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Adherence to quality indicators and best practices in surveillance endoscopy of Barrett's esophagus: A video-based assessment

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ABSTRACT

Background and study aims Adherence to quality indicators (QIs) and best practices (BPs) for endoscopic surveillance of Barrett's esophagus (BE) is low based on clinical documentation which is an inaccurate representation of events occurring during procedures. This study aimed to assess adherence to measurable QI and BP using video evaluation.

Methods We performed a single center video-based retrospective review of surveillance endoscopies performed for BE ≥1 cm between March 1, 2018 and October 1, 2020. Adherence to QIs and BPs was assessed through video review and documentation. Videos were evaluated by five gastroenterologists. Interrater variability was determined using 10 videos before reviewing the remaining 128 videos. A generalized linear regression model was used to determine predictors of adherence to QIs and BPs.

Results There were 138 endoscopies reviewed. Inspection with virtual chromoendoscopy (VC) occurred in 75 cases (54%) on video review with documentation in 50 of these cases (67%). Adherence to the Seattle protocol (SP) occurred in 74 cases (54%) on video review with documentation in 28 of these cases (38%). Use of VC or the SP was documented but not observed on video review in 16 (12%) and 30 (22%) cases, respectively. Length of BE was associated with increased use of the Prague classification (odds ratio [OR] 1.21, 95% confidence interval [CI] 1.07–1.37) while years in practice was associated with a decreased likelihood of VC use (OR 0.93, 95% CI 0.88–0.99).

Conclusions This study validates prior data demonstrating poor adherence to QIs and BPs and highlights discrepancies between clinical documentation and events occurring during procedures.

Introduction

Barrett's esophagus (BE) is the predominant premalignant condition associated with progression to esophageal adenocarcinoma (EAC). The incidence rates of EAC increased significantly between 1975 and 2000 and have since stabilized [1]. As of 2017 the incidence rate of EAC was 2.8 per 100,000 person-years [1]. Post-endoscopy esophageal cancer (PEEC), where EAC is diagnosed within a year of endoscopic surveillance, may comprise up to 13% of EAC diagnosed [2]. Current societal guidelines recommend a screening and surveillance program with upper endoscopy (UE) in BE for early detection of dysplasia and EAC [3,4,5,6].A recent meta-analysis has shown surveillance programs to be associated with detection of early-stage cancer and a possible association with an improvement in EAC-related mortality [7]. Despite these findings, there remain questions regarding the utility and efficacy of screening and surveillance programs. Specifically, the effectiveness of BE surveillance may be blunted by the failure to adhere to high-quality UE practices.

Quality indicators (QI) and best practices (BP) provide important metrics to ensure optimal patient outcomes. A 2015 expert consensus supported by the American Gastroenterological Association identified several QI for surveillance endoscopy for BE which included; 1) systematic biopsies per the Seattle Protocol; 2) documentation of the extent of BE using the Prague classification; and 3) documentation of squamocolumnar junction (SCJ), gastroesophageal junction (GEJ), and diaphragmatic indentation (DI) [8].Virtual chromoendoscopy (VC) has been demonstrated to improve dysplasia detection rates in endoscopists of all training levels and visual inspection aided by chromoendoscopy is recommended by the most recent societal guidelines [3,4,9]. Barrett's inspection time (BIT) of 1 minute per cm of BE has been associated with increased dysplasia detection rates and may also serve as a useful quality marker, similar to withdrawal time in colorectal cancer screening [10,11].Identification of quality metrics is important; however, meaningful clinical impact is ultimately dependent on endoscopist adherence.

Previous studies have demonstrated poor adherence to clinical guidelines and quality metrics. Adherence rates to the Prague classification and systematic biopsies per the SP have been as low as 27% to 53% and 24% to 51%, respectively [12,13,14]. However, a limitation of these studies has been the reliance on clinical documentation or surveys which may not accurately reflect the performance of key procedural aspects of surveillance exams. Our study aimed to determine adherence rates to BP and QI for surveillance endoscopy for BE at a large academic institution using a video-based assessment.

Patients and methods

Study design

A single-center video-based study was conducted investigating endoscopist adherence to QI and BP for BE surveillance endoscopy from March 1, 2018 to October 1, 2020. During this period, all endoscopic procedures performed for any indication were recorded and uploaded to a cloud-based system after removal of patient identifiers per institutional policy. Endoscopists were aware of this policy during this study period. All adults ≥18 years of age undergoing an UE with BE listed as an indication, a maximal BE length ≥1 cm, and an available recording of the UE were included. Patients previously treated with endoscopic eradication therapy (EET) or scheduled for EET at time of UE were excluded. Patient and endoscopist characteristics, procedure reports, pathology reports and UE video recordings were reviewed. Procedure reports were generated using a dedicated endoscopy writer (Provation, Minneapolis, Minnesota, United States) by the performing endoscopist. No institutional template for BE surveillance exams existed at the time of the study. A total of 138 cases underwent final review.

Assessment of QI and BP

QI and BP were identified based on literature review and are listed in ▶**Table 1**. QI and BP assessed via video review included the use of VC for esophageal mucosal inspection, random biopsies per the SP, BIT, presence of erosive esophagitis, inspection of the gastric cardia via retroflexion and identification and biopsies of visible lesions. BIT was defined as time spent inspecting the esophageal mucosa on withdrawal excluding time spent obtaining biopsies. Adherence to a select number of QI and BP evaluated via video review were also assessed through review of the procedure reports to determine the accuracy of clinical documentation. QI and BP assessed through video review and procedure reports included the use of VC, performance of the SP, presence of erosive esophagitis and presence of visible lesions. Adherence to the SP required four-quadrant biopsies at 1- to 2-cm intervals on video review and clear documentation of use of the Seattle protocol in the procedure report. Adherence to the use of VC required inspection of the entire length of BE with VC on video review and documentation that VC was used in the procedure report. QI and BP that could not be assessed through video review were evaluated through review of procedure reports alone. These included documentation of anatomic landmarks (SCJ, GEJ and DI) and maximal length and circumferential length of BE using the Prague classification.

Video assessment

Video reviews were performed by five practicing gastroenterologists with expertise in BE. An initial video review of 10 cases was conducted by all reviewers individually to assess interrater variability. Standardization of each QI and BP was subsequently discussed and agreed upon among the raters before proceeding with the remaining video review. The cases were divided among the reviewers and each of the remaining 128 videos were reviewed by a single reviewer.

Data analysis

Descriptive statistics were used to describe the sample of patients and endoscopists. These included median and interquartile range (IQR) for age, mean and standard deviation (SD) for years since fellowship, and counts and percentages for categorical descriptors. Agreement between reviewers on video re-

▶ **Table 1** Quality indicators and best practices assessed.

Quality indicators	Rationale
Documentation of anatomic landmarks (SCJ, GEJ and DI) [3, 6, 8, 11]	Standardizes report
Use of Prague classification to document extent of Barrett's esophagus [3, 5, 6, 8, 11]	Standardizes reporting
Use of chromoendoscopy or virtual chromoendoscopy [3, 4]	Increases dysplasia detection rate
Use of Seattle protocol [3, 4, 5, 6, 8, 11]	Increases dysplasia detection rate
Best practices	**Rationale**
Mucosal cleansing prior to esophageal inspection [11]	Enhances visualization of mucosa and lesions during esophageal inspection
Barrett's inspection time (BIT) [11]	BIT >1 minute per cm of Barrett's esophagus has been associated with increased dysplasia detection
Biopsies of visible lesions [3, 4, 6, 8]	Visible lesions may reflect dysplastic lesion or esophageal adenocarcinoma
Inspection of gastric cardia via retroflexion [3, 6, 11]	Assess for neoplastic lesions
Documentation of erosive esophagitis [6, 8]	Presence of erosive esophagitis suggests need to optimize anti-reflux therapy and may mask underlying lesions

SCJ, squamocolumnar junction; GEJ, gastroesophageal junction; DI, diaphragmatic indentation.

view was assessed using Fleiss' kappa, a generalization of Cohen's kappa that allows for more than two reviewers. After all videos were reviewed and protocol established, generalized linear regression models, with a logit link to model binary outcomes, were fit to determine if either endoscopist or patient characteristics were associated with adherence to QI or BP. These models included a covariance structure to account for multiple ratings by each reviewer. Due to limited sample sizes, each potential predictor was fit in separate models. All analyses were calculated in SASv9.4, Cary, North Carolina, United States. As this was a convenience sample, 95% Confidence Intervals are presented, and claims of statistical significance are avoided.

▶ **Table 2** Interrater variability based on initial 10 video review.

Review item	Fleiss' kappa
Was retroflexion of the gastroesophageal junction performed?	0.714
Were mucosal changes consistent with Barrett's esophagus present?	0.333
Was virtual chromoendoscopy used?	0.908
Was erosive esophagitis present?	0.835
Did the endoscopist follow the Seattle Protocol?	0.915

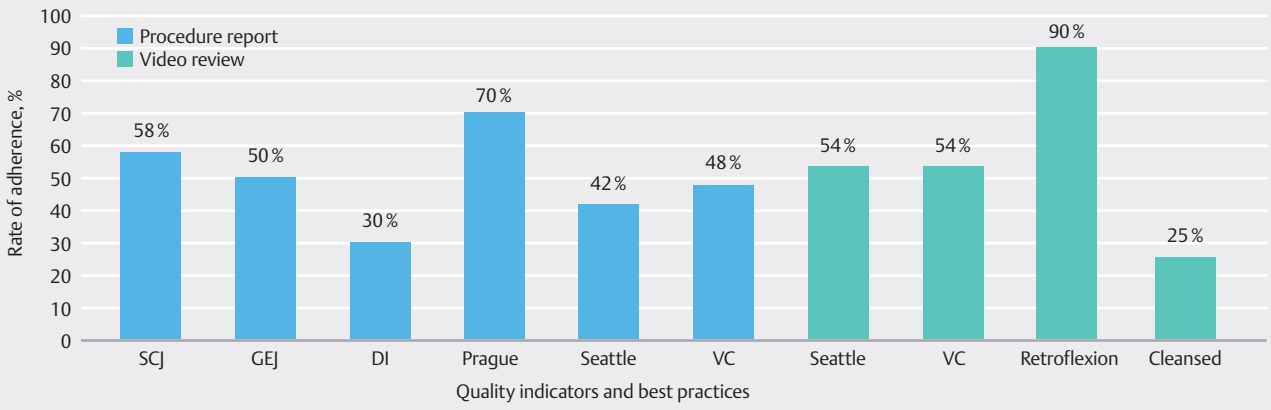
Results

General characteristics

A total of 138 surveillance UE for BE underwent final review. The median age of patients was 65 years (IQR, 55–70), 120 (87.0%) identified as White and 91 (65.9%) identified as male. All but one patient (0.7%) had undergone prior UE for BE surveillance or screening. Prior histological findings included 119 (86.2%) cases with non-dysplastic BE, 18 (13.0%) with low-grade dysplasia and one (0.7%) with high-grade dysplasia. The average maximal extent of BE was 2.7 cm. Twenty-seven endoscopists, including two therapeutic endoscopists, performed at least one surveillance UE during this study period with an average of 18.0 (SD = 10) years in practice after fellowship. The median number of surveillance UE performed by an individual endoscopist during the study period was 3 (IQR, 1–7) and the most BE endoscopies performed by a single endoscopist was 35.

Interrater variability

A total of 10 videos were reviewed individually by five endoscopists and responses to the questionnaires were assessed for interrater variability (▶**Table 2**). All reviewers agreed in response to whether stomach inspection occurred, and indeed, all videos did show stomach inspection, so kappa could not be estimated. Substantial agreement was observed when reviewers were asked whether retroflexion of the gastric cardia with 360-degree visualization was performed (Kappa 0.71) and almost perfect agreement was observed when reviewers were asked to evaluate whether VC was used (Kappa 0.91), erosive esophagitis was present (Kappa 0.84), and whether the SP was followed (Kappa 0.92). Only fair agreement occurred when reviewers were asked whether mucosal changes consistent with BE was present (Kappa 0.33).



▶ **Fig. 1** Rates of adherence to quality indicators and best practices based on procedure reports (blue) and video review (orange). SCJ, documentation of the squamocolumnar junction; GEJ, documentation of the gastroesophageal junction; DI, documentation of the diaphragmatic indentation; Prague, Prague classification; Seattle, Seattle protocol; VC, virtual chromoendoscopy; retroflexion, retroflexion of the gastric cardia with 360-degree visualization; cleansed, esophageal mucosa cleansed prior to inspection.

Procedure report review

All procedure reports were manually reviewed to assess documentation of QI and BP. The Prague classification was used to describe the extent of BE in 96 cases (69.6%) with the remaining 42 cases (30.4%) only documenting the maximal extent of BE. The SCJ was the most frequently documented landmark and was labeled in 80 cases (58.0%). Documentation of the GEJ occurred in 69 cases (50.0%) and the DI in 42 cases (30.4%). All three landmarks were documented in only 37 cases (26.8%), while 49 cases (35.5%) had no landmarks documented. Hiatal hernias were documented in 85 cases (61.6%). The use of VC was documented in 66 cases (47.8%) and performance of biopsies per SP was reported in 58 cases (42.0%). Visible lesions were reported in 10 cases (7.2%). Erosive esophagitis was reported in 13 (9.4%) cases: five grade A, four grade B, three grade C, and one grade D.

Video assessment

Retroflexion with a 360-degree visualization of the gastric cardia was performed in 124 cases (89.9%). Esophageal mucosa was cleansed prior to inspection in 35 cases (25.4%). Esophagitis was identified by reviewers in 12 cases (8.7%) but was documented in 13 procedural reports (9.4%). Random biopsies were obtained in six of the 12 cases (50.0%). VC was utilized during esophageal mucosal inspection in 75 cases (54.4%) but was only documented in 50 cases of these cases (66.7%); furthermore in 16 additional cases, the use of VC was documented in the procedure report but not observed during video review. BIT was calculated by the reviewer for 134 cases with a median BIT of 42 seconds (IQR, 27–72) and median BIT per cm of BE of 20 seconds (IQR, 9–39). Only 19 cases (14%) had a BIT >1 minute per cm of BE. A total of 21 visible lesions in 17 cases were identified during video review, of which 16 (76.2%) were biopsied. Only six of the 21 visible lesions (28.6%) identified by the reviewers were documented in the procedure report. Following mucosal inspection, random biopsies adhering to the SP were performed in 74 cases (53.6%) based on video review with documentation of the SP only occurring in 28 of these cases (37.8%). In 30 (21.7%) cases the endoscopist documented performance of the SP, however, did not adhere to the SP based on video review. Adherence rates based on procedure reports and video assessment are summarized in ▶ **Fig. 1**.

Characteristics associated with adherence to QI and BP

The associations between endoscopist and patient characteristics with adherence to QI and BP were assessed (▶ **Table 3**). Endoscopists who performed the surveillance UE using monitored anesthesia care were more likely to document the Prague classification (odds ratio [OR] 3.90, 95% confidence interval [CI] 1.38–11.07), document the SCJ (OR 2.48, 95% CI 1.44–4.26), use VC (OR 3.19, 95% CI 1.12–9.08), and perform the SP (OR 2.02, 95% CI 1.28–3.18). There was an association between maximal length of BE and documentation of the SP (OR 1.16, 95% CI 1.01–1.32); however, this association was limited to the procedure report and not the video review (OR 1.12, 95% CI 0.99–1.27). Notably, years in practice following fellowship was associated with a decreased likelihood to use VC during mucosal inspection (OR 0.93, 95% CI 0.88–0.99).

Discussion

QI and BP for endoscopic surveillance of BE aim to increase dysplasia detection and promote the performance of a high-quality exam. Results from this video-based study validate previous data demonstrating poor practice adherence based on clinical documentation [12, 13, 14]. However, clinical documentation has been demonstrated to be an inaccurate representation of all the steps performed during endoscopy and it was unclear whether poor adherence to QI and BP for BE surveillance based on chart review accurately reflected adherence rates. The addition of a video-based review to assess procedural performance

▶ **Table 3** Odds ratios and 95% confidence intervals for predictors of adherence to quality indicators and best practices during surveillance endoscopy for Barrett's esophagus.

Characteristics	SCJ landmark	Use of Prague	VC	Seattle Protocol	BIT ≥1 minute per cm of BE
Therapeutic endoscopist	2.28 (1.12–4.67)*	8.59 (2.50–29.50)*	3.32 (0.98–11.30)	0.75 (0.43–1.30)	1.69 (0.55–5.18)
Years in practice after fellowship	0.96 (0.91–1.02)	0.96 (0.88–1.04)	0.93 (0.88–0.99)*	1.00 (0.97–1.04)	1.00 (0.94–1.08)
Patient age	1.00 (0.98–1.01)	0.99 (0.97–1.01)	1.00 (0.98–1.03)	0.99 (0.96–1.02)	0.99 (0.95–1.04)
Patient race (White)	0.91 (0.50–1.65)	1.03 (0.65–1.63)	0.90 (0.49–1.65)	0.53 (0.20–1.39)	2.19 (0.45–10.57)
Patient sex (male)	0.78 (0.51–1.18)	0.97 (0.57–1.64)	0.46 (0.28–0.77)	0.73 (0.44–1.21)	0.72 (0.27–1.90)
History of hiatal hernia	0.65 (0.40–1.05)	1.11 (0.80–1.53)	1.64 (0.77–3.50)*	2.04 (0.96–4.33)	0.98 (0.45–2.15)
Erosive esophagitis	1.52 (0.57–4.06)	1.09 (0.64–1.86)	1.05 (0.49–2.26)	0.94 (0.23–3.90)	0.39 (0.03–4.60)
Monitored anesthesia care	2.48 (1.44–4.26)*	3.90 (1.38–11.07)*	3.19 (1.12–9.08)*	2.02 (1.28–3.18)*	0.95 (0.27–3.33)
Barrett's esophagus as only indication	0.78 (0.44–1.40)	0.85 (0.58–1.24)	0.94 (0.51–1.74)	0.95 (0.52–1.72)	1.34 (0.63–2.83)
Maximal length of BE	0.95 (0.84–1.08)	1.21 (1.07–1.37)	1.06 (0.89–1.27)	1.12 (0.99–1.27)	–

* Statistically significant ($P < 0.05$)
SCJ, squamocolumnar junction; VC, virtual chromoendoscopy; BE, Barrett's esophagus, BIT, Barrett's inspection time, defined as time spent inspecting the segment of Barrett's esophagus immediately prior to obtaining biopsies.

of QI and BP provides a more accurate snapshot of the quality of endoscopy performed for BE surveillance. In addition, we identified discrepancies between documentation and procedural performance regarding use of VC and SP sampling highlighting key limitations of prior studies using clinical documentation alone.

In this study endoscopists inappropriately documented the use of VC and SP in 12% and 22% of cases, respectively, demonstrating the limitations of clinical documentation when assessing true performance of QI and BP. Interestingly, our study found that endoscopists further removed from fellowship training were less likely to use VC (OR 0.93, 95% CI 0.88–0.99). It is important to note that the first American society guidelines recommending the use of VC were published in September of 2019 and likely contribute to the low use of VC during mucosal inspection [4]. However, this is less likely to impact the association between use of VC and years after practice as it impacted all endoscopist in this study.

The current study also underscores that endoscopists also often do not document key aspects of a quality exam despite having performed them (as identified by video review). At our institution, endoscopy reports are generated using a dedicated endoscopy writer (Provation, Minneapolis, Minnesota, United States) which utilizes drop-down lists and free text to generate reports. Development of a standardized template for BE surveillance prompting documentation of critical aspects of the exam may increase adherence to clinical documentation. Implementation of standardized templates have been shown to improve the completeness of procedural reports in colonoscopies and upper endoscopies [15]. Furthermore, a recent study by Yen et al. demonstrated that the use of standardized software templates improved adherence to guideline-based recommendations for patients who underwent endoscopy for an upper gastrointestinal bleed [16]. Standardized reporting may also allow for routine quality audits to promote adherence to guideline recommendations for surveillance exams, similar to the use of adenoma detection rate in colorectal cancer [17]. Following this study, a standardized template for BE screening and surveillance exams was developed and has been implemented at the study institution in an attempt to improve adherence rates.

Shortcomings with clinical documentation have also been described in colorectal surgery where narrative operative reports adequately captured key operative moments in only 52.5% of cases [18]. Implementation of intraoperative video capturing of predefined operative steps increased the adequacy of documentation to 85.1% ($P < 0.001$) when used as an adjunct with the narrative operative report [18]. Routine video recording of BE surveillance exams in addition to standard photo-documentation may improve the adequacy and accuracy of procedural reports. Furthermore, the addition of video docu-

mentation to a written report may deter inappropriate documentation by physicians as key aspects of the exam will have a corresponding video recording. Advancements in artificial intelligence (AI) may help increase the quality of endoscopic surveillance exams. An AI system developed at the University of Oxford was able to identify anatomic landmarks and measure the extent of BE up to a millimeter scale with small relative errors compared to expert endoscopists, 8% (3.6 mm) and 7% (2.8 mm) for C and M scores, respectively [19]. The AI system also possessed the ability to map the location and distance between esophageal biopsies which may increase endoscopist adherence to the SP [19].Identifying interventions that improve adherence to quality metrics in BE surveillance will foster high-quality endoscopic exams, potentially improve dysplasia detection rates and reduce the incidence of PEEC.

There are limitations to this study because it was retrospective and conducted at a single academic institution, and the adherence rates of endoscopists reported in this study may not be generalizable. A single endoscopist performed 24.6% of the endoscopic surveillance exams, which may bias associations between endoscopist characteristics and adherence rates. In addition, the median number of surveillance exams performed by an endoscopist was only three; however, this split represents many academic practices with more esophageal subspecialization. Furthermore, our study is at risk for observer bias because all endoscopists were aware that they were being recorded and true adherence rates may be lower than reported. The decision to evaluate adherence to QI and BP for BE surveillance was decided after conclusion of the study period which likely minimizes this impact. Overall interrater reliability was good, but fair when evaluating mucosal changes consistent with BE. This was likely related to challenges determining if a short segment of BE extended to 1 cm based on video review alone. To ensure video review was optimized, we included a formal train the trainer session during which all questions and ambiguity were discussed.

Formalized educational programs may help endoscopists remain current with updated clinical guidelines, particularly as more gastroenterologists have subspecialized practices. A prospective study by Ooi and others reported a significant increase in SP and Prague classification adherence in endoscopists who received formal training in BE and maintained dedicated BE surveillance sessions [20]. Furthermore, detection of dysplasia or EAC was significantly higher in the trained endoscopists (18% vs 8%, P <0.001) compared to the non-specialist cohort [20]. The AQUIRE trial was the first randomized controlled trial investing the impact of educational interventions on the quality of BE exams [21]. Endoscopists randomized to receive the educational intervention demonstrated a significant increase in compliance to the SP (absolute improvement, 8.4%, P <0.01) compared with those who continued the standard of care (absolute difference, –0.1%, P = 0.95) at 6 months, however no difference in dysplasia detection rate was observed [21].

Conclusions

The current video-based assessment underscores a continued need for education and training for performance of a high-quality exam for screening and surveillance of BE. The use of video and procedural documentation also suggests the problem may be worse with certain QI/BP documented and not performed. Further studies assessing the impact of formalized educational efforts on improving adherence to QI and BP with the intent of improving neoplasia detection are needed.

Conflict of Interest

RNK is a consultant for Boston Scientific, Medtronic, and Neptune Medical. SK is a consultant for Boston Scientific, Endogastric Solutions, Ethicon, and Castle Biosciences. The remaining authors have no conflicts of interest to disclose.

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