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Adherence to quality indicators and surveillance guidelines in the management of Barrett's esophagus: a retrospective analysis

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ABSTRACT

Background Adherence to quality indicators and surveillance guidelines in the management of Barrett's esophagus (BE) promotes high-quality, cost-effective care. The aims of this study were (1) to evaluate adherence to standardized classification (Prague Criteria) and systematic (four-quadrant) biopsy protocol, (2) to identify predictors of practice patterns, and (3) to assess adherence to surveillance guidelines for non-dysplastic BE (NDBE).

Methods This was a single-center retrospective study of esophagogastroduodenoscopy (EGD) performed for BE (June 2008 to December 2015). Patient demographics, procedure characteristics, and histology results were obtained from the procedure report-generating database and chart review. Adherence to Prague Criteria and systematic biopsies was based on operative report documentation. Multiple logistic regression analysis was performed to identify predictors of practice patterns. Guideline adherent surveillance EGD was defined as those performed within 6 months of the recommended 3- to 5-year interval.

Results In total, 397 patients (66.5 % male; mean age 60.1 ± 12.5 years) had an index EGD during the study period. Adherence to Prague Criteria and systematic biopsies was 27.4 % and 24.1 %, respectively. Endoscopists who performed therapeutic interventions for BE were more likely to use the Prague Criteria (OR: 3.16; 95 %CI: 1.47 – 6.82; P < 0.01) than those who did not. Longer time in practice was positively associated with adherence to Prague Criteria (OR 1.07; 95 %CI: 1.02 – 1.12; P < 0.01) but with a lower likelihood of performing systematic biopsies (OR 0.91; 95 %CI: 0.85 – 0.97; P < 0.01). More than half (55.6 %) of patients with NDBE underwent surveillance EGD sooner (range 1 – 29 months) than the recommended interval.

Conclusion Adherence to quality indicators and surveillance guidelines in BE is low. Operator characteristics, including experience with endoscopic therapy for BE and time in practice predicted practice pattern. Future efforts are needed to reduce variability in practice and promote high-value care.

Introduction

Barrett's esophagus (BE) is a metaplastic condition in which the esophageal squamous epithelium is replaced by specialized intestinal-like columnar lining [1, 2]. BE is strongly associated with gastroesophageal reflux disease (GERD) and is a precursor for the development of esophageal adenocarcinoma (EAC), with an estimated risk of EAC up to 10-fold higher when compared to the general population [3 – 5]. While surveillance in BE remains an ongoing topic of debate, recent data suggest that surveillance endoscopy is associated with improved outcomes of EAC in patients with BE [6]. Hence, most gastrointes-

tinal societies recommend some form of regular surveillance in the evaluation and management of BE [7 – 10].

The introduction of a standardized classification system (Prague C & M Criteria) and systematic (four-quadrant) biopsies has improved surveillance. Furthermore, the use of systematic biopsies has been shown to enhance detection of early neoplastic changes in patients with BE [11, 12]. Adherence to these standardized practices and societal recommendations on surveillance intervals are likely to ensure high-quality patient care and limit unnecessary health-related expenditures. Nonetheless, prior studies have shown significant variability in clinical practice in the management of BE among US gastroenterologists [13 – 15]. The inherent limitations of these survey-based studies include response and reporting bias that may not accurately reflect actual practice patterns. The aims of this study were to review real life practice patterns and (1) to evaluate adherence to the standardized classification (Prague Criteria) and systematic biopsies, (2) to identify predictors of practice patterns, and (3) to assess adherence to surveillance guidelines for non-dysplastic BE (NDBE).

Materials and methods

Study design and patients

This study was approved with a waiver of informed consent by the institutional review board (IRB) of the University of Florida. The prospectively maintained electronic procedure report-generating endoscopic database (ProVation MD; ProVation Medical, Minneapolis, MN, USA) at the University of Florida (UF Health) was retrospectively reviewed to search for patients who had undergone evaluation for BE between January 2008 and December 2015. All cases recorded following the release of the 2015 American College of Gastroenterology (ACG) clinical guideline on the diagnosis and management of BE were excluded from the analysis [8]. In order to identify all potential BE cases, we searched all upper esophagogastroduodenoscopy (EGD) using the following terms: "Barrett's esophagus", "salmon colored mucosa", "suspicious for Barrett's" within the ProVation software during the study period. Patients were included if there were endoscopic findings of Barrett's mucosa (i. e. report describing "Barrett's esophagus", appearance "suspicious for Barrett's esophagus" and/or "salmon colored mucosa") on the procedural report. The electronic medical chart was then reviewed for each retrieved case to identify the total number of unique patients and confirm the histopathological diagnosis of BE.

Data collection

Procedural parameters were obtained from the endoscopy operative report in the ProVation database and/or from the patient's electronic chart record. These included: esophagogastric landmarks (i. e. squamocolumnar junction, gastroesophageal junction), the extent of BE (i. e. Prague Criteria, length of BE, number of tongues and/or islands, visible lesions), and if and how biopsies (i. e. cold biopsy forceps, endoscopic mucosal resection) were performed. Patient demographics and histopathology results were retrieved from the electronic chart review. Demographic data included age, sex, body mass index (BMI), smoking history, GERD, use of proton-pump inhibitor (PPI) medications, and histopathology of specimen(s) obtained during the EGD. A dedicated panel of gastroenterology pathologists evaluated all specimens and the histopathology was classified according to the revised Vienna classification [16]. Time interval between successive procedures was obtained by reviewing the operative dates on each EGD report.

Definitions and outcome measures

Adherence to standardized BE classification was based on the use of the Prague Criteria to describe the extent of BE in the procedural report. Adherence to a standardized biopsy protocol for BE was determined by the documentation of systematic four-quadrant biopsies (performed either at every 1 cm or 2 cm interval) on endoscopy (EGD) and by reviewing the pathology report to confirm that biopsies had been obtained and labeled as separate specimens every 1 cm or 2 cm along the length of the BE segment.

The index EGD was defined as the first endoscopy procedure performed for a given patient in which endoscopic findings of BE were documented. Index EGDs were defined as being performed in an academic (UF Health) or community (all procedures performed at non-academic community centers) setting. The EGDs following the index EGD, performed in patients with NDBE, were labeled as confirmatory EGD (1st EGD following index EGD) or surveillance EGD (EGD following confirmatory EGD), respectively. Since the published societal guidelines during the study period permitted a confirmatory EGD to establish BE diagnosis, the time period between the index EGD and the confirmatory EGD was not used to assess the adherence to suggested surveillance recommendations. An appropriate surveillance interval for patients with NDBE was defined as a surveillance EGD performed within 6 months (either prior to or after) of the 3- to 5-year window following the confirmatory EGD. This was based on the available 2008 – 2012 ACG, American Gastroenterology Association (AGA) and American Society of Gastrointestinal Endoscopy (ASGE) guidelines corresponding to our study period [7, 10, 17].

Different variables (patient, procedural, and endoscopists' characteristics) were evaluated to identify predictors of practice patterns (use of Prague Criteria; use of a standardized biopsy protocol). Practitioners were identified as BE therapeutic endoscopists if they performed esophageal endoscopic mucosal resection (EMR) and/or ablative techniques (i. e. radiofrequency ablation, cryoablation) for the management of BE. Time in practice was measured by years of experience as board-certified gastroenterologists (from the time of completion of a 3-year gastroenterology fellowship to the beginning of the study period in 2011). An endoscopist was considered junior faculty if they had < 5 years of experience before the beginning of the study period (2011).

Patient follow-up

All patients were followed from the date of the index EGD to the date of the last EGD available in our electronic medical record through 31 December 2015.

▶ **Table 1** Baseline characteristics of all patients (n = 397) who underwent index EGD during the study period and subdivided into academic (n = 311) and community (n = 86) setting.

Characteristics	Overall (n = 397)	Academic setting (n = 311)	Community setting (n = 86)	*P* value[1]
Age, mean ± SD, years	60.1 ± 12.5	58.8 ± 12.9	64 ± 10.7	0.0007
Male gender, n (%)	264 (66.5)	193 (61.4)	74 (86.0)	0.0001
BMI, mean ± SD	28.5 ± 5.7	28.5 ± 5.9	28.5 ± 4.3	0.68
Smoking history				0.87
▪ Current, n (%)	65 (16.4)	52 (16.7)	13 (15.1)	
▪ Previous, n (%)	177 (44.6)	129 (41.5)	48 (55.8)	
▪ Never, n (%)	136 (34.2)	114 (36.7)	22 (25.6)	
▪ Unknown, n (%)	19 (4.8)	16 (5.1)	3 (3.5)	
History of GERD at time of index EGD				0.27
▪ Yes, n (%)	324 (81.6)	250 (80.4)	74 (86.0)	
▪ No, n (%)	73 (18.4)	61 (19.6)	12 (14.0)	
History of PPI use at time of index EGD				0.0001
▪ Yes, n (%)	262 (66.0)	200 (64.3)	62 (72.1)	
▪ Unknown, n (%)	33 (8.3)	25 (8.0)	8 (9.3)	
Classification of BE				0.036
▪ Short-segment BE, n (%)	175 (44.1)	146 (47.0)	29 (33.7)	
▪ Long-segment BE, n (%)	120 (30.2)	85 (27.3)	35 (40.7)	
▪ Not specified, n (%)	102 (25.7)	80 (25.7)	22 (25.6)	

GERD = gastroesophageal reflux; EGD = esophagogastroduodenoscopy; BMI = body mass index; PPI = proton-pump inhibitor; BE = Barrett's esophagus. Short-segment BE was defined as < 3 cm of BE mucosa.
[1] *P* value of comparisons of variables between the two cohorts (academic vs. community setting).

Statistical analysis

Descriptive statistics for continuous variables were summarized using means and standard deviations whereas categorical variables were summarized using proportions. Two-sample Student's *t* test was used to test the difference in means between two continuous variables whereas Pearson's Chi-squared test of independence was used to test for associations between two categorical variables. The difference in proportions was assessed using *z* test large-sample statistics. Univariate logistic regression was used to estimate unadjusted associations of main predictors of interest with the response variables. Multiple (multivariable) logistic regression models were fitted to model the associations of the responses with the predictors while adjusting for demographic factors and other covariates in the model. The level of significance was set at 5% throughout the analysis. Stata Statistical Software: Release 14 was used for analysis (StataCorp LLC, College Station, TX, USA).

Results

Study population

A total of 727 patients treated between June 2008 and December 2015 were identified on our initial search in the ProVation endoscopy database. Three-hundred and thirty patients were excluded from the analysis as their index EGD was not available. Of the remaining 397 subjects, 311 had their index EGD at UF Health (academic setting) whereas 86 had their index EGD performed in the community setting before their referral into our system.

Endoscopist characteristics

Data on endoscopists' characteristics were available for procedures performed at the University of Florida during the study period. In all, 41 individual endoscopists were identified based on operative reports. Eight (20%) of them were BE therapeutic endoscopists. Overall, the mean years in practice was 8 ± 7 years (range; 1 to 25 years). This was not significantly different between endoscopists who treated BE (mean 8.6 ± 7 years, range; 1 to 22 years) and those who did not (mean 7.7 ± 7.1 years, range; 1 to 25 years) ($P = 0.73$). Fifteen (37%) of the endoscopists had ≥ 10 years in practice whereas 20 (49%) were identified as junior faculty (< 5 years of experience).

Baseline characteristics

The baseline characteristics of patients who underwent index EGD are summarized in ▶ **Table 1**. Patients with index EGD performed in the community were predominantly male (86% vs. 61.4%; $P < 0.001$) and older (mean age 64 ± 10.7 years vs.

▶ **Table 2** Histopathology results of biopsies obtained from all patients who underwent index EGD.

Histopathology	Academic setting (n = 273)	Community setting (n = 80)	*P* value
Non-dysplastic BE, n	146	14	< 0.001
Indefinite for dysplasia, n	8	8	0.01
Low grade dysplasia, n	21	21	< 0.001
High grade dysplasia, n	33	36	< 0.001
EAC, n	13	12	0.002
Other[1], n	62	6	0.003

EAC, esophageal adenocarcinoma.
[1] Other = normal squamous epithelium, esophagitis.

▶ **Table 3** Adherence to the use of Prague Criteria for BE classification and systematic four-quadrant biopsies during index EGD.

	Overall	Academic setting	Community setting	OR (95 %CI)[1]	*P* value[1]
Adherence to Prague Criteria, n (%)	109/397 (27.5)	101/311 (32.4)	8/86 (9.3)	4.81 (2.34 – 10.33)	< 0.001
Adherence to systematic biopsies, n (%)	85/353 (24.1)	68 (24.9)	17 (21.2)	1.14 (0.63 – 2.06)	0.77

OR = odds ratio; CI = confidence interval.
[1] OR and *P* value of comparison between the two cohorts (academic vs. community).

mean age 58.8 ± 12.9; $P < 0.001$) when compared to their counterparts who had their index EGD at an academic center. There were no statistically significant differences in smoking history or GERD symptoms between the two groups. Long-segment BE (40.7 % vs. 27.3 %; $P = 0.04$) and use of a proton-pump inhibitor (72.1 % vs. 64.3 %; $P < 0.001$) were also more commonly reported in patients with index EGD performed in the community setting.

Biopsies were performed in 273 (87.8 %) and 80 (93 %) patients during their index EGD in the academic and community setting, respectively ($P = 0.24$). Histopathological results from these biopsies are shown in ▶ **Table 2**. In aggregate, dysplastic BE (low grade and/or high grade) and EAC were more commonly encountered on index EGD in the community setting.

Adherence to Prague Criteria for BE classification and the use of systematic four-quadrant biopsies

In aggregate, the Prague classification system for the endoscopic characterization of BE was only used in 27.5 % (109/397) of the procedures. Prague Criteria were more often utilized by endoscopists in the academic (32.4 %) vs. the community (9.3 %) setting (odds ratio 4.81; 95 % confidence interval: 2.34 – 10.33, $P < 0.001$). Systematic four-quadrant biopsies were performed in less than a quarter of cases when biopsies were obtained and this did not vary based on practice setting (▶ **Table 3**).

Predictors for practice patterns

Univariate and multiple logistic regression analyses were performed to identify independent factors associated with adherence to the use of Prague Criteria and systematic biopsies during index EGD performed at an academic setting. The variables included were: age, gender, BMI, GERD symptoms (yes vs. no), PPI use (yes vs. no), cigarette smoking (yes vs. no), length of BE (short vs. long), background in BE therapeutics (yes vs. no), trainee involvement (yes vs. no), and endoscopist's time in practice (years).

Patient characteristics, including older age, male gender, length of BE, GERD symptoms, cigarette smoking, and PPI use, did not have an impact on the adherence to Prague Criteria or the use of systematic biopsies during index EGD for BE on multivariable analysis (▶ **Table 4** and ▶ **Table 5**). Trainee involvement during the procedures also did not affect practice patterns. With each year of additional experience, endoscopists were more likely to use the Prague Criteria (OR 1.07; 95 %CI:1.02 – 1.12; $P < 0.01$) and less likely to perform systematic four-quadrant biopsies (OR: 0.91; 95 %CI: 0.85 – 0.97; $P = 0.001$). Endoscopists who performed endoscopic therapy for BE and those having at least 10 years of experience were more likely to adhere to the use of the Prague Criteria. Conversely, time in practice was inversely associated with the likelihood of performing systematic biopsies for BE (▶ **Table 4** and ▶ **Table 5**).

A multivariable analysis was performed to evaluate the impact of practice setting (academic vs. community) for adherence to the use of the Prague Criteria or systematic biopsies in our entire cohort. Overall, endoscopists in the academic setting were more likely to use the Prague Criteria than their community counterparts (OR 6.9, 95 %CI: 2.87 – 16.7; $P < 0.01$), yet, there was no statistically significant difference in the likelihood of performing systematic biopsies between the two groups (OR 0.80, 95 %CI: 0.39 – 1.74; $P = 0.58$).

▶ **Table 4** Factors associated with adherence to the use of Prague Criteria for BE evaluation.

Clinical variable	Prague Criteria			
	Univariate analysis		Multivariable analysis	
	OR (95 %CI)	*P* value	OR (95 %CI)	*P* value
Age	1.02 (0.99 – 1.04)	0.06	1.00 (0.98 – 1.04)	0.53
BMI	1.00 (0.95 – 1.04)	0.84	0.98 (0.93 – 1.04)	0.60
Sex (male)	2.34 (1.38 – 3.94)	0.001	2.07 (0.99 – 4.31)	0.05
GERD	1.31 (0.71 – 2.43)	0.40	0.64 (0.17 – 2.40)	0.51
PPI use	1.48 (0.90 – 2.47)	0.13	1.29 (0.49 – 3.39)	0.61
Smoking history				
▪ Current smoker	1.53 (0.77 – 3.00)	0.22	2.16 (0.81 – 5.80)	0.17
▪ Previous smoker	0.97 (0.57 – 1.70)	0.91	0.82 (0.37 – 1.81)	0.62
Short segment BE	1.28 (1.09 – 2.84)	0.02		
Long segment BE	0.78 (0.44 – 1.37)	0.40	0.61 (0.27 – 1.34)	0.22
1 experience year[1]	1.06 (1.02 – 1.11)	0.001	1.07 (1.02 – 1.12)	< 0.01
BE therapeutics[2]	3.82 (2.31 – 6.33)	< 0.001	3.16 (1.47 – 6.82)	< 0.01
Attending only[3]	0.70 (0.43 – 1.14)	0.157	0.77 (0.36 – 1.64)	0.50
Total years[4]				
▪ 5.0 – 9.9	0.94 (0.47 – 1.88)	0.866	0.93 (0.44 – 1.95)	0.85
▪ 10.0 – 14.9	2.16 (1.09 – 4.26)	0.03	3.25 (1.52 – 6.96)	0.002
▪ 15.0 – 24.9	2.54 (1.22 – 5.31)	0.01	2.84 (1.27 – 6.36)	0.01

[1] Odds of adherence to Prague Criteria or systematic biopsies with each additional year of clinical experience.
[2] Endoscopists trained in the endoscopic therapy of BE (i. e. endoscopic mucosal resection and/or ablative techniques).
[3] Procedures done without trainee (gastroenterology fellow) participation.
[4] Categorical years set against 0.0 – 4.9 years as a reference frame.

Surveillance intervals for non-dysplastic BE

Of the 311 patients with an index EGD at UF Health, 146 patients were diagnosed with NDBE (▶ **Fig. 1**). A total of 38 patients did not undergo repeat EGD whereas 78 patients (53.4 %) had a confirmatory EGD and a subsequent surveillance EGD at a median of 20.5 months (range: 3 – 85 months). Thirty-two of 78 patients (41 %) had either remission of BE (n = 21) or dysplastic progression based on histopathology (n = 11). Fourteen patients were lost to follow-up. Of the remaining 28 patients with NDBE, surveillance EGD was performed at a median of 27 months (range: 10 – 62 months) with most of these (15/28; 53.6 %; ▶ **Fig. 1**) being performed prior to the recommended interval of 3 to 5 years (range 1 – 29 months).

Discussion

The implementation and adherence to quality indicators and surveillance guidelines in the evaluation and management of BE is of utmost importance to ensure high-quality and cost-effective care for patients. Nonetheless, previous studies have shown significant variability in the treatment of BE in clinical practice [13 – 15]. In this single-center retrospective study, adherence to the use of both a standardized BE classification system (Prague Criteria) and systematic four-quadrant biopsies (Seattle protocol) during endoscopic examination of BE was low. These practice patterns were affected by the level of experience of practitioners and whether they performed endoscopic therapy for BE. Furthermore, this study suggests that many patients with NDBE still undergo surveillance endoscopy at more frequent time intervals than what is recommended by published gastroenterology societal guidelines.

Accurate measurement and description of the extent of BE are clinically relevant given its implications on management strategies and the risk of developing EAC [18, 19]. Measurement of BE using the Prague Criteria, which account for both circumferential and maximal length of the segment, has been shown to have a high inter-observer agreement among endoscopists [11] and has been advocated by experts as the preferred classification system for BE [20]. Even though the Prague Criteria have been studied and validated in multiple settings and their use endorsed by societal guidelines [7 – 9, 17, 21], these criteria were only used in 27.4 % of all index EGDs in this study. The adherence to the Prague Criteria for measuring the extent of BE was significantly lower in community-based practitioners

▶ **Table 5** Factors associated with adherence to the use of systematic four-quadrant biopsies for BE evaluation.

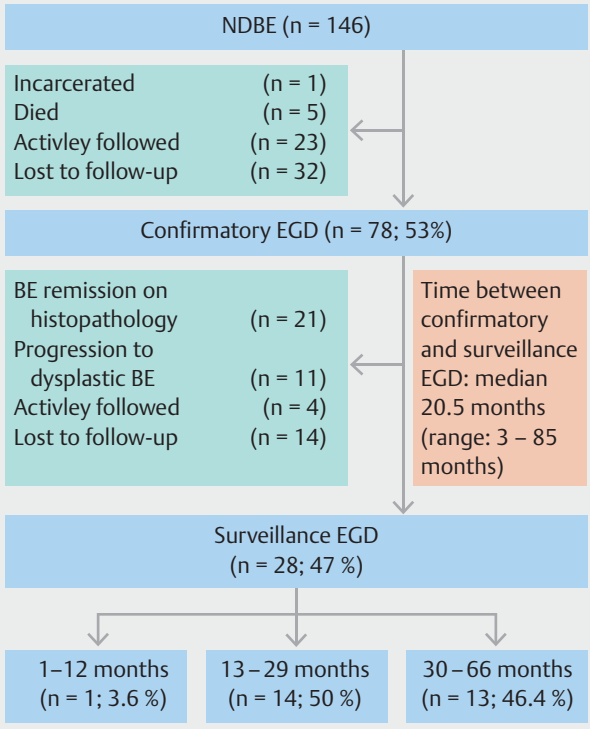
Clinical variable	Systematic biopsies			
	Univariate analysis		Multivariable analysis	
	OR (95 %CI)	*P* value	OR (95 %CI)	*P* value
Age	1.02 (0.99 – 1.05)	0.06	1.01 (0.97 – 1.05)	0.42
BMI	0.96 (0.90 – 1.03)	0.23	0.96 (0.89 – 1.05)	0.40
Sex (male)	1.32 (0.73 – 2.40)	0.35	1.18 (0.46 – 3.01)	0.73
GERD	1.74 (0.78 – 3.89)	0.18	1.75 (0.34 – 8.96)	0.50
PPI use	1.25 (0.68 – 2.28)	0.72	0.45 (0.15 – 1.33)	0.15
Smoking history				
▪ Current smoker	1.98 (0.86 – 4.60)	0.11	1.59 (0.45 – 5.65)	0.47
▪ Previous smoker	1.91 (0.97 – 3.8)	0.06	1.29 (0.46 – 3.63)	0.63
Short segment BE	0.22 (0.18 – 0.82)	0.01		
Long segment BE	4.54 (2.37 – 8.7)	0.001	2.36 (0.96 – 5.88)	0.06
1 experience year[1]	0.91 (0.87 – 0.94)	0.001	0.91 (0.85 – 0.97)	0.001
BE therapeutics[2]	1.40 (0.78 – 2.50)	0.26	1.11 (0.43 – 2.88)	0.83
Attending only[3]	1.40 (0.77 – 2.56)	0.27	1.41 (0.54 – 3.63)	0.48
Total years[4]				
▪ 5.0 – 9.9	0.93 (0.47 – 1.84)	0.84	0.74 (0.33 – 1.66)	0.47
▪ 10.0 – 14.9	0.32 (0.13 – 0.77)	0.01	0.35 (0.13 – 0.95)	0.04
▪ 15.0 – 24.9	0.28 (0.10 – 0.80)	0.02	0.29 (0.10 – 0.91)	0.03

[1] Odds of adherence to Prague Criteria or systematic biopsies with each additional year of clinical experience.
[2] Endoscopists trained in the endoscopic therapy of BE (i. e. endoscopic mucosal resection and/or ablative techniques).
[3] Procedures done without trainee (gastroenterology fellow) participation.
[4] Categorical years set against 0.0 – 4.9 years as a reference frame.

when compared to the academic setting (9.3 % vs. 32.4 %; *P*< 0.001). The available data from survey-based studies on the use of the Prague Criteria has varied widely, with rates ranging from 19 % to 67 % [14, 15, 21]. Potential shortcomings of those studies include both recall and reporting bias. Hence, our study may potentially provide a more accurate estimate of the actual adherence rate to the use of Prague Criteria for BE in clinical practice.

The use of a systematic biopsy protocol (four-quadrant biopsies every 1 or 2 cm) remains an important component in the detection of intestinal metaplasia and/or dysplasia, and is advocated as a quality indicator in the management of BE [20]. When compared to non-systematic surveillance biopsies, a systematic four-quadrant biopsy approach has been associated with an almost 13-fold increase in the detection of dysplasia [12]. Yet, adherence to biopsy guidelines for BE surveillance is low and has been estimated to range between 30 % and 50 % [22, 23]. In our study, overall adherence to a systematic biopsy protocol was 24.1 % and this did not vary significantly based on practice setting (academic vs. community setting). Surveillance systematic biopsies may be perceived as time-consuming and labor intensive, which can be potential deterrents for adherence. Having said this, it is important to highlight that systematic biopsies are not devoid of sampling error and alternative/adjunct methods to improve detection of dysplasia are actively being studied [22, 24, 25].

Our study identified the number of years the endoscopists had spent in practice and whether they performed endoscopic BE therapy as predictors of practice patterns. On logistic regression analysis, endoscopists who treated BE (i. e. EMR and/or ablation) were found to be more likely to use the Prague Criteria when compared to those who did not perform therapeutic interventions for BE (OR 3.16, 95 %CI: 1.47 – 6.82; *P*< 0.01). Similarly, increasing time in practice was positively associated with the use of Prague Criteria. Endoscopists with at least 10 years in practice were approximately threefold more likely to use the Prague Criteria when compared to gastroenterologists in their first year of practice. We speculate that endoscopists with increasing experience and those who treat BE may be more aware of the Prague Criteria and the importance of recording landmarks during BE evaluation for prognostic and therapeutic reasons. Conversely, our study demonstrated that a longer time in practice was inversely associated with the use of a systematic four-quadrant biopsy protocol.



▶ **Fig. 1** Flow diagram of surveillance intervals in patients with NDBE.

These findings are congruent with those reported by Falk et al. who showed that gastroenterologists in practice for less than 10 years obtained biopsies at 1 cm intervals more frequently than those in practice for more than 10 years (36 % vs. 25 %; $P = 0.03$) [13]. The reason for this discrepancy remains uncertain. With the ongoing emphasis on restraining costs in healthcare delivery and improvement in diagnostic performance, several non-invasive imaging techniques for BE are being evaluated as adjuncts or alternatives to tissue sampling [26]. Whether the reduction in the use of systematic biopsies based on time in practice reflects the evolving landscape in BE and perhaps the incorporation of advanced endoscopic imaging and targeted biopsies remains to be determined.

Surveillance endoscopy in BE patients has not conclusively been shown to provide a survival advantage in patients with BE but there is evidence supporting its association with improved outcomes for EAC [6]. Hence, current societal guidelines recommend performing surveillance endoscopy in patients with NDBE every 3 – 5 years [7, 8]. In our study, more than half of the patients (55.6 %) underwent surveillance within 29 months from their confirmatory EGD, instead of the guideline recommended interval. Given the low risk of progression to EAC in patients with NDBE [1, 2, 27], surveillance at an interval shorter than 3 – 5 years is not a cost-effective approach [28]. The costs associated with more frequent procedures should not be overlooked, especially considering the ever-changing legislative measures underscoring the need to reduce healthcare associated expenditures. Current research focusing on identifying potential factors associated with a higher risk for progression in patients with NDBE and non-invasive surveillance methods may assist in the effort of limiting unnecessary frequent endoscopies [29 – 31].

This study has several strengths. Unlike prior studies that have used surveys to assess patterns of practice in the management of BE, our study reviewed all endoscopic reports within the study period (2011 – 2015) to estimate adherence rates to the use of Prague Criteria and systematic biopsies for BE. Hence, our results may be more reflective of actual clinical practice patterns as survey-based responses can be limited by recall bias and be skewed toward adherence to guidelines. Furthermore, in addition to evaluating adherence to suggested quality indicators for BE, we also performed a logistic regression analysis which helped us identify predictors of practice patterns, specifically operator characteristics.

We also acknowledge the limitations of this study. This is a single tertiary-care academic experience and may not apply to other healthcare settings. The relatively small number of patients, particularly in the community cohort, may have precluded the detection of other meaningful differences in outcomes. Given the observational and retrospective nature of this study, unobserved confounding factors may have influenced our outcome measures. These may have included important variables, such as the use of chromoendoscopy and the duration of the examination during BE evaluation. Furthermore, the baseline characteristics of the two cohorts (patients with index EGD at an academic vs. community setting) were different. Patients who had index EGD in the community setting were older, predominantly male, had a higher proportion with long-segment BE and more advanced histopathology when compared to patients with an index EGD at the academic center. These differences were somewhat expected as the community-based cohort likely represented the more complicated patients who required referral to our system for further management. Hence, it comes as no surprise that the proportion of patients with non-dysplastic BE from the community was artificially low; as most of these uncomplicated patients were likely followed in the community and not referred to our center and thereby included in the study. Therefore, direct comparisons in outcomes between the two cohorts (academic vs. community-based) are limited and should be interpreted with caution. Lastly, factors that could have influenced surveillance intervals, including patients' willingness and availability, endoscopy unit scheduling and the role of the referring physician, were not accounted for in the analysis.

In summary, adherence to quality indicators (use of Prague Criteria and systematic biopsies) for the management of BE is low in clinical practice. Endoscopists who perform therapeutic BE interventions are more likely to use the Prague Criteria. Likewise, longer time in practice (years of experience) was positively associated with adherence to Prague Criteria but a lower likelihood of performing systematic biopsies in the evaluation of BE. A significant proportion of patients with NDBE still undergo surveillance sooner than the guideline recommended intervals.

Future efforts are needed to promote adherence to quality indicators and published surveillance guidelines in order to reduce variability in practice and thereby promote high-quality, cost-effective care.

Competing interests

None

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