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The value of traditional upper endoscopy as a diagnostic test for Barrett's esophagus

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Abstract

Background—The standard test for diagnosing Barrett's esophagus (BE) is a conventional upper endoscopy. However, studies have shown that confirmation of BE by endoscopy with histologic intestinal metaplasia can be difficult.

Objective—To determine the overall accuracy, as well as factors that influence the accuracy of a conventional upper endoscopy in diagnosing BE.

Setting—Thirteen academic, community, and Veterans Affairs sites.

Design—A retrospective data review.

Patients—Patients who underwent an upper endoscopy with a finding of “suspected Barrett's esophagus” and esophageal biopsies. Pathology reports were examined to identify cases with intestinal metaplasia.

Main Outcome Measurements—Percentage of pathology-confirmed BE among suspected cases.

Results—A total of 2511 procedures were examined; the frequency of biopsy-confirmed BE was 48.4%. Multivariate logistic regression identified the following factors to be independently associated with biopsy-confirmed BE: long-segment BE that measured ≥ 3 cm (odds ratio [OR] 4.61 [95% CI, 3.73–5.69]), male sex (OR 1.82 [95% CI, 1.49–2.22]), increasing age (age interval 70–79 years with OR 2.33 compared with age <50 years [95% CI, 1.75–3.10]), the presence of a hiatal hernia (OR 1.46 [95% CI, 1.22–1.84]), and white race (OR 1.90 [95% CI, 1.49–2.22]).

Limitations—Biopsy specimens were assumed to sample the tubular esophagus; the actual pathology slides were not reevaluated by the investigators.

Conclusions—Endoscopic evaluation has limitations for the diagnosis of BE. Specific patient and endoscopic characteristics may be associated with the confirmation of BE on biopsy specimens. Further study is needed to determine if new endoscopic imaging technologies improve the ability to correctly identify BE.

Barrett's esophagus (BE) is a premalignant condition that precedes the development of esophageal adenocarcinoma.^{1–4} Although this malignancy is still relatively rare, increasing trends in incidence over the past few decades have made BE a topic of clinical and research

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interest.⁵⁻⁷ The Surveillance Epidemiology and End Results program statistics indicate that, among white men, the incidence of esophageal adenocarcinoma has increased from 0.72 in 100,000 inhabitants from 1974 to 1978 to 3.7 in 100,000 inhabitants from 1994 to 1998, a rise of more than 400%.⁸ The rate of increase for esophageal adenocarcinoma over the last 25 years exceeds that of any other malignancy in the United States.⁹

Despite this, the actual prevalence of BE (the presumed precursor for esophageal adenocarcinoma) is difficult to assess given its asymptomatic nature. However, studies estimated that up to 12% of patients with GERD¹⁰ and 1% of patients who undergo endoscopy for any clinical indication⁴ have BE. A recent Swedish population study of 3000 participants determined an overall prevalence of 1.6%, with a prevalence of 2.3% in those with GERD and 1.4% without GERD.¹¹ These data suggest that BE occurs in a significant proportion of the population.

In response to these observations, screening and surveillance practices were recommended for at-risk populations. Current practice guidelines suggest performing a diagnostic upper endoscopy in patients with chronic GERD symptoms, taking into consideration sex, race, and age as additional risk factors. By using the definition provided by the American College of Gastroenterology (ACG), BE is diagnosed by the following criteria: (1) the endoscopic recognition of columnar epithelium in the tubular esophagus, (2) subsequent histologic confirmation of intestinal metaplasia (IM) within biopsy specimens from this segment, and (3) exclusion of IM of the cardia.^{12,13} Once the diagnosis of BE is established, the patient can be considered for further endoscopic surveillance.

Studies showed that this seemingly straightforward approach to diagnosing BE is actually difficult in practice.¹⁴⁻¹⁸ In 1999, Eloubeidi and Provenzale¹⁵ reported the results from a retrospective study of patients who underwent an upper endoscopy for suspected BE. Biopsies were performed in 146 patients with suspected short-segment BE (SSBE) or long-segment BE (LSBE). BE was histologically confirmed in only 25% of those with suspected SSBE compared with 55% of those with suspected LSBE.¹⁵ In a more recent study, by Padda and Ramirez,¹⁷ 248 suspected BE cases with esophageal biopsies were examined. Suspected SSBE was confirmed in only 38.4% of cases, and suspected LSBE was confirmed in 75%. These findings suggest a significant discordance between the endoscopic suspicion of BE and biopsy confirmation.

In this study, we performed a retrospective review of the patient population represented by endoscopic centers across the United States that participate in the Clinical Outcome Research Initiative (CORI) database to examine cases of suspected BE for which esophageal biopsy reports were available. The goals of our study were to determine the accuracy of the endoscopic diagnosis of BE by conventional endoscopy across various practice settings, as well as to identify variables that best predict biopsy-confirmed BE.

PATIENTS AND METHODS

CORI

The CORI was established in 1995 to study the utilization and outcomes of endoscopy in diverse practice settings. All participating sites agree to use a standardized computerized report generator to create all endoscopic reports and to comply with quality-control requirements. The data files from the sites are transmitted electronically to a central data repository, the National Endoscopic Database (NED). Patient and physician identifiers are removed from the data files before transmission to protect both patient and physician confidentiality. The data then undergo computerized quality-control checks to identify

missing fields. After quality-control checks are completed, the data from all sites are merged in the NED for analysis.

For the purposes of this study, we extracted endoscopy reports only from those participating sites that reported pathology follow-up in at least 75% of all procedure reports. The 13 selected sites were distributed as follows: community or health maintenance organization (HMO) centers 60.1%, academic 13.6%, and Veterans Affairs (VA)/military 26.3%.

Patients

The database was queried between the dates of January 1, 2000, to December 31, 2005, to identify a patient population that was undergoing an upper endoscopy for any indication. Incomplete or duplicate reports and patients younger than 18 years old were excluded. Of this group, we selected reports from procedures with an endoscopic finding of “suspected Barrett's esophagus.” If the indication for the procedure was for BE surveillance or if the procedure had an endoscopic finding of “established Barrett's esophagus,” a prior known diagnosis of BE was assumed, and it was excluded from the study group. Patient age, sex, and race is required for each CORI report, and these were included as part of the data set.

The procedures with suspected BE were then reviewed to determine if esophagus biopsy specimens of the suspected segment of BE were obtained and followed up. Cases in which esophageal biopsy specimens were acquired for reasons other than suspected BE were not included in the analysis. Further exclusion occurred if procedures either had no biopsy sampling of the segment of interest or had no pathology follow-up of these samples. Reasons for not taking biopsy specimens were not consistently reported, but potential indications and esophageal findings that would influence this behavior were documented when possible by the investigators of this study. Reasons for not reporting pathology results in the CORI database could not be extrapolated from the information available.

Endoscopic characteristics and findings

Each endoscopy procedure report was examined to identify procedure location, indication, and the presence of a training fellow. The location of an endoscopy could be classified as an academic, a community, or a VA/military setting. Indication groups were dichotomized into reflux symptoms and/or BE screening versus other. The presence of a training fellow indicated involvement of the fellow during the procedure under the supervision of an attending physician.

Endoscopic findings of interest included the length of suspected BE, the presence of esophageal inflammation with Los Angeles (LA) grade classification (when available), and the presence of a hiatal hernia. The proximal and distal boundaries of suspected segments were consistently reported, and these were used to calculate length. SSBE was defined as a segment measurement less than 3 cm. Reports with descriptive terms alone, such as “tongue,” “island,” or “irregular Z-line” were also classified as SSBE. LSBE was defined as a length equal to or greater than 3 cm. Those without segment measurements or descriptors were classified as “unknown.” This category was also included in the analysis but did not represent a large percentage of the study group (3.4% of all examined procedures).

Confirmation of BE

All biopsy specimens were assumed to represent tissue sampling of the tubular esophagus. Cases of confirmed BE were identified when a patient with “suspected Barrett's esophagus” on upper endoscopy had pathology results that indicated “Barrett's esophagus,” “intestinal metaplasia,” “columnar epithelium with goblet cells,” or descriptions that were consistent with BE (as interpreted by G.M.E. and/or C.L.C.).

Statistical analyses

The Pearson χ^2 test for categorical variables, by using the Yates correction for continuity where appropriate, was used to compare distributions of patient and procedure characteristics among pathology-confirmed BE cases and those not confirmed. Ordered variables were also analyzed by the Mantel-Haenszel test of trend. Variables selected to proceed to multivariate model building were chosen based on the significance level of their univariate analysis or based on their potential to confound the associations between other predictor variables and the outcome (eg, site type). Multiple logistic regression analysis was used to investigate characteristics associated with pathology confirmation of BE while controlling for potential confounding variables. The model was created manually by entering candidate variables one at a time and by assessing changes in the likelihood-ratio test statistic, although all potential interaction terms were investigated by using an automated forward stepwise procedure. Reports with missing race/ethnicity (n Z 55) were excluded in the final model. The level of significance of .05 was used to retain variables in the model. Adjusted odds ratios (OR) and 95% CIs are presented. The Hosmer and Lemeshow goodness-of-fit test was used to assess model fit. The multivariate model was used to generate the estimated probability of the outcome that occurred, given specified levels of the predictor variables. The number needed to biopsy is the reciprocal of the estimated probability and represents the number of suspected BE cases that would need to be biopsied to detect one pathology-confirmed case. It is recognized that there were several statistical tests performed on data arising from individual patients. The P values for the univariate statistical tests are not corrected for multiple testing, because these tests were taken as exploratory. The subsequent multivariate logistic regression analysis was considered the main definitive result, because it determined those variables independently associated with pathology-confirmed BE, after adjusting for the contributions of the other variables. Although there may have been a few patients who contributed more than one report to the set of data analyzed in the study, for the purposes of performing statistical analyses, it was assumed that data from different reports were statistically independent observations. All analyses were performed with SAS v9.1 software (SAS Institute Inc, Cary, NC).

RESULTS

Patient demographics and procedure characteristics

From January 1, 2000, to December 31, 2005, 380,918 upper endoscopy reports were received in the NED. Of these, 67,252 procedures were derived from 13 practice sites that consistently reported pathology follow-up in more than 75% of all procedures with biopsies. A comparison of the makeup of these sites with the rest of the NED is shown in Table 1. The pathology-reporting centers differed from non pathology-reporting sites in the site types represented, with a larger percentage of VA centers compared with the nonpathology centers (26.3% vs 12.8%). An upper endoscopy was performed more often for indications of reflux symptoms and BE screening among the pathology-reporting sites (26.7% vs 24.4% for reflux symptoms, 2.9% vs 0.9% for BE screening). Overall, BE was suspected more often in the pathology-reporting sites (4.1% vs 2.8%). Both cohorts were otherwise similar in sex, age, and race or ethnicity distribution.

A total of 3116 procedures had the endoscopic finding of interest, "suspected Barrett's esophagus." We excluded 416 cases, because no esophageal biopsy specimens were taken of the suspected segment. Presumed reasons for not taking biopsy specimens, as extrapolated from the comments or free text of the procedure reports, included findings of esophagitis, poor patient tolerance to the procedure, multiple patient comorbidities, or alternative indications, such as upper-GI bleeding, varices, or dilation therapy. This list is not

comprehensive, because an explanation for not taking biopsy specimens is not required of the endoscopist for completion of the CORI report. Another 189 procedures were excluded because no pathology follow-up was found within the procedure report. A total of 2511 cases with complete data and pathology follow-up were examined, which represented 2455 unique patients.

The demographic characteristics of the final cohort are shown in Table 2. Male subjects represented the majority of patients studied and accounted for 72.8% of the study cohort. Nearly 75% of the group was 50 years of age or older, with a small percentage being older than 80 years (4.5%). Ninety percent of the patients were white, non-Hispanic, with minority groups being composed of small percentages of black, non-Hispanic (4.2%), Native American (2.8%), Hispanic (1.7%), and Asian/Pacific Islander (0.4%) ethnic groups.

The characteristics and findings of the endoscopic procedures are also shown in Table 2. Most procedures were performed at community/HMO centers (53.9%), followed by VA/military centers (36.2%), and then academic centers (9.8%). Reflux symptoms or BE screening were slightly more frequent indications for an endoscopy than other indications, 56.6% (reflux/BE screening) versus 43.4% (other indications) (not shown in any table). A training fellow was not present in the majority of cases (72.9%). The presence of a hiatal hernia was common in patients with a suspected BE (61.5%), whereas only 10% had documented esophagitis. SSBE was found more often than LSBE, at a frequency of 68.6% compared with 27.9%. Endoscopic margins of BE were missing in 161 of cases. However, after using descriptors of length (ie, "short segment," "tongue," "irregular Z-line," or "island") to identify SSBE, a total of 87 cases (3.5%) were unable to be classified and were labeled as "unknown."

Confirmation of BE

The frequency of histologically confirmed BE in different patient groups is presented in Table 2. Of the 2511 cases of endoscopically suspected BE, the diagnosis was confirmed by pathology in 1215 (48.4%). When these cases were examined by sex, men were more likely to have a confirmed BE than women (53.6% vs 34.4%, $P < .0001$). White race had the highest frequency of confirmed BE, at 50.9%, with smaller percentages seen for all other ethnic groups (black 19.2%, Hispanic 37.2%, Asian/Pacific Islander 33.3%, Native American 37.1%).

Various endoscopic characteristics and findings were compared in relation to pathology-confirmed BE in the same table. VA/military medical centers, which typically serve a higher proportion of male patients, were more likely to have a confirmed BE than community or academic centers (56.7% [VA/military] vs 43.4% [community/HMO] and 45.3% [academic], $P < .0001$). The presence of a training fellow also appeared to influence confirmation (52.8% [fellow present] vs 46.8% [no fellow present], $P < .01$). Also, the presence of esophageal inflammation, a hiatal hernia, and a long segment of suspected BE all suggested a higher likelihood of pathology confirmation. LA grade classification was provided for only 56.2% of observed cases of esophagitis. An analysis of the available data indicated that LA class C-D was associated with 77.8% pathology-confirmed BE, whereas LA class A-B was associated with 56.8% confirmed pathology (continuity corrected $P < .07$). There was also no statistical difference between an upper endoscopy performed for reflux symptoms and/or BE screening versus other indications (47.5% vs 49.6%, $P = .29$).

The multivariate logistic regression model is presented in Table 3. The likelihood of confirmed BE was decreased among blacks compared with whites (OR 0.24 [95% CI, 0.14-0.41]), was higher for men (OR 1.82 [95% CI, 1.49-2.22]), increased with the age interval 70-79 years (with OR 2.33 compared with age <50 years [95% CI, 1.75-3.10]),

LSBE measured ≥ 3 cm (OR 4.61 [95% CI, 3.73- 5.69]), and the presence of a hiatal hernia (OR 1.46 [95% CI, 1.22-1.84]). A significant interaction is present between the effects of sex and age such that men are more than 2 times more likely than women to have pathology-confirmed BE among the ages 50 to 69 years, but the sex difference is not significant for the younger age group (18-49 years) and the older age groups (≥ 70 years). For both sexes, the likelihood of pathology-confirmed BE increased as the age groups increased, with the exception of the group 80 years of age and older. In this age group, the likelihood continued to increase with female patients but dropped for male patients. Among all age groups, male sex was associated with a higher probability of confirmed BE (Fig. 1).

The multivariate model was used to calculate the number of patients that must have endoscopically suspected BE and undergo a biopsy to identify 1 patient with pathology-confirmed BE among specific ethnic groups (Table 4). We determined the absolute risk based on sex, age (dichotomized as <50 years or ≥ 50 years), race, and length of BE, and then calculated the number of suspected cases with biopsies to confirm 1 patient. By using the extremes of at-risk populations as an example, 18 African American women younger than 50 years of age with SSBE would need to be biopsied to identify 1 confirmed case of BE (absolute risk of 6%); on the contrary, only 2 white men older than 50 years of age with LSBE would need to be biopsied to find a confirmed case (absolute risk of 85%). These data also demonstrate that, regardless of sex and race, one needs to perform biopsy on only 2 or 3 individuals older than 50 years of age and with LSBE to confirm IM on histology.

DISCUSSION

Our data represent the first evaluation for the confirmation of BE from a diverse population of patients from academic, community, and VA/military centers throughout the country. Our results are similar to those of previous smaller studies, which suggested that endoscopic diagnosis of BE was poor but improved as the length of suspected BE increased.^{15,17} The study also showed that white race, older age, and the presence of a hiatal hernia are additional predictors of biopsy-confirmed BE. These findings are consistent with the currently defined at-risk population for chronic GERD and BE.¹⁹⁻²¹

Our results have implications for the practice of diagnosing BE. We found that a young, female, minority patient is very unlikely to have confirmed BE in the setting of a short suspected segment, whereas biopsy specimens from patients who are older, white, or male are more likely to confirm BE. In the setting of LSBE, the number needed to biopsy is decreased overall, particularly in any patient over the age of 50 years with a suspected segment of this extent. Our analysis raises the question as to whether it is clinically beneficial or cost effective to perform biopsy on patients of a certain population, particularly in light of the controversies that already exist regarding BE screening and surveillance.

It is also imperative to evaluate the reasons why an endoscopic diagnosis of BE may be flawed. The initial suspicion for BE occurs when an endoscopist recognizes an area of abnormal mucosa below a proximally displaced squamocolumnar junction (SCJ). Identification of pertinent landmarks, such as the SCJ or the gastroesophageal junction, can be difficult to identify. Sampling error also plays a role in the accuracy of diagnosing BE. Targeting biopsies can be difficult, because landmarks move during esophagus peristalsis, breathing, and, in the setting of sub-optimal sedation, patient retching. Furthermore, numerous biopsies within the segment can obliterate the landmarks, making targeted sampling more challenging. Sampling error may occur because of the patchy nature of IM within a segment of BE. In our study, we assumed that all esophageal biopsy specimens were accurately obtained from the tubular esophagus and that sampling error did not occur. It is possible that tissue was inadvertently obtained from the gastric cardia in some cases,

and, for these, “intestinal metaplasia” would not represent true BE according to the ACG definition.

There are limitations to our study. The use of CORI as our database subjected us to selection bias; the cohort may not have adequately represented the distribution of practices throughout the United States. This was also a retrospective study, and the endoscopists participating in the CORI database were not prompted to enter comprehensive data for the purposes of this specific study, and, therefore, the data may be incomplete or inaccurate. For instance, the procedure reports did not consistently report an LA classification when esophagitis was present. Because the patient's demographics are provided by the endoscopist rather than the patient, there is only an assumption that the race or ethnic group is accurately identified. BE cases that were described in the comments or free text of the report rather than by “drop boxes” would not have been picked up in the initial data screen. Also, the number of biopsy specimens taken in each procedure was not standardized and was not documented in the reports.

Some procedures were excluded for the absence of esophageal biopsy specimens and pathology report follow-up. Reasons for not taking biopsy specimens were not consistently documented, although a possible explanation was surmised by reading the comments on some of procedure reports. We cannot exclude bias that occurs when the endoscopist chose not to perform biopsies on certain patients because of comorbidities, the presence of esophageal inflammation, or beliefs on the importance of SSBE.

We did not review the actual specimen slides for confirmation nor were we able to review the official pathology report. Thus, we were dependent on the pathology follow-up entered in the procedure reports and assumed that the endoscopist's interpretation of the pathology report was accurate in terms of confirming IM. When the recorded pathology results were not definitive for BE (eg, the absence of “Barrett's esophagus,” “intestinal metaplasia,” or “columnar epithelium with goblet cells”), the findings were interpreted by the investigators. Descriptions that used unconventional wording or terminology were reviewed by one of the investigators (C.L.C.) with expertise in GI pathology. The lack of access to the official pathology report also hindered our ability to determine how many biopsy specimens were taken for the area of suspected BE. Also, because the pathologist results represented reports from numerous pathologists from the participating CORI sites, by not having access to the actual slides from these sites, we had to assume that all pathologists were correctly identifying BE by the presence of IM. All of the above conditions may introduce misclassification bias to our study.

Performance of conventional upper endoscopy is currently the standard of care for screening and surveillance of BE. However, our study demonstrated that endoscopic evaluation has limitations for the diagnosis of BE. In light of these results, there are undoubtedly other patients who undergo an endoscopy and do not have their BE recognized. Until a superior screening test replaces conventional endoscopy, it is important to continue efforts to identify what limits our endoscopic detection and diagnosis of BE. Newer modalities for detecting IM and dysplasia, such as chromoendoscopy and narrow-band imaging, are evolving but are not yet widely used in routine practice. Further study is needed to determine if these technologies may improve our ability to correctly identify BE.

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the CORI, a non-profit organization that receives funding from federal and industry sources. The CORI database was used in this study.

Abbreviations

ACG	American College of Gastroenterology
BE	Barrett's esophagus
CORI	Clinical Outcome Research Initiative
HMO	health maintenance organization
IM	intestinal metaplasia
LA	Los Angeles
LSBE	long-segment Barrett's esophagus
NED	National Endoscopic Repository
OR	odds ratio
SCJ	squamocolumnar junction
SSBE	short-segment Barrett's esophagus
VA	Veterans Affairs

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Figure 1.
Pathology-confirmed BE, sex by age group.

Table 1

Characteristics of Cohort, Non-Pathology Site vs. Pathology Site

2000-2005	Non-Path Site		Path Site	
	N	%	N	%
Total # EGD reports	313666	82.3%	67252	17.7%
Gender				
Male	157019	50.1%	38286	56.9%
Female	156647	49.9%	28966	43.1%
Age (years)				
<50	93475	29.8%	19494	28.9%
50-59	70730	22.6%	16415	24.4%
60-69	62587	20.0%	13432	20.0%
70-79	58551	18.7%	11981	17.8%
80	28323	9.0%	5930	8.8%
Race/Ethnicity				
White non-Hispanic	247084	78.8%	55363	82.3%
Black non-Hispanic	22311	7.1%	4532	6.7%
Hispanic	27995	8.9%	1389	2.1%
Asian/Pacific Islander non-Hispanic	6143	2.0%	803	1.2%
Native American non-Hispanic	2227	0.7%	2608	3.9%
Multi-racial non-Hispanic	596	0.2%	152	0.2%
missing/not entered	7310	2.3%	2405	3.6%
Site Type				
Community/HMO	221790	70.7%	40423	60.1%
Academic	51785	16.5%	9172	13.6%
VA/Military	40091	12.8%	17657	26.3%
Indications				
Screening for Barrett's Esophagus	2664	0.9%	1923	2.9%
Reflux symptoms	76623	24.4%	17967	26.7%
Findings				
Suspected Barrett's Esophagus	8901	2.8%	2721	4.1%

Table 2

Characteristics of Cohort, Cases of Newly Suspected BE and Pathology-Confirmation BE

	Path Available N (%)	Cases of Confirmed BE N	Proportion of Confirmed BE (%)	p-value
Total	2511	1215	48.4	
<u>Patient Characteristics</u>				
Male Gender	1827 (72.8%)	980	53.6%	<0.0001
Age Group				
18-49 years	645 (25.7%)	222	34.4%	<0.0001
50-59 years	770 (30.7%)	385	50.0%	M-H trend
60-69 years	597 (23.8%)	309	51.8%	<0.0001
70-79 years	387 (15.4%)	235	60.7%	
80 years	112 (4.5%)	64	57.1%	
Race/Ethnicity				
White Non-Hispanic	2226 (88.7%)	1132	50.9%	NA
Black Non-Hispanic	105 (4.2%)	20	19.1%	
Hispanic	43 (1.7%)	16	37.2%	
Asian/Pacific Islander	9 (0.4%)	3	33.3%	
Native American	70 (2.8%)	26	37.1%	
Multi-racial	3 (0.1%)	2	66.7%	
Unknown	55 (2.2%)	16	29.1%	
Site Type				
Academic	247 (9.8%)	112	45.3%	<0.0001
Community/HMO	1354 (53.9%)	587	43.4%	
VA/Military	910 (36.2%)	516	56.7%	
<u>Procedure Characteristics</u>				
Fellow Present	680 (27.1%)	359	52.8%	<.01
Fellow not present	1831 (72.9%)	856	46.8%	
Esophageal Inflammation reported	258 (10.3%)	141	54.7%	<.04
Esophageal Inflammation not reported	2253 (89.7%)	1074	47.4%	
Hiatal Hernia reported	1544 (61.5%)	830	53.8%	<.0001
Hiatal Hernia not reported	967 (38.5%)	385	39.8%	
Length of BE				
SSBE (<3 cm)	1723 (68.6%)	659	38.3%	<0.0001
LSBE (≥ 3 cm)	701 (27.9%)	527	75.2%	
Unknown	87 (3.5%)	29	33.3%	

NA, Not available.

*Mantel-Haenszel χ^2 test of trend.

Table 3

Multivariate Analysis: Variables Associated with Pathology- confirmed BE

	Adjusted Odds Ratio	95% Confidence Interval
<u>Predictor Variables</u>		
Gender		
Female	1.00 (reference)	
Male	1.82	1.49-2.22
Age Group		
18-49 years	1.00 (reference)	
50-59 years	1.72	1.36-2.17
60-69 years	1.85	1.44-2.37
70-79 years	2.33	1.75-3.10
80 years	1.96	1.25-3.08
Race/Ethnicity *		
White Non-Hispanic	1.00 (reference)	
Black Non-Hispanic	0.24	0.14-0.41
Hispanic	0.82	0.42-1.60
Asian/Pacific		
Islander	0.48	0.11-2.08
Native American	1.04	0.62-1.75
Multi-racial	1.83	0.14-24.63
Hiatal Hernia		
No	1.00 (reference)	
Yes	1.46	1.22-1.74
Length of BE		
SSBE (<3cm)	1.00 (reference)	
LSBE (≥ 3cm)	4.61	3.73-5.69
Unknown	0.79	0.49-1.26

* exclude 55 with unknown race/ethnicity

Table 4

Number Needed to Biopsy to Identify 1 Patient with Pathology-confirmed Barrett's Esophagus

	FEMALE				MALE			
	SSBE		LSBE		SSBE		LSBE	
	<50 years	50 years	<50 years	50 years	<50 years	50 years	<50 years	50 years
White non-Hispanic	5	3	2	2	4	3	2	2
Black non-Hispanic	18	10	5	3	10	6	3	2
Hispanic	6	4	2	2	4	3	2	2
Asian/PI non-Hispanic	10	6	3	2	6	4	2	2