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Use of Appropriate Surveillance for Patients With Non-Dysplastic Barrett's Esophagus

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Abstract

Background & Aims—Barrett's Esophagus (BE) is a precursor to esophageal adenocarcinoma (EAC). Guidelines recommend that patients with nondysplastic BE (NDBE) undergo surveillance endoscopy every 3–5 years. We aimed to identify factors associated with surveillance endoscopy of patients with NDBE and identify trends in appropriate surveillance endoscopy of NDBE at a large tertiary care center.

Methods—We performed a retrospective analysis of data from a Barrett's Esophagus Registry, identifying patients with NDBE who underwent endoscopy in 2002 or later. We identified patients with NDBE and collected data on length of BE segment, esophageal lesions, demographic features, medications, histology findings, comorbidities, development of EAC, and dates of

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follow-up endoscopies. We defined appropriate surveillance as 3–5 years between 2nd and 3rd endoscopies, over-users as patients who had less than 3 years between their 2nd and 3rd endoscopies, under-users as patients who had more than 5 years between their 2nd and 3rd endoscopies; and no surveillance as patients who never received a 2nd endoscopy. The primary outcomes were effects of patient factors, year, and referring providers on appropriateness of surveillance intervals.

Results—We identified 477 patients with NDBE. Only 15.9% had appropriate surveillance; 37.9% had surveillance overuse, 15.7% had surveillance underuse, and 30.4% received no surveillance. Patients were less likely to be surveillance over-users if their primary care physician referred them for their 3rd endoscopy instead of a gastroenterologist (adjusted odds ratio, 0.51; 95% CI, 0.27–0.95). Male patients or those with an increased number of comorbidities were more likely to have surveillance underuse or no surveillance, whereas patients with long BE segment were more likely to have surveillance overuse.

Conclusion—In a retrospective analysis of data from a registry of patients with BE, we found that less than 16% receive appropriate surveillance for NDBE. A primary care provider in the same health system as the endoscopy clinic reduced risk of over-surveillance. This could reflect better coordination of care between specialists and primary care providers

Keywords

cancer risk; PCP; early detection; prevention

Introduction

Barrett's Esophagus is identified as a precursor lesion for the development of esophageal adenocarcinoma (EAC) and the risk of malignant transformation among patients with non-dysplastic BE (NDBE) has been estimated to be between 0.12%–0.4% per year.^{1–3} In the past 40 years, there has been a rise in the incidence of EAC with few breakthroughs in medical therapies for advanced esophageal cancer.^{1,4–6} As a result, more attention has been placed on surveillance endoscopy of BE with the intent of preventing EAC or diagnosing EAC at a more favorable stage.^{1,4} The results of these studies have been mixed and have prompted the American College of Gastroenterology (ACG), the American Gastroenterological Association (AGA), and the American Society for Gastrointestinal Endoscopy (ASGE) to change their recommendations for surveillance of NDBE. In 2002, these three GI societies had recommended surveillance at one year after diagnosis and then every three years; however, in 2011, their recommendations shifted to recommending surveillance endoscopy every 3–5 year.^{7–11}

In an effort to reduce over-utilization of testing and procedures, the AGA joined the American Board of Internal Medicine (ABIM) in their Choosing Wisely campaign, listing that patients should question their provider if recommended to have surveillance EGD sooner than 3 years after their last one.¹² However, it is not clear whether endoscopists are following the guidelines for surveillance intervals of NDBE. Prior studies have aimed to determine the utilization patterns of EGD among patients with NDBE and risk factors for inappropriate utilization. A multicenter study that involved three sites included 235 patients

with NDBE found that 65% of patients reported >1 endoscopy in a 3-year period, which resulted in an estimated 2.3 excess endoscopies per patient.¹³ But the authors did not detect any factors that were significantly associated with over-utilization.¹³ Another study aimed to evaluate utilization of endoscopy in a Veterans Affairs (VA) population; among 4,499 patients with BE and 6 years of follow-up, only 6.7% had 3 or more EGDs, which they defined as probable over-utilizer.¹⁴ These findings seem to indicate that utilization of endoscopy in a VA population is not common and they found that VA patients were more likely to get endoscopically surveilled if they were white, younger than 65 years old, and had frequent outpatient visits.¹⁴ Finally, a recent study found that patients with non-dysplastic BE insured through Medicaid or without insurance were more likely to be under-surveilled as compared to those patients with private insurance.¹⁵

It is not clear to what extent the results of these studies are generalizable to other populations. Therefore, we aimed to identify factors associated with utilization of endoscopy among patients with NDBE and identify trends in the appropriateness of surveillance EGD of NDBE at a large tertiary care center, the University of Michigan (UM).

Methods

University of Michigan Barrett's Esophagus Registry

The University of Michigan Barrett's Esophagus Registry (UMBER) is a retrospectively collected database of BE patients managed at UM from 1994 through 2016. Subjects were identified by querying the UM Department of Pathology database for search terms 'Barrett's' and 'biopsy' combined. Patients were excluded from UMBER if they did not have an EGD at UM. The electronic medical record (including imaged copies of outside hospital [OSH] reports) was manually reviewed, and cases were included only if there was both endoscopic and histologic confirmation of BE. BE was defined as the endoscopic appearance or documentation of salmon colored mucosa with corresponding findings of intestinal metaplasia with goblet cells on histological evaluation. Data was manually abstracted using elements from the Barrett's Esophagus Translational Research Network Shared Minimal Dataset including date of endoscopies; location of endoscopies (outside hospital [OSH] or UM), endoscopic findings including length of BE segment and visible esophageal lesions (nodules, esophagitis, mass, ulcers); demographic data (age, gender, race); medications; histological findings; comorbidities; and staging (pre-and post-treatment) if they developed EAC. In 2016, patients identified in the registry who were over-due for surveillance endoscopy were contacted via telephone and letter notifying them that they were due for surveillance. If a patient had an endoscopy at an outside institution in the intervening time-period, attempts were made to obtain their endoscopic reports after obtaining a waiver for their medical records. Study data were collected and managed using REDCap electronic data capture tools hosted at The University of Michigan.¹⁶

Identification of utilization patterns

UMBER was utilized to identify patients with NDBE. Patients with a history of dysplasia (low-grade, indefinite, high grade dysplasia) and esophageal adenocarcinoma were excluded from the analysis (Figure 1). To allow for patients who had a repeat EGD within one year of

their NDBE diagnosis, as per guidelines recommendations prior to 2011, our primary outcome relied on the time between their 2nd and 3rd EGD. We included patients who had at least 3 EGDs or at least 5 years of follow-up since their last EGD. In order to account for differences in surveillance recommendations from GI societies prior to 2002, we excluded any patient who had their index endoscopy before 2002. Furthermore, we excluded any patient whose second EGD was done outside of the University of Michigan. Last, we excluded patients who did not have a University of Michigan primary care provider (PCP) since those patients may be more likely to have missing data on outside endoscopies.

Over-utilizers were defined as those patients who had less than 3 years between their 2nd and 3rd EGD. Under-utilizers were defined as those patients who had greater than 5 years between their 2nd and 3rd EGD or who never received their 3rd EGD. We also classified patients who never received their 2nd EGD as never-surveyed. All patients were compared to those who underwent appropriate surveillance, defined as between 3 and 5 years between their 2nd and 3rd EGD.

Variables of Interest & Primary Outcomes

The variables of interest in our study included sex, race, age at the last endoscopy, year of the second endoscopy, length of Barrett's segment (short segment or long segment, defined as < or ≥ 3cm), income estimated by patient zip code, distance to the University of Michigan estimated by patient zip code, Charlson Comorbidity Index (CCI), a family history of esophageal cancer, and the referring physician for their first, second and third endoscopies (University of Michigan GI provider versus PCP). Indications for repeat endoscopy among our cohort were defined as Barrett's related if the endoscopy indication was listed as suspected Barrett's esophagus, surveillance of Barrett's esophagus, or follow-up of Barrett's esophagus; all other indications (n=17) were defined as non-Barrett's related indications. Mean household income for zip codes was obtained from the 2010 US Census data and distance to the University of Michigan was calculated using the length of the shortest curve between the patient's zip code and University of Michigan.

The primary outcomes of our study were the effects of patient factors, year, and referring providers on appropriateness of surveillance intervals.

Statistical Analysis

Student's t-test was used for continuous variables and Fisher exact test or Chi-Square test was used for categorical variables. Logistic regression was used to estimate the odds ratios (ORs) for our variables of interest among the four utilization groups included in our study. Stepwise forward regression was used to develop the multivariable model. Sensitivity analyses were conducted 1) additionally including patients whose PCP was outside the UM system and 2) restricted to patients with more recent second endoscopy (over- & under-utilization) or first endoscopy (never-surveilled). 2008 was chosen since new guidelines recommendations were published at that time (Supplemental material online). Stata version 14 was used to perform all analyses (StataCorp. 2015. *Stata Statistical Software: Release 14*. College Station, TX: StataCorp LP).

Results

A total of 3,445 patients with BE were identified in the pathology database. 145 patients were excluded because there was no data available in the electronic medical record. We then excluded 1,692 patients with dysplasia, no BE on endoscopy, or less than five years of follow-up, 600 patients with an index endoscopy before 2002, 63 patients who had their second endoscopy at an outside institution, and 468 patients with no PCP at the University of Michigan. A total of 477 patients were included in our analysis (Figure 1). There were 76 (15.9%) patients with appropriate surveillance, 181 (37.9%) patients who were over-surveilled, 145 (30.4%) patients who were never-surveilled, and 75 (15.7%) patients who were under-surveilled.

Overall, the majority of our cohort were male (65.8%), Caucasian (91.4%), and had a mean age of 60.9 ± 13.7 years at the time of the last endoscopy (Table 1). 74.0% of over-utilizers, 70.3% of under-utilizers, and 51.1% of never-surveilled patients had a University of Michigan GI provider refer them for their 3rd, 2nd, and 1st endoscopy, respectively. In addition, 22.4% had long-segment BE (Table 1). The indication for a repeat endoscopy in the majority of patients were for Barrett's related reasons (Table 1).

As per our study protocol, we contacted over-utilizers who were due for their endoscopic surveillance. During that process, we identified a total of 43 patients (12 over-utilizers, 7 under-utilizers, and 24 never-surveilled patients) who died and did not receive their follow-up endoscopy.

Over-Utilization of endoscopy

In univariable analysis, over-utilization of surveillance endoscopy was less likely if a University of Michigan PCP referred the patient for their third endoscopy, as compared to a University of Michigan GI provider (Table 2). Furthermore, a more recent year of second endoscopy, from 2006–2011, was protective of over-utilization. However, long segment BE and a higher Charlson Comorbidity Index was associated with an increased risk of over-utilization (Table 2). In multivariable analysis, there were only 2 factors found to be associated with over-surveillance. Long segment BE was associated with an almost 4 times higher risk of over-utilization as compared to short segment BE (adjusted odds ratio [aOR] = 3.78, 95% confidence interval [CI] = 1.51 – 9.46) (Table 2). Furthermore, a PCP at the University of Michigan as the referring physician for the third endoscopy was associated with a reduced risk of over-surveillance as compared to a University of Michigan GI provider (aOR = 0.51, 95% CI = 0.27 – 0.95) (Table 2).

Under-Utilization of endoscopy

In univariable analysis, male patients, those with long-segment BE, those at the farthest distance from the University of Michigan, and patients with a higher Charlson Comorbidity Index were associated with an increased risk of under-utilization (Table 3). There was a trend toward patients who were referred by a University of Michigan PCP for their second endoscopy being less likely to be under-surveilled (Table 3). In multivariable analysis, an older age at the time of the last endoscopy (aOR 0.74 per year, 95% CI 0.54–0.90) and a

BMI > 30 kg/m² (aOR 0.39, 95% CI 0.15–0.99) were protective of being under-utilized (Table 3). However, male patients, those with long-segment BE, those with a higher Charlson Comorbidity Index, and patients at the farthest distance from the University of Michigan were at increased risk of under-utilizing surveillance endoscopy for NDBE (Table 3).

Never Surveilled

In univariable analysis, male patients, those with long segment BE, and those with a higher Charlson Comorbidity Index were associated with an increased risk of never receiving their first surveillance endoscopy (Table 4). Patient who were referred by a University of Michigan PCP for their first endoscopy trended toward being protected from being never-surveilled (Table 4). Patients with long segment BE and those patients with a higher Charlson Comorbidity Index were associated with an increased risk of never being surveilled (Table 4). In the multivariable analysis, male patients (aOR 1.90, 95% CI 1.01–3.57), long segment BE (aOR 3.02, 95% CI 1.10–8.25), and a higher Charlson Comorbidity Index (aOR 3.01, 95% CI 1.19–7.58) were associated with an increased risk of never being surveilled (Table 4).

Discussion

In this single center cohort study, we found that there was a small minority of patients who received appropriate surveillance for their NDBE. A University of Michigan PCP as the referring provider for the third endoscopy was protective of over-utilization and this trend was also seen among patients who were under or never surveilled. Male patients, those with long segment BE, and patients with a higher Charlson Comorbidity Index were at increased risk of both under-surveillance and never being surveilled.

PCP's are critical in the management of patients with chronic illnesses and prior studies have found that visits to PCP's account for over 50% of all office visits.^{17,18} The relationship between PCP's and specialists is an integral component of care for many patients. Studies have found that poor coordination and communication between PCP's and specialist physicians contribute to avoidable patient morbidity and mortality, fragmented care, and increased costs.^{19–21} In addition, the PCP-specialist physician relationship has been closely evaluated among cancer patients and survivors, with the 2005 Institute of Medicine report emphasizing that coordination between specialists and PCPs remains one of the four key components to cancer survivorship care.^{21,22} Within gastroenterology, the presence of a PCP at a center has been associated with an increased likelihood of patients attending their outpatient gastroenterology clinic appointments and improved coordination of colorectal cancer screening.^{23,24} PCPs also have an expanding role in the management of patients with Hepatitis C and cirrhosis.^{23–25} However, to our knowledge, the role of PCPs in the management of patients with BE has not yet been explored. Our study found that the presence of a PCP at the University of Michigan decreases the risk of over-utilization and trended towards protecting under and never-surveilled patients. The findings of our study suggest that PCPs play an important role in the health care utilization of endoscopic resources for patients with NDBE and presumably help to coordinate care between patients

and their specialist physician. Another consideration is the use of patient navigation programs, which have been shown to be an effective intervention to help overcome barriers in health care systems, especially among patients who may not have a PCP or if PCP engagement is not effective.^{26–31}

Furthermore, our study found that patients who were under and never surveilled had similar risk factors for inappropriate surveillance. Male patients were more likely to be under or never surveilled. Prior studies in the infectious diseases and orthopedic trauma surgery literature have found a similar independent risk for male patients to be lost-to-follow-up or not return for their regularly scheduled appointments.^{32,33} In addition, the distance from the University of Michigan also played an important role in being under-surveilled, specifically among those patients who were >47 miles from the University. Lastly, patients with a higher number of comorbidities per the Charlson Comorbidity Index were at higher risk of being under or never surveilled, which may be appropriate and reflect an informed decision with their provider regarding the risk and benefits of surveillance endoscopy considering their comorbidities. Given that the majority of BE patients are male, it is important to recognize their increased risk of inappropriate or decreased surveillance, which has also been noted in a prior study that found that patients at lowest risk of BE (women) are more likely to receive endoscopic screening for gastroesophageal reflux disease (GERD) as compared to men.³⁴

We acknowledge that there are limitations to our study. First, given that the data is retrospective, patients could have received appropriate endoscopic surveillance at an outside hospital without our knowledge. However, our study did make attempts to contact patients who were over-due for surveillance EGD after the initial data collection to determine if they have received a surveillance EGD at an outside institution and our current data reflects their updated records. Second, this is a single center study in which the results may not be generalizable to other centers. Third, long-segment Barrett's disease was associated with an increased risk of over-surveillance, under-surveillance and never surveilled in our multivariable analyses, as compared to appropriate surveillance. Perhaps over-surveillance of long-segment BE is driven by concerns of the increased risk of cancer, and under/never surveillance is driven by relative resolution of gastroesophageal reflux symptoms compared to patients with short segment BE. These findings need to be validated and explored further in additional studies. Fourth, we identified 43 patients who did not receive their endoscopy due to death and there could be additional deaths of which we are unaware. Last, we did exclude those patients who did not have a primary care provider at the University of Michigan given the concern for missing data on outside endoscopies. However, a supplementary analysis that included patients with an outside hospital PCP was similar to the findings of the primary analysis (Supplementary Table 1–3).

Our study does have several strengths. To our knowledge, it is the first study to identify patient factors, outside of insurance status, that are associated with both over and under surveillance of endoscopy among patients with NDBE. Prior studies that have evaluated surveillance endoscopy among patients with NDBE were not able to identify patient related factors associated with utilization patterns. Second, to our knowledge, our study is also one of the first to explore risk factors for never being surveilled or being under-surveilled, both of which are important and vital to describe as our health care system grows and becomes

more complex. Third, our study focused on patients who had their index endoscopy after 2002 and on the time interval between the 2nd & 3rd endoscopy only in order to better understand utilization patterns according to more recently updated guidelines. Fourth, given the number of patients with NDBE in the UMBER dataset, we were able to examine associations with a large number of factors among the different groups of patients studied.

In conclusion, our study found that appropriate surveillance intervals were uncommon (15.95%), with over-surveillance (37.9%), under-surveillance (15.7%), and never surveillance (30.4%) all occurring frequently. Furthermore, we found several factors that were associated with an increased risk of inappropriate surveillance including the importance of a PCP at the center where surveillance occurs in order to decrease the risk of inappropriate surveillance. Future efforts should focus on identifying barriers to receiving endoscopic surveillance among NDBE patients with particular attention to those patients who are the most vulnerable and improving the coordination of care between endoscopists and PCPs, particularly if the PCP is not in the same healthcare system.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations

BE	Barrett's Esophagus
EAC	Esophageal adenocarcinoma
NDBE	Non-dysplastic Barrett's Esophagus
LGD	Low grade dysplasia
PCP	primary care provider
UM	University of Michigan
EGD	esophagogastroduodenoscopy

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Figure 1. Flow chart of eligible subjects and classification of appropriateness of surveillance
Appropriateness based on the interval between 2nd and 3rd EGD. Over-surveillance defined as < 3 year, under-surveillance as > 5 years, and never surveilled as no 2nd EGD.

Table 1

Baseline characteristics for cohort of patients

	Total Number (N)	Mean (%) or $\pm$ SD
Male Sex	477	314 (65.8%)
Age at last endoscopy	477	60.9 $\pm$ 13.7
Caucasian Race	477	436 (91.4%)
BMI > 30 kg/m ²	432	185 (42.8%)
Long segment BE	428	96 (22.4%)
Mean number of EGDs	477	2.7 $\pm$ 1.54
Mean years of follow-up	477	3.6 $\pm$ 3.58
Family History of esophageal cancer	476	3.4%
Year of 2 nd Endoscopy *	332	
2002–2005		60 (18.1%)
2006–2011		221 (66.6%)
>2012		51 (15.4%)
Household Income	440	
\$19,000–\$45,000		61 (13.9%)
\$45,001–\$57,600		77 (17.5%)
\$57,601–\$74,000		141 (32.0%)
\$74,001–142,000		161 (36.7%)
Charlson Comorbidity Index	477	
0		253 (53.0%)
1		116 (24.3%)
2		108 (22.6%)
Distance to UM	464	
1 mi – 13 mi		179 (38.6%)
14 mi – 23 mi		158 (34.1%)
24 mi – 47 mi		83 (17.9%)
> 47 mi		44 (9.5%)
Indications of endoscopy by cohort		
Appropriate Utilizers	76	
Non-BE Surveillance		9 (11.8%)
BE Surveillance		67 (88.2%)
Over-Utilizers *	181	
Non-BE surveillance		42 (23.2%)
BE surveillance		139 (76.8%)
Under-Utilizers **	75	
Non-BE surveillance		21 (28.0%)
BE surveillance		54 (72.0%)

* Indication for third endoscopy;

** indication for second endoscopy;

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Table 2

Univariable and multivariable regression models for over-surveillance compared to appropriate surveillance

	Total Number (N) N=181	Unadjusted OR (95% CI)	Mutually Adjusted OR (95% CI)
Male Sex	115 (63.5%)	1.41 (0.82–2.43)	—
Age at last endoscopy (per 10 years)	63.3 ± 11.4	1.22 (0.90–1.48)	—
Caucasian Race	170 (93.9%)	1.09 (0.36–3.25)	—
Michigan referring provider for third endoscopy			
University of Michigan GI	134 (74.0%)	Ref	Ref
University of Michigan PCP	43 (17.1%)	0.48 (0.27–0.86)	0.51 (0.27–0.95)
BMI > 30 kg/m ² (n=174)	71 (40.8%)	0.71 (0.41–1.22)	----
Long segment BE (n=157)	43 (27.4%)	4.09 (1.65–10.1)	3.78 (1.51–9.46)
Family History of EAC (n=181)	9 (5.0%)	1.27 (0.34–4.84)	—
Year of 2 nd Endoscopy	n=181		—
2002–2005	37 (20.4%)	Ref	
2006–2011	100 (55.3%)	0.46 (0.21–0.99)	
>2012	44 (24.3%)	1.70 (0.59–4.90)	
Household Income	n=170		—
\$19,000–\$45,000	20 (11.8%)	Ref	
\$45,001–\$57,600	28 (16.5%)	1.4 (0.51–3.86)	
\$57,601–\$74,000	53 (31.2%)	1.27 (0.52–3.07)	
\$74,001–142,000	69 (40.6%)	1.36 (0.58–3.19)	
Charlson Comorbidity Index			—
0	105 (58.0%)	Ref	
1	33 (18.2%)	0.75 (0.39–1.45)	
2	43 (23.8%)	2.46 (1.07–5.63)	
Distance to UM	n=179		—
1 mi – 13 mi	82 (45.8%)	Ref	
14 mi – 23 mi	51 (28.5%)	0.60 (0.32–1.12)	
24 mi – 47 mi	29 (16.2%)	0.85 (0.39–1.89)	
> 47 mi	17 (9.5%)	3.00 (0.65–13.8)	

Table 3

Univariable and multivariable regression models for under-surveillance compared to appropriate surveillance

	Total Number (N) N=75	Unadjusted OR (95% CI)	Mutually Adjusted OR (95% CI)
Male Sex	56 (74.7%)	2.39 (1.20–4.75)	2.55 (1.01–6.45)
Age at last endoscopy (per 10 years)	59.8 ± 15.2	0.90 (0.74–1.22)	0.74 (0.54–0.90)
Caucasian Race	67 (89.3%)	0.59 (0.18–1.89)	—
Michigan referring provider for second endoscopy			—
University of Michigan GI	52 (70.3%)	Ref	
University of Michigan PCP	22 (29.7%)	0.55 (0.28–1.08)	
BMI > 30 kg/m ² (n=140)	24 (36.9%)	0.60 (0.31–1.18)	0.39 (0.15–0.99)
Long segment BE (n=136)	17 (26.2%)	3.84 (1.41–10.5)	6.03 (1.76–20.6)
Family History of EAC (n=151)	2 (2.7%)	0.67 (0.11–4.11)	—
Year of 2 nd Endoscopy			—
2002–2005	13 (17.3%)	Ref	
2006–2011	62 (82.7%)	0.81 (0.33–1.98)	
>2012	0 (0%)	—	
Household Income	N=66		—
\$19,000–\$45,000	13 (19.7%)	Ref	
\$45,001–\$57,600	14 (21.2%)	1.08 (0.35–3.32)	
\$57,601–\$74,000	19 (28.8%)	0.70 (0.26–1.91)	
\$74,001–142,000	20 (30.3%)	0.60 (0.23–1.63)	
Charlson Comorbidity Index			
0	35 (46.7%)	Ref	Ref
1	17 (22.7%)	1.17 (0.53–2.54)	1.86 (0.69–5.04)
2	23 (30.7%)	3.94 (1.58–9.84)	4.32 (1.25–14.9)
Distance to UM (n=145)			
1 mi – 13 mi	18 (25.0%)	Ref	Ref
14 mi – 23 mi	28 (38.9%)	1.50 (0.69–3.29)	1.79 (0.67–4.77)
24 mi – 47 mi	14 (19.4%)	1.88 (0.71–4.96)	2.97 (0.88–9.98)
> 47 mi	12 (16.7%)	9.67 (1.94–48.3)	7.31 (1.18–45.2)

Table 4

Univariable and multivariable regression models for never-surveilled compared to appropriate surveillance

	Total Number (N) N=145	Unadjusted OR (95% CI)	Mutually Adjusted OR (95% CI)
Male Sex	101 (69.7%)	1.86 (1.05–3.30)	1.90 (1.01–3.57)
Age at last endoscopy (per 1 year)	58.2 ± 16.0	0.90 (0.74–1.10)	0.82 (0.60–1.00)
Caucasian Race	128 (88.3%)	0.53 (0.19–1.50)	—
Michigan referring provider for first endoscopy			—
University of Michigan GI	71 (51.1%)	Ref	
University of Michigan PCP	68 (48.9%)	0.64 (0.36–1.14)	—
BMI > 30 kg/m ² (n=118)	53 (44.9%)	0.84 (0.47–1.50)	—
Long segment BE (n=36)	30 (22.2%)	3.10 (1.22–7.84)	3.02 (1.10–8.25)
Family History of EAC (n=144)	2 (1.4%)	0.34 (0.06–2.08)	—
Year of 1 st Endoscopy			—
2002–2005	32 (22.1%)	Ref	
2006–2011	113 (77.9%)	1.95 (1.05–3.59)	
>2012		—	
Household Income	N=131		—
\$19,000–\$45,000	17 (13.0%)	Ref	
\$45,001–\$57,600	24 (18.3%)	1.41 (0.50–4.00)	
\$57,601–\$74,000	46 (35.1%)	1.29 (0.52–3.21)	
\$74,001–142,000	44 (33.6%)	1.02 (0.42–2.49)	
Charlson Comorbidity Index			
0	65 (44.8%)	Ref	Ref
1	46 (31.7%)	1.70 (0.89–3.23)	1.98 (0.97–4.02)
2	34 (23.5%)	3.14 (1.33–7.39)	3.01 (1.19–7.58)
Distance to UM (n=140)			—
1 mi – 13 mi	50 (35.7%)	Ref	
14 mi – 23 mi	49 (35.0%)	0.95 (0.50–1.81)	
24 mi – 47 mi	28 (20.0%)	1.35 (0.60–3.06)	
> 47 mi	13 (9.3%)	3.77 (0.79–17.9)	