance information is not a mandatory field in the GIQuIC, we do not have the ability to understand if and how insurance status influences recommendations and endoscopist decision making.

In conclusion, we found that neoplastic findings increase with age, but those under surveillance appear to be at lower risk than those presenting for other reasons. Surveillance colonoscopy is frequently recommended at advanced ages even when recent findings may be considered clinically insignificant. While recommendations for follow-up among older adults are generally concordant with guidelines for younger adults (ages 50–75), these recommendations might be considered aggressive for older adults, given the shifting balance of benefits and risks with increasing age. With the ever-growing use of surveillance colonoscopy and the aging population, further work is needed to define where harms outweigh benefits in older adults and ultimately develop and implement guidelines for best practice regarding when to stop surveillance in older adults.

CONFLICTS OF INTEREST

Guarantor of the article: Audrey H. Calderwood, MD, MS.

Specific author contributions: Conception and design of the study (A.H.C.), acquisition of data (A.H.C., J.L.H., and D.A.G.), analysis and interpretation of data (A.H.C., J.L.H., D.A.G., and D.J.R.), statistical analysis (J.L.H.), drafting of the manuscript (A.H.C.), critical revision of the manuscript (A.H.C., J.L.H., D.A.G., and D.J.R.), study supervision (A.H.C.), approval of the final version of the manuscript (A.H.C., J.L.H., D.A.G., and D.J.R.).

Financial support: This study was funded by a Salix Investigator Initiated Award #2017-2547 (A.H.C.). The grant funding body had no role in study design; collection, analysis, or interpretation of data; writing of the manuscript; or decision to submit for publication. A.H.C is supported by a Dartmouth SYNERGY Clinical Research Fellowship.

Potential competing interests: None to report.

Study Highlights

WHAT IS KNOWN

- ✓ Surveillance is the most common indication for colonoscopy in older adults.
- ✓ Little guidance exists on when to stop surveillance colonoscopy by age.

WHAT IS NEW HERE

- ✓ Risk of CRC increases with age and is lowest for surveillance compared with other indications.
- ✓ Even at the most advanced ages, few older adults are told to stop.
- ✓ Among older adults told to return, recommended intervals were generally guideline concordant.

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