🎋 Thieme

Diagnosis and management of Barrett esophagus: European Society of Gastrointestinal Endoscopy (ESGE) Guideline

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🌐 Supplementary material
Supplementary material is available under https://doi.org/10.1055/a-2176-2440

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MAIN RECOMMENDATIONS

MR1 ESGE recommends the following standards for Barrett esophagus (BE) surveillance:

– a minimum of 1-minute inspection time per cm of BE length during a surveillance endoscopy

– photodocumentation of landmarks, the BE segment including one picture per cm of BE length, and the esophagogastric junction in retroflexed position, and any visible lesions

– use of the Prague and (for visible lesions) Paris classification

– collection of biopsies from all visible abnormalities (if present), followed by random four-quadrant biopsies for every 2-cm BE length.

Strong recommendation, weak quality of evidence.

MR2 ESGE suggests varying surveillance intervals for different BE lengths. For BE with a maximum extent of ≥1 cm and <3 cm, BE surveillance should be repeated every 5 years. For BE with a maximum extent of ≥3 cm and <10 cm, the interval for endoscopic surveillance should be 3 years. Patients with BE with a maximum extent of ≥10 cm should be referred to a BE expert center for surveillance endoscopies.

For patients with an irregular Z-line/columnar-lined esophagus of <1 cm, no routine biopsies or endoscopic surveillance are advised.

Weak recommendation, low quality of evidence.

MR3 ESGE suggests that, if a patient has reached 75 years of age at the time of the last surveillance endoscopy and/or the patient's life expectancy is less than 5 years, the discontinuation of further surveillance endoscopies can be considered.

Weak recommendation, very low quality of evidence.

MR4 ESGE recommends offering endoscopic eradication therapy using ablation to patients with BE and low grade dysplasia (LGD) on at least two separate endoscopies, both confirmed by a second experienced pathologist.

Strong recommendation, high level of evidence.

MR5 ESGE recommends endoscopic ablation treatment for BE with confirmed high grade dysplasia (HGD) without visible lesions, to prevent progression to invasive cancer.

Strong recommendation, high level of evidence.

MR6 ESGE recommends offering complete eradication of all remaining Barrett epithelium by ablation after endoscopic resection of visible abnormalities containing any degree of dysplasia or esophageal adenocarcinoma (EAC).

Strong recommendation, moderate quality of evidence.

MR7 ESGE recommends endoscopic resection as curative treatment for T1a Barrett's cancer with well/moderate differentiation and no signs of lymphovascular invasion.

Strong recommendation, high level of evidence.

MR8 ESGE suggests that low risk submucosal (T1b) EAC (i.e. submucosal invasion depth ≤500 μm AND no [lympho]vascular invasion AND no poor tumor differentiation) can be treated by endoscopic resection, provided that adequate follow-up with gastroscopy, endoscopic ultrasound (EUS), and computed tomography (CT)/positrion emission tomography-computed tomography (PET-CT) is performed in expert centers.

Weak recommendation, low quality of evidence.

MR9 ESGE suggests that submucosal (T1b) esophageal adenocarcinoma with deep submucosal invasion (tumor invasion >500 μm into the submucosa), and/or (lympho)vascular invasion, and/or a poor tumor differentiation should be considered high risk. Complete staging and consideration of additional treatments (chemotherapy and/or radiotherapy and/or surgery) or strict endoscopic follow-up should be undertaken on an individual basis in a multidisciplinary discussion.

Strong recommendation, low quality of evidence.

MR10 a ESGE recommends that the first endoscopic follow-up after successful endoscopic eradication therapy (EET) of BE is performed in an expert center.

Strong recommendation, very low quality of evidence.

b ESGE recommends careful inspection of the neo-squamocolumnar junction and neo-squamous epithelium with high definition white-light endoscopy and virtual chromoendoscopy during post-EET surveillance, to detect recurrent dysplasia.

Strong recommendation, very low level of evidence.

c ESGE recommends against routine four-quadrant biopsies of neo-squamous epithelium after successful EET of BE.

Strong recommendation, low level of evidence.

d ESGE suggests, after successful EET, obtaining four-quadrant random biopsies just distal to a normal-appearing neo-squamocolumnar junction to detect dysplasia in the absence of visible lesions.

Weak recommendation, low level of evidence.

e ESGE recommends targeted biopsies are obtained where there is a suspicion of recurrent BE in the tubular esophagus, or where there are visible lesions suspicious for dysplasia.

Strong recommendation, very low level of evidence.

MR11 After successful EET, ESGE recommends the following surveillance intervals:
– For patients with a baseline diagnosis of HGD or EAC:
at 1, 2, 3, 4, 5, 7, and 10 years after last treatment, after which surveillance may be stopped.

– For patients with a baseline diagnosis of LGD:
at 1, 3, and 5 years after last treatment, after which surveillance may be stopped.
Strong recommendation, low quality of evidence.

ABBREVIATIONS

AAC	acetic acid chromoendoscopy
AE	adverse event
APC	argon plasma coagulation
BE	Barrett esophagus
BE-IND	indefinite for dysplasia in a patient with BE
CE IM	complete eradication of intestinal metaplasia
CT	computed tomography
EAC	esophageal adenocarcinoma
EET	endoscopic eradication therapy
EMR	endoscopic mucosal resection
ER	endoscopic resection
ESD	endoscopic submucosal dissection
ESGE	European Society of Gastrointestinal Endoscopy
EUS	endoscopic ultrasound
GERD	gastroesophageal reflux disease
HGD	high grade dysplasia
IHC	immunohistochemistry
IM	intestinal metaplasia
LNM	lymph node metastasis
MDM	methylated DNA marker
NBI	narrow-band imaging
NLR	neutrophil-to-lymphocyte ratio
NSAID	nonsteroidal anti-inflammatory drug
OR	odds ratio
PDT	photodynamic therapy
PET	positron emission tomography
PPI	proton pump inhibitor
RFA	radiofrequency ablation
TTF-3	Trefoil-factor 3
WLE	white-light endoscopy

SCOPE AND PURPOSE
This Guideline is an official statement of the European Society of Gastrointestinal Endoscopy (ESGE). It is an update of the previous (2017) Position Statement on the endoscopic management of Barrett esophagus.

1 Introduction

In 2017, the European Society of Gastrointestinal Endoscopy (ESGE) published their first Position Statement on the endoscopic management of Barrett esophagus (BE) [1]. The purpose of that document was to optimize patient management according to the best scientific evidence, and to harmonize the diagnosis and care for patients with BE.

Since the publication of the Position Statement, new evidence has emerged on various aspects of BE management. Therefore, the 2017 Position Statement on the endoscopic management of BE was updated, using a systematic review methodology. Additional recommendations were formulated on the screening, surveillance, and management of BE. The aim of this document is to deliver a practical guide, even when supporting evidence is weak [2].

2 Methods

The ESGE commissioned this Guideline (Guideline Committee Chair, K.T.) and appointed a Guideline Leader (B.W.). In October 2021, an invitational email to join the guideline group was sent out to several key opinion leaders in the field of BE and BE-related neoplasia. Individual ESGE members were informed about this Guideline revision and were asked to apply if they were interested in contributing to the Guideline. Seven individual members (E.C., M.B.*, R.E.P., A.R., G.F.-E., M.J., and F.B.-S.) were selected based on their expertise and scientific output. Finally, a guideline group was formed comprising of 20 members.

All guideline group members reviewed all of the statements in the 2017 ESGE Position Statement on the endoscopic management of BE to identify statements on which new evidence had emerged since its date of publication, and determine which statements could be retained. In addition, all guideline group members were asked to identify potential new areas to be covered in the revised guideline. In total, six statements from the 2017 Position Statement on the endoscopic management of BE were retained. These statements are listed in ▶ **Table 1**.

Six taskforces were created, based on the input of the guideline group members: chemoprevention, screening and case finding, surveillance, pathology sampling and risk stratification, treatment, and management after endoscopic treatment. A taskforce leader was appointed for each of these (M.D.-R., M.C.W.S., R.B., M.d.P., O.P., and R.E.P., respectively) and group members were assigned to one or more taskforces (**Appendix 1 s**, see online-only Supplementary Material).

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* M.B. represented the Société Française d'Endoscopie Digestive

▶ Table 1 Statements preserved from the 2017 ESGE Position Statement on the endoscopic management of Barrett esophagus (BE) [1].

1	The diagnosis of BE is made if the distal esophagus is lined with columnar epithelium with a minimum length of 1 cm (tongues or circular) containing intestinal metaplasia at histopathological examination
2	The diagnosis of any degree of dysplasia (including "indefinite for dysplasia") in BE requires confirmation by an expert gastrointestinal (GI) pathologist
3	Patients with a diagnosis of "indefinite for dysplasia" confirmed by a second expert GI pathologist should be managed with optimization of antireflux medication and repeat endoscopy at 6 months. If no definite dysplasia is found in subsequent biopsy samples (including if the biopsies are again classified as "indefinite for dysplasia"), then the surveillance strategy should follow the recommendation for nondysplastic BE
4	Patients with LGD on random biopsies confirmed by a second expert GI pathologist should be referred to a BE expert center. A surveillance interval of 6 months after confirmed LGD diagnosis is recommended. i) If no dysplasia is found at the 6-month endoscopy, the interval can be broadened to 1 year. After two subsequent endoscopies negative for dysplasia, standard surveillance for patients with nondysplastic BE can be initiated. ii) If a confirmed diagnosis of LGD is found in the subsequent endoscopies, endoscopic ablation should be offered.
5	Prophylactic endoscopic therapy (such as ablation therapy) for non-neoplastic BE should not be performed
6	All patients with a BE ≥ 10 cm, a confirmed diagnosis of LGD, HGD, or early cancer should be referred to a BE expert center for surveillance and/or treatment. A BE expert center should meet the following requirements: (i) annual case load of ≥ 10 NEW patients with endoscopic treatment for HGD or early carcinoma per BE expert endoscopist (ii) endoscopic and histologic care is provided by endoscopists and pathologists who have followed additional training in this field (either by courses or guest visits) – a minimum of 30 supervised cases of endoscopic resection and 30 cases of endoscopic ablation should be performed to acquire competence in technical skills, management pathways, and complications (iii) patients with Barrett's neoplasia are discussed in multidisciplinary meetings (iv) access to experienced esophageal surgery (v) all patients with BE are registered prospectively in a database

LGD, low grade dysplasia; HGD, high grade dysplasia.

The kick-off meeting for this guideline was held virtually using an online platform on November 22, 2021. Clinical questions were formulated, and subsequently translated into research questions. The research questions followed the PICO format (P, population in question; I, intervention; C, comparator; and O, outcomes of interest) where appropriate. Systematic literature searches were performed using MEDLINE, Embase, and the Cochrane library. Evidence levels and recommendation strengths were assessed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) system [3]. Further details on the methodology of ESGE guidelines have been reported elsewhere [2].

The results of data extraction are available in the evidence tables viewable at the ESGE website: https://www.esge.com/assets/downloads/pdfs/guidelines/a_2176_2440_Evidence_tables.pdf. Available literature, draft recommendations, and strength of evidence were discussed during a face-to-face meeting at Schiphol Airport, Amsterdam on September 24, 2022. Subsequently, further refinement of the recommendations was carried out using an online voting platform (https://docs.google.com/forms). Voting was based upon a five-point Likert scale (1, strongly disagree; 2, disagree; 3, neither disagree nor agree; 4, agree; 5, strongly agree). All respondents were invited to leave comments supporting their votes, on the basis of which the recommendations were adjusted. In total, two iterations of the online voting process were needed to reach the final document.

In April 2023, a draft prepared by B.W. and R.E.P. was sent to all group members. A revised version was drafted based on the feedback received. After the agreement of all group members had been obtained, the manuscript was reviewed by the ESGE Guideline Committee Chair (K.T.) and two external reviewers, and was sent for further comments to the ESGE national societies and individual members. After this, it was submitted to *Endoscopy* for publication. All participants declared any potential conflicts of interest.

3 Background

BE is a condition in which the distal esophagus is lined with columnar epithelium with a minimum length of 1 cm (either tongues or circumferentially) containing intestinal metaplasia (IM) on histopathologic examination (▶ Table 1) [1].

BE has an estimated prevalence of up to 1%–2% based on two large population-based studies from Europe and two systematic reviews. In those with chronic gastroesophageal reflux disease (GERD) symptoms, it may increase to 8%–13% [4–9], although a recent prospective screening study in patients aged 50 years or older with GERD symptoms also demonstrated a prevalence of 2% [10]. BE is a condition predisposing to esophageal adenocarcinoma (EAC). Although the risk of progression to high grade dysplasia (HGD) or EAC is low (0.3%–0.8% per year [11–13]), in most countries patients with BE are managed with endoscopic surveillance at regular intervals, because the consequences of a diagnosis of invasive adenocarcinoma are severe with high lethality and treatment-associated morbidity.

4 Chemoprevention

> **RECOMMENDATION 1**
>
> **a** ESGE suggests a proton pump inhibitor (standard dose* once daily) for chemoprevention in patients with BE.
> Weak recommendation, moderate quality of evidence.
>
> **b** ESGE recommends against the use of aspirin or non-steroidal anti-inflammatory drugs (NSAIDs) for chemoprevention.
> Strong recommendation, moderate quality of evidence.

It is widely accepted that BE and EAC are related to GERD. Proton pump inhibitors (PPIs), through their acid-suppressive effects and potential antioxidant and anti-inflammatory effects, may potentially prevent carcinogenesis [15]. In patients with BE, PPIs are primarily indicated for their control of reflux symptoms. There is however increasing evidence that PPIs may have a chemopreventive effect among BE patients based on five systematic reviews including meta-analyses of observational studies and one multicenter randomized controlled trial (RCT) [16–21].

In a large meta-analysis of 12 observational studies with 155 769 subjects, PPI use was associated with a two-fold risk reduction of BE progression to HGD/EAC (odds ratio [OR] 0.47, 95 %CI 0.32–0.71) [19].

The AspECT trial enrolled 2557 BE patients who were followed up for a median of 8.9 years and received high dose (40 mg twice daily) or low dose (20 mg once daily) PPI, with or without aspirin [20]. This trial demonstrated that high dose PPI is superior to low dose PPI in the primary composite end point of time to all-cause mortality or development of HGD or EAC (time ratio [TR] 1.27, 95 %CI 1.01–1.58), with a number needed to treat of 34. In fact, combining high dose PPI with aspirin had the strongest effect compared with low dose PPI without aspirin (TR 1.59, 95 %CI 1.14–2.23), suggesting an additive effect, whereas differences in the primary end point between aspirin and no aspirin failed to reach a statistically significant difference. However, despite being well conducted, this trial did not include a no-PPI group, and used a composite end point including all-cause mortality. Therefore, based on the AspECT trial, no conclusion can be drawn about the effect of high dose PPI or aspirin on cancer progression and their use as chemopreventive agents.

Long-term PPI administration has garnered interest with regards to potential side effects; however, most associations have failed to demonstrate conclusive evidence and/or document a causal relationship. The structural and functional changes in the gastric mucosa, the increased risk of enteric infections, and the potential interference with the absorption of vitamin B$_{12}$, magnesium, and calcium are putative associations that need further confirmation [22]. In fact, these associations have recently been studied in a randomized, double-blind trial of 17 598 patients who received either PPI or placebo and were followed up for 3.01 years. This trial demonstrated no associations, except for enteric infections (OR 1.33, 95 %CI 1.01–1.75) [23]. In addition, the aforementioned AspECT trial demonstrated a favorable safety profile for high dose PPI [20].

In summary, GERD symptom control and reflux esophagitis healing are clear indications for PPI. A secondary benefit from curtailing mucosal inflammation with regard to neoplastic disease progression is plausible and studies support this contention. Further study is required to determine if the use of PPI for chemoprevention is most efficacious in patient groups at higher risk of progression (e. g. male sex, long BE segment, family history). Given the required cohort sizes to draw meaningful conclusions, these data are most likely to come from real-world data.

Other agents, such as statins, metformin, bisphosphonates, nonsteroidal anti-inflammatory drugs (NSAIDs), and ursodeoxycholic acid, have insufficient evidence for their role in chemoprevention in BE patients.

5 Screening and case finding

> **RECOMMENDATION 2**
>
> **a** ESGE recommends against screening for BE in an unselected population.
> Strong recommendation, low quality of evidence.
>
> **b** ESGE suggests that case finding for BE could be considered in a select population, consisting of patients ≥ 50 years of age with a history of chronic GERD symptoms, and at least one of the following risk factors (white ethnicity, male sex, obesity, smoking, having a first-degree relative with BE or EAC).
> Weak recommendation, low quality of evidence.

Screening for BE or EAC in an unselected population is not recommended because of the relatively low risk in the general population, the estimated prevalence in a general population being up to 1 %–2 % [4–9], with an annual risk of progression to HGD or EAC of 0.3 %–0.8 % [11–13]. Therefore, the (cost)effectiveness of BE screening programs has been disputed [24–26]. The ESGE suggests that, if screening is considered, it should be limited to a select population with a high anticipated BE prevalence in order to be acceptable and cost-effective.

The prevalence of BE in individuals with known risk factors has recently been assessed in a systematic review and meta-analysis by Qumseya et al. [27]. BE prevalence was low (0.8 %) in individuals without GERD symptoms. A higher prevalence was found in individuals with known risk factors for BE, such as family history of BE/EAC (23 %), male sex (6.8 %), age > 50 years (6.1 %), GERD (2.3 %), and obesity (1.9 %). Also, the prevalence in patients with GERD symptoms and one additional risk factor

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* Standard PPI dose for the indication "severe esophagitis" is omeprazole 40 mg or its dose equivalent (pantoprazole 40 mg, esomeprazole 40 mg, rabeprazole 20 mg, or lansoprazole 30 mg) [14].

was significantly higher (12.2%) than in individuals with GERD symptoms alone. A positive linear relationship was shown between BE prevalence and the number of risk factors, increasing the prevalence of BE by 1.2% for each additional risk factor. These data support the concept of case finding of BE in select individuals with GERD symptoms and at least one additional risk factor. It must be noted that approximately 50%–60% of all BE cases occur in patients without GERD symptoms [28, 29]. These patients will be missed when adhering to the currently suggested strategies for screening and case finding, because these all require GERD symptoms as an indication for screening. However, given the large population of individuals without GERD symptoms, all-comer screening would lead to substantial economic costs.

The cost-effectiveness of screening programs may be improved by using prediction tools that incorporate multiple risk factors (i.e. GERD symptoms, white ethnicity, obesity, male sex, age ≥50 years, smoking, family history) to select patients for screening. Such prediction tools have already been studied [30] but, because these were retrospective analyses, additional prospective studies using questionnaires or electronic tools are needed before clinical implementation can be considered. Finally, new screening modalities that do not require sedation may be more cost-effective than screening with standard sedated endoscopy [26]. With the implementation of such modalities, the indications for BE screening/case finding may be expanded in the future.

5.1 Nonendoscopic technologies

> **RECOMMENDATION 3**
> ESGE recommends that a swallowable nonendoscopic cell collection device such as the Cytosponge, combined with a cytopathologic assessment and biomarker Trefoil-factor 3 (TFF3) can be used as an alternative to endoscopy for case finding of BE. Other nonendoscopic technologies cannot yet be recommended.
> Strong recommendation, high quality of evidence for Cytosponge, low quality of evidence for other nonendoscopic technologies.

There has been a recent emergence of minimally invasive, nonendoscopic cell sampling devices that can be administered in an office-based setting, typically by a trained nurse. Most of the evidence to date is for swallowable esophageal sampling devices that are encapsulated and expand when the capsule dissolves, such as the Cytosponge (Medtronic, Watford, UK) and EsophaCap, or an inflatable silicon balloon, such as the EsoCheck. These devices are deployed to the upper stomach and withdrawn orally, and the samples obtained are sent to a central laboratory for processing. The samples are then tested for biomarkers to assess for the presence of BE: hematoxylin and eosin (H&E) coupled with immunohistochemistry (IHC) for Trefoil-factor 3 (TFF3) is used to detect IM (Cytosponge) [10, 31, 32]; combined cytopathology and IHC for MUC2 to detect IM (EsophaCap) [33]; or a quantitative polymerase-based assay is used to detect a panel of methylated DNA markers (MDMs) to predict the presence of BE mucosa (EsophaCap and EsoCheck) [34–38].

Among these technologies, by far the largest body of evidence pertains to the Cytosponge, which has been rigorously tested in both observational case–control studies and a randomized trial in the intended screening population. A recent trial, the Barrett Esophagus Screening Trial 3 (BEST3), a multicenter, pragmatic RCT that was conducted in over 13 000 individuals from >100 primary care practices in the UK, showed that the offer of a Cytosponge test was associated with a 10-fold higher rate of diagnosis of BE compared with usual care among a screening population reporting symptoms of reflux disease and taking a PPI [10]. As a secondary outcome, those randomized to the Cytosponge group also had more dysplastic BE (n=5) and early stage EAC (n=4) diagnosed, compared with usual care, suggesting that screening using the Cytosponge could lead to earlier stage disease diagnosis, although the study was not powered for this analysis. In addition, it was shown that the interpretation of TFF3 positivity could be performed in an automated manner, thereby significantly reducing pathologist workload [39]. Further, modelling studies suggest Cytosponge TFF3-based screening to be cost-effective when used on a hypothetical population of white individuals aged ≥50 years with acid reflux symptoms [40, 41].

Other nonendoscopic technologies such as the EsophaCap [34, 36–38], EsoCheck [35], and Cytosponge combined with MDMs [42] have also shown significant promise, although their evidence to date has been limited to small observational studies in enriched populations. Studies to test these technologies on a screening population are ongoing.

For a further discussion of potential alternative screening and case finding modalities, please refer to **Appendix 2s**. A detailed discussion of the effect of a positive family history of BE/EAC on the prevalence of BE is provided in **Appendix 3s**.

6 Surveillance

In accordance with the 2017 ESGE Position Statement on the endoscopic management of BE, the Working Group recommends endoscopic surveillance of patients with BE [1]. However, for the individual patient, patient factors should explicitly be taken into consideration, such as co-morbidity, life expectancy, and patient preferences. The Working Group wishes to underscore that BE surveillance is only indicated if detection of dysplasia or EAC would reasonably impact a patient's management.

A flowchart showing the recommended BE surveillance intervals, biopsy practice, and when to refer a patient to a BE expert center is provided in ▶ **Fig. 1**.
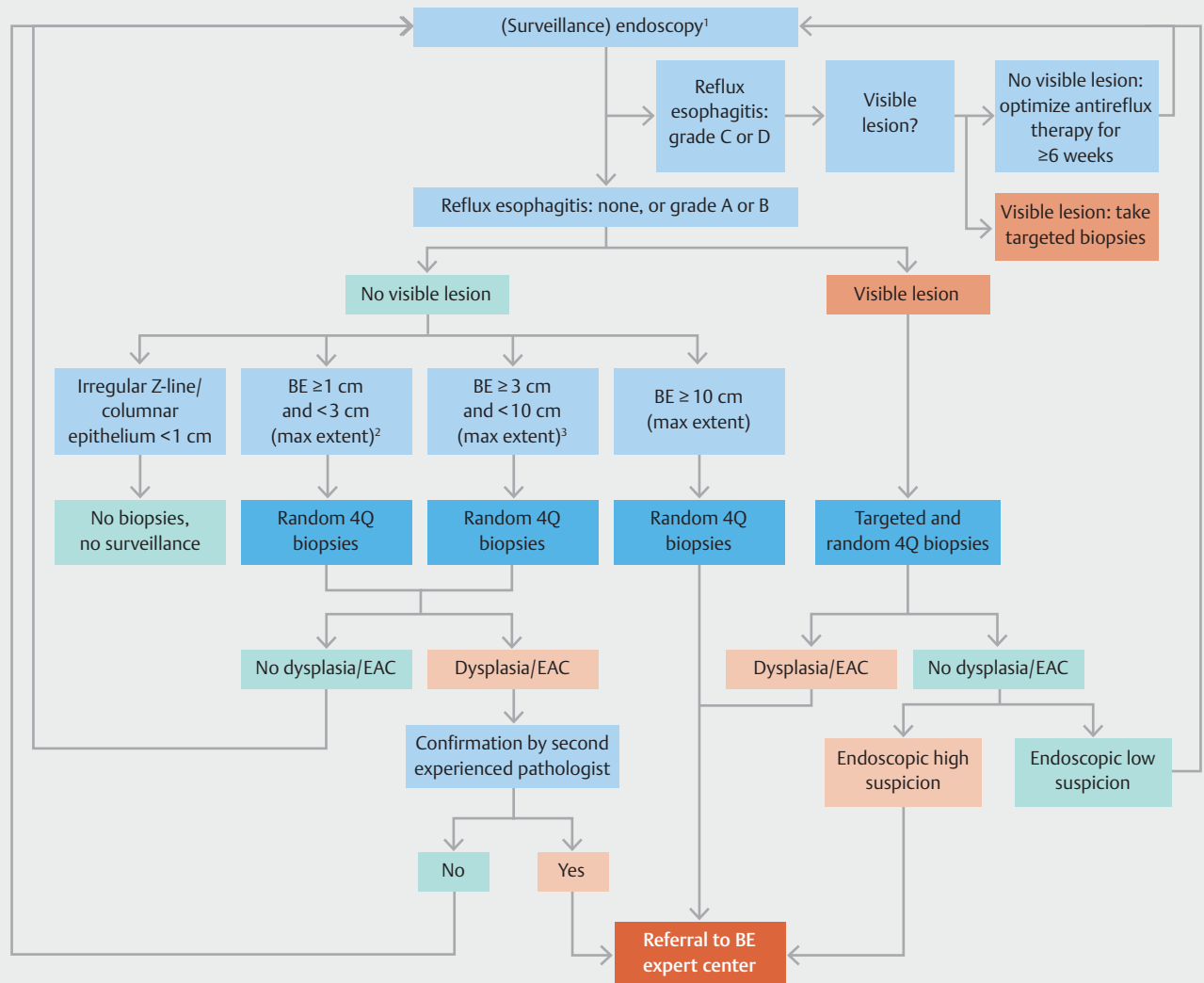
▶ **Fig. 1** Flowchart of the recommended surveillance for patients with Barret esophagus (BE).
4Q, four quadrant; EAC, esophageal adenocarcinoma.
[1] Consider stopping surveillance if a patient has reached the age of 75 at the time of the last surveillance endoscopy.
[2] Surveillance interval 5 years.
[3] Surveillance interval 3 years.

6.1 Endoscopy equipment and (virtual) chromoendoscopy

RECOMMENDATION 4

a ESGE recommends the use of high definition endoscopy for endoscopic surveillance of BE.
Strong recommendation, low quality of evidence.

b ESGE suggests the use of chromoendoscopy (acetic acid and/or virtual chromoendoscopy) for endoscopic surveillance of BE.
Weak recommendation, low quality of evidence.

High definition endoscopy systems (endoscope, processor, and screen) provide superior image resolution and are widely available; however, the role of high definition endoscopy systems in BE surveillance is based on limited low quality studies. In a retrospective study, a high definition endoscopy system was superior to a standard definition system in detecting dysplastic lesions, and in detecting HGD or cancer on random and targeted biopsies [43]. Given its inferior imaging quality and limited biopsy sampling capability, transnasal endoscopy should not be used for BE surveillance.

With regard to narrow-band imaging (NBI), there are studies demonstrating a significantly higher rate of dysplasia detection with fewer biopsies when the use of NBI is compared with standard resolution white-light endoscopy (WLE) [44], but no

differences in detection rate when NBI is compared with high definition WLE with four-quadrant biopsies [45].

Acetic acid chromoendoscopy (AAC) has been studied for its usefulness to detect Barrett neoplasia in several studies [46]. Longcroft-Wheaton et al. reported on a feasibility study in which patients scheduled for BE surveillance underwent two gastroscopies 6–8 weeks apart: one regular endoscopy with random biopsies according to the Seattle protocol, and one endoscopy using AAC with AAC-targeted biopsies only. The authors found a similar dysplasia/EAC detection rate between the two protocols, with a significant reduction in the number of biopsies in the AAC arm [47]; however, larger studies are needed.

Although the evidence to support the use of (virtual) chromoendoscopy is weak, the Working Group favors its use. Currently, all of the high definition endoscopy systems are equipped with virtual chromoendoscopy, and the use of AAC is associated with very limited additional costs. An important additional advantage is that the use of virtual chromoendoscopy and AAC requires decent cleaning of the esophagus. In addition, the use of (virtual) chromoendoscopy is generally associated with an extra pull through, which translates to increased inspection time. These factors, apart from the possible intrinsic properties of (virtual) chromoendoscopy, might improve quality in BE surveillance.

Evidence that these techniques can replace the Seattle protocol in a standard surveillance setting is still lacking. Therefore, it is recommended that these techniques be used prior to and in addition to Seattle protocol biopsy sampling.

Additional considerations on the role of virtual chromoendoscopy with NBI, blue-light imaging, and i-SCAN in surveillance of patients with BE are provided in **Appendix 4s**.

6.2 Artificial intelligence in BE surveillance

ESGE has recently published a Position Statement on the expected value of AI in gastrointestinal (GI) endoscopy [48]. It is anticipated that AI will improve the quality of routine endoscopy. In view of the fact that many lesions are missed on referral or in daily practice [49,50], expectations after the first pilot study to improve this outcome are high. The value of AI in BE surveillance lies not in exceeding expert performance but in raising routine practice to expert level performance. Different research groups have demonstrated high sensitivities of AI systems for detecting dysplasia/EAC during real-time endoscopy, ranging from 83.7 % to 95.4 % [51–53]. Two systematic reviews and meta-analyses have indicated high detection performances, ranging between 88 % and 96 % [54,55]. Nonetheless, most studies are pilot feasibility studies in enriched populations, and therefore more evidence is needed before AI can be generally accepted as an adjunct to – or a replacement of – the Seattle biopsy protocol during surveillance. At the advent of the launch of commercial devices, emphasis must remain on basic endoscopy quality standards with regard to technical performance and cleaning of the esophagus: if the lesion is not adequately shown to the system because of hurried pull through, insufficient insufflation, or insufficient cleaning, AI will not be of any help.

6.3 Quality standards and pathology sampling

> **RECOMMENDATION 5**
> ESGE recommends the following standards for BE surveillance:
> - a minimum of 1-minute inspection time per cm of BE length during a surveillance endoscopy
> - photodocumentation of landmarks, the BE segment including one picture per cm of BE length, and the esophagogastric junction in retroflexed position, and any visible lesions
> - use of the Prague and (for visible lesions) Paris classification
> - collection of biopsies from all visible abnormalities (if present), followed by random four-quadrant biopsies for every 2-cm BE length.
> Strong recommendation, weak quality of evidence.

The Working Group underscores the importance of adherence to the Performance Measures mentioned in the ESGE Position Paper statement on quality metrics in upper GI endoscopy [56]. In addition, endoscopy reports should be complete, including: (i) the location of the esophagogastric junction and diaphragmatic pinch; (ii) the circular and maximum extent of the BE segment, according to the Prague classification, and location of any islands proximal to the maximum BE segment extent; (iii) a description of location (in cm from the incisors and clockwise orientation) of any visible abnormality within the Barrett epithelium, in addition to lesion size (mm) and macroscopic appearance using the Paris classification; (iv) the presence or absence of erosive esophagitis using the Los Angeles classification [1].

There are no randomized controlled data supporting a minimum inspection time for BE surveillance; however, a few retrospective studies suggest an increase in dysplasia detection with longer BE inspection times [57,58]. Even more important than inspection time is what endoscopists do during the time they are inspecting. Proper inspection includes cleaning of the esophagus, multiple pull throughs with both high definition WLE and (virtual) chromoendoscopy, as well as accurate photodocumentation of landmarks and the BE segment. If this is applied consistently, BE inspection time easily exceeds 1 minute per cm of BE length prior to biopsy taking.

Biopsy samples should be taken of all visible mucosal abnormalities. One to two biopsies, targeted on the most suspicious part of the lesion, are considered enough for lesions (Paris type 0-I, 0-II) that are potentially amenable to endoscopic resection (ER) in order to confirm the diagnosis and not compromise subsequent ER [59]. In addition, random four-quadrant biopsies should be collected every 2 cm within the Barrett segment, starting from the upper end of the gastric folds. Biopsies from each level are preferably collected in separate, marked containers. Several studies have indicated low compliance with guidelines with regard to obtaining a sufficient number of random biopsies [60–62], with lower dysplasia detection rates if

the Seattle biopsy protocol was not adhered to [63]. These studies highlight points of improvement in current practice and the importance of high quality endoscopy. These standards are key to minimizing the risk of undetected lesions and avoiding redundant repeat endoscopies that are scheduled because of nonadherence to quality guidelines. This will help to reduce the carbon footprint and environmental burden of elective endoscopy [64].

In patients with reflux esophagitis grade C or D, no random biopsies should be taken, and BE surveillance endoscopy should be repeated at least 6 weeks after optimization of antireflux therapy. However, even in the presence of severe reflux esophagitis, a careful inspection of the BE segment is warranted and targeted biopsies of suspected lesions are still recommended (▶ Fig. 1).

The Working Group feels that it is essential to allocate at least 30 minutes to surveillance procedures, preferably in well-sedated patients, in order to allow for adequate inspection time, photodocumentation, and biopsy sampling, increasing to 40 minutes for ultralong BE segments [58].

RECOMMENDATION 6

a ESGE recommends the use of p53 immunohistochemistry to support reproducibility of dysplasia diagnosis and aid the assessment of atypia of uncertain significance.
Strong recommendation, moderate level of evidence.

b ESGE does not recommend routine use of molecular biomarkers in patients with no evidence of dysplasia.
Weak recommendation, low to very low level of evidence.

The use of biomarkers on esophageal biopsies/brushing material has the potential to improve clinical decision-making, and simulation studies suggest that the introduction of biomarker-guided management strategies may be cost-effective compared with the standard of care [65–68].

In terms of direct applicability to routine practice, to date, most available evidence in this field pertains to p53 measured by IHC on esophageal biopsies or esophageal cytology material. p53 IHC is a relatively inexpensive biomarker that tightly correlates with *TP53* mutation status. p53 IHC already forms part of the existing diagnostic arsenal and can be easily integrated into routine clinical practice [69]. *TP53* is the most commonly mutated gene in EAC, occurring as early as the premalignant dysplastic stages [70]. Several studies have shown that p53 IHC can serve as an adjunct test to establish the presence of dysplasia and increase interobserver agreement [71–74]. In recent studies, the use of p53 immunostaining significantly improved interobserver agreement and the percentage of correct diagnoses among both experienced and nonexperienced BE pathologists [75–77].

In addition, p53 IHC may also help to better define the presence or absence of dysplasia in Barrett patients considered as "indefinite for dysplasia" (BE-IND) [75,77,78]. In a recent study, the diagnosis of BE-IND was reduced by over 40%, and more than half of cases previously designated as BE-IND were reclassified as nondysplastic after p53 IHC slides were evaluated [77]. In a multicenter randomized crossover study, the presence of molecular biomarkers (p53 and aneuploidy) in biopsies targeted by image-enhanced endoscopy improved diagnostic accuracy for dysplasia [79]. In summary, there is now clear evidence that p53 IHC increases the reproducibility of histopathologic dysplasia diagnosis and aids in the assessment of atypia of uncertain significance in the context of BE surveillance biopsies.

Recently, a novel 3-tier 15-feature classifier (TissueCypher; Cernotics, Pittsburgh, Pennsylvania, USA) has been developed to risk stratify patients into low, intermediate, and high risk for progression. This test employs a multiplexed fluorescence imaging platform to generate quantitative and objective data on nine protein-based biomarkers implicated in different pathways that drive disease progression (company proprietary information). A recent pooled analysis of four case–control studies (552 patients) suggested that TissueCypher is predictive of progression to HGD/EAC when used as an adjunct to histopathology diagnosis and performs on a par with expert histopathology diagnosis in all BE patients. [80]. The Working Group feels that more independent studies with the gold standard as a back-to-back procedure in average-risk populations will be needed before TissueCypher can be recommended for routine clinical practice.

Other biomarkers have been investigated in the effort to identify predictors of disease behavior [81–88]. None of these are ready for implementation in clinical practice yet.

RECOMMENDATION 7

ESGE suggests that brushing techniques such as WATS³D should not be routinely used as an alternative for, or adjunct method to, conventional biopsies for tissue collection during endoscopic BE surveillance.
Weak recommendation, low level of evidence.

Tissues sampling with endoscopic brushing might have the advantage of allowing coverage of larger areas of BE epithelium compared with standard biopsies, with the potential to reduce sampling error and reduce the rate of nonadherence to the Seattle protocol. A technology recently approved and widely investigated for this purpose is the WATS³D (CDx Diagnostics, New York, New York, USA), a rigid endoscopic brush with long and hard bristles that allow deep transepithelial sampling coupled with tridimensional computer-assisted analysis, which consists of computerized neural network analysis of transepithelial cytology specimens to identify cytologic and histologic features suspicious for dysplasia, with subsequent evaluation by a trained pathologist in a centralized laboratory.

To date, the routine use of brushing techniques such as the one employed in the WATS³D technology cannot be recommended in clinical practice because of uncertainties about the clinical meaning of dysplasia detected by brushes only and the cost-effectiveness of incorporating brush sampling into BE sur-

veillance, in addition to the lack of proof that this technology could replace forceps biopsies. For a more comprehensive discussion on the topic, please refer to **Appendix 5s**.

> **RECOMMENDATION 8**
> ESGE does not recommend the use of nonendoscopic tools (swallowable cell collecting devices or blood-based biomarkers) for the surveillance of BE.
> Weak recommendation, moderate quality of evidence for swallowable cell collecting device; low quality of evidence for blood-based biomarkers.

Pilonis et al. recently reported on a retrospective study in which the Cytosponge swallowable cell collecting device was combined with a multidimensional biomarker panel encompassing cytopathologic assessment for atypia, p53 IHC, and clinical risk factors such as length of BE, sex, and age [89]. Based on findings from a training cohort (n = 557), patients were assigned a high risk category if they were found to have atypia on cytopathologic assessment, or if cell material stained positive for p53 IHC. Moderate risk was defined by the absence of atypia or negative p53 IHC, but with the presence of a longer segment length (C ≥ 3 or M ≥ 6), and age > 60 years or male sex; low risk as not meeting the criteria for high or moderate risk. When applied in a validation cohort of 344 patients (10 % of whom had HGD on biopsies), 41 % of patients classified as high risk (31/75) were shown to have HGD/EAC on biopsies, compared with 1 % (2/185) in the low risk group. When subsequently applied onto a real-world BE surveillance cohort, not enriched for dysplasia, who underwent Cytosponge surveillance during the COVID pandemic owing to unavailability of the endoscopy service, the positive predictive value for HGD/EAC of the Cytosponge was 31 % (12/39), and 44 % (17/39) for any dysplasia [89]. Although promising, larger prospective studies are required to validate the biomarker panel and, at present, this technology cannot be recommended for clinical adoption.

Over the past few years, the blood-based neutrophil-to-lymphocyte ratio (NLR) has emerged as a potentially simple and clinically applicable biomarker for risk stratification in BE. Two retrospective observational studies have shown that the NLR correlated with a diagnosis of dysplasia and could predict progression [90, 91]. Although promising, the lack of a well-defined NLR cutoff value hinders its application in a clinical setting. Larger prospective studies with longer follow-up are required to clarify the real clinical utility of this test.

Other blood-based biomarkers such as serum glycoprotein biomarkers (complement C9, gelsolin, serum paraoxonase/arylesterase 1, serum paroxonase/lactonase 3) [92], squamous cellular carcinoma antigen [93], leucocyte telomere length (measured by quantitative PCR) [94], and genetic alteration in cell-free DNA (fractional allelic loss index) [95] have shown promise in risk stratification, but so far lack sufficient evidence for their clinical adoption in the routine surveillance of BE.

6.4 Surveillance intervals

> **RECOMMENDATION 9**
> ESGE suggests varying surveillance intervals for different BE lengths. For BE with a maximum extent of ≥ 1 cm and < 3 cm, BE surveillance should be repeated every 5 years. For BE with a maximum extent of ≥ 3 cm and < 10 cm, the interval for endoscopic surveillance should be 3 years. Patients with BE with a maximum extent of ≥ 10 cm should be referred to a BE expert center for surveillance endoscopies.
> For patients with an irregular Z-line/columnar-lined esophagus of < 1 cm, no routine biopsies or endoscopic surveillance are advised.
> Weak recommendation, low quality of evidence.

RCTs on optimal surveillance strategies in BE patients are lacking and the suggested cutoff levels are arbitrary. Although adequate endoscopic surveillance has been associated with improved survival from EAC [96], the cost-effectiveness of current surveillance strategies is in doubt [97, 98]. In the absence of new data, the Working Group decided to keep the previous surveillance intervals unchanged (▶ **Fig. 1**).

Current surveillance intervals are stratified by BE length and dysplasia, as these are both accepted risk factors for disease progression. This is corroborated by several recent studies, which demonstrate significantly lower rates of neoplastic progression in patients with short-segment BE compared with long-segment BE [99–101]. The cost-effectiveness of current surveillance strategies could be further improved by reducing the frequency of surveillance in low risk patients [97, 98], but identifying low risk patients remains challenging. There is a need for improved risk stratification strategies, incorporating multiple risk factors including segment length, sex, age, smoking, and previous biopsy findings [21]. Currently, several multifactorial risk estimation tools are being studied to determine the optimal surveillance interval per individual patient, but such tools cannot yet be implemented.

Patients with an irregular Z-line should be excluded from surveillance because of their low progression risk [101, 102]. There are no data on the optimal surveillance interval for patients with an ultralong BE (≥ 10 cm), but most experts adhere to a surveillance interval of 1–2 years in such cases.

In accordance with the 2017 ESGE Position Statement on the endoscopic management of BE [1], the Working Group recommends that the diagnosis of any degree of dysplasia (including "indefinite for dysplasia") in BE requires confirmation by an experienced GI pathologist (▶ **Table 1**). Patients with a diagnosis of "indefinite for dysplasia" confirmed by a second experienced GI pathologist should be managed with optimization of anti-reflux treatment and repeat endoscopy at 6 months. If no definite dysplasia is found in subsequent biopsy samples (including if the biopsies are again classified as "indefinite for dysplasia"), the surveillance interval should follow the recommendation for nondysplastic BE.

6.5 Discontinuation of surveillance

Evidence on the optimal age cutoff for endoscopic surveillance in patients with BE is very limited. In general, it is reasonable to stop surveillance in patients who are no longer fit for repeated endoscopy or who cannot tolerate the treatment modalities needed to cure esophageal dysplasia/EAC. More importantly, endoscopic surveillance should be limited to patients who are expected to benefit from treatment of BE-related dysplasia/EAC, meaning those who are not likely to die from other causes within a few years after treatment.

There is only one modelling study available about the optimal age to stop endoscopic surveillance based on sex and co-morbidity [103]. This study found that the optimal age for last surveillance is lower in women and in patients with co-morbidities, with an optimal stop-age varying between 69 years (in women with co-morbidity) and 81 years (in men without co-morbidity). However, real-world data are missing and prospective studies are needed to validate these findings.

The age cutoff of 75 years is arbitrary, and is based on average life expectancy; hence, surveillance extension up to 80 years can be considered in individual cases.

7 Treatment

In accordance with the 2017 ESGE Position Statement on the endoscopic management of BE [1], the working group recommends against prophylactic endoscopic therapy (such as ablation therapy) for nondysplastic BE (▶ Table 1).

In accordance with the 2017 ESGE Position Statement on the endoscopic management of BE [1], the working group recommends that patients with low grade dysplasia (LGD) on random biopsies confirmed by a second experienced GI pathologist should be referred to a BE expert center. As a rule, upper GI endoscopy will be repeated in the expert center, because studies have shown that, in a significant proportion of patients with a referral diagnosis of flat BE with "invisible" LGD, more advanced pathology (HGD or EAC) is detected in a BE expert center when the endoscopy is repeated [49, 104, 105]. In the absence of visible lesions and more advanced pathology, a surveillance interval of 6 months after a confirmed LGD diagnosis is recommended.

(i) If no dysplasia is found at the 6-month endoscopy, the interval can be broadened to 1 year. After two subsequent endoscopies negative for dysplasia, standard surveillance for patients with nondysplastic BE can be initiated.

(ii) If a confirmed diagnosis of LGD is found in the subsequent endoscopies, endoscopic ablation can be offered (▶ Table 1).

For patients with LGD, the risk of progression to HGD/EAC is between 9.2 % and 13.4 % per patient per year [106–108]. A risk factor for progression is confirmation of the LGD diagnosis by at least one experienced GI pathologist [106, 107, 109]. Therefore, independent confirmation of the LGD diagnosis by an experienced GI pathologist should always be obtained. It has also been shown that the diagnosis of LGD on two or more endoscopies is associated with a higher risk for progression [109, 110]. Aberrant p53 expression is also associated with increased risk of progression; however, whether patients with a single diagnosis of LGD plus p53 aberrant expression would benefit from endoscopic eradication therapy (EET) is a point for further study. Whether multifocal LGD diagnosed on a single endoscopy is a risk factor has not been confirmed up to now [109].

Regarding the preferred method of ablation in the context of BE-related neoplasia in general, radiofrequency ablation (RFA) is the ablation method most extensively studied. RFA has proven to be safe and effective in several large prospective randomized and non-randomized studies [111–115]. Alternative treatment methods are argon plasma coagulation (APC), hybrid APC, and cryoablation (cryoballoon and cryospray). Studies have demonstrated inferior outcomes compared to RFA with APC and cryospray (56 %–79 % complete eradication of intestinal metaplasia [CE IM], 9 %–13 % strictures for APC [116, 117]; 41 %–61 % CE IM, 3 % strictures for cryospray [118–120]) and outcomes comparable to RFA for hybrid APC and cryoballoon ablation (87 % CE IM, 4 % strictures for hybrid APC [121]; 91 % CE IM, 12 % strictures for cryoballoon [122]).

Several studies have demonstrated that RFA of BE with confirmed LGD can significantly reduce the progression rate to HGD and/or EAC [113, 123, 124]. In two multicentric prospective randomized studies comparing RFA with surveillance, the risk of progression was reduced by up to 25 % [113, 123]. In contrast to the European and the US multicenter trials, a French study showed surprisingly high rates of progression of 13.5 % in the RFA arm compared with 26.2 % in the surveillance group [125]. The reason for this discrepancy might be the low rate of 35 % CE IM in the RFA arm compared with the US and European studies with CE IM rates of 77.4 % and 91 %, respectively [113, 123] and the wide range of expertise in the technology among the recruiting centers in the French trial.

The effect of cryoablation and ablation with APC in patients with LGD has been investigated in non-randomized prospective multicenter studies, which have demonstrated a protective effect of ablation against progression [122, 126]. In the US cryo-

ablation study, there was no progression in 29 patients with LGD within 12 months [122], and, in the Polish APC study, with 71 patients, no progression was observed within 2 years [126].

In specialized BE centers, close surveillance of patients with LGD does however appear to be a valid alternative to ablation in individual cases. Pouw et al. reported on the long-term follow-up of patients who were initially included in the previously mentioned RCT on RFA versus surveillance for patients with confirmed LGD [124]. During an additional follow-up time of 40 months, a total of 23/68 patients (34%) who were randomized to the surveillance arm progressed to HGD/EAC. Of these 23 patients, 22 were free of dysplasia after EET with RFA, with or without ER. In one patient, an esophagectomy was performed after ER of a poorly differentiated submucosal cancer. The esophagectomy specimen revealed no residual cancer, nor positive lymph nodes.

RECOMMENDATION 12

ESGE recommends endoscopic ablation treatment for BE with confirmed HGD without visible lesions, to prevent progression to invasive cancer.
Strong recommendation, high level of evidence.

The risk of progression from flat HGD to cancer is not clear. Two RCTs have been performed in patients with BE without visible lesions, and a diagnosis of HGD. One study randomized 63 patients to either RFA (n = 42) or sham treatment (n = 21) and reported eradication rates for IM of 73.8% and for dysplasia of 81% [123]. Among patients with HGD, 19.0% of those in the control group progressed to cancer, compared with 2.4% of those in the ablation group (P = 0.04). At 5-year follow-up of this study, the incidence of dysplasia recurrence after initial eradication of IM after RFA, was 7.3 per 100 person-years for patients with baseline HGD [127]. The second study randomized 208 patients with HGD to treatment with photodynamic therapy (PDT; n = 138) versus PPI only (n = 70). Eradication of HGD was achieved in 77% of the treatment group and 38% of the surveillance group, with progression to cancer in 13% of patients in the PDT group versus 28% in the control group (P = 0.006) [128]. The 5-year follow-up of this study demonstrated cancer progression in 15% of the PDT group, versus 29% of the control group (P = 0.004) [129]. These results suggest that ablation of flat BE with HGD significantly decreases the risk of progressing to cancer.

Different studies have studied ablation techniques to eradicate BE with dysplasia, including HGD. Two meta-analyses have demonstrated that ablation of BE is effective and safe. One systematic review and meta-analysis assessed the use of RFA and, in a total of 3802 patients, of whom 31% had HGD, eradication of all dysplasia was achieved in 85% of patients, with an annual progression risk to cancer of 0.4% [130]. Esophageal stricture was the most common adverse event (AE), being reported in 5% of patients. Another systematic review and meta-analysis evaluated cryoablation. A total of 405 patients with dysplasia, includ-

ing HGD, were included. In the high quality studies, a pooled proportion of eradication of dysplasia of 91.3% and a pooled proportion of eradication of IM of 71.6% were found [131]. AEs were reported in 12.2% patients.

RECOMMENDATION 13

ESGE recommends offering complete eradication of all remaining Barrett epithelium by ablation after endoscopic resection of visible abnormalities containing any degree of dysplasia or EAC.
Strong recommendation, moderate quality of evidence.

It has been shown that the rate of recurrence or metachronous HGD and/or EAC is up to 20%–35% after successful ER of focal lesions [117, 132, 133]. Because of this high risk of subsequent lesions, most expert centers follow the two-step strategy of ER of all visible lesions, followed by ablation of the remaining at-risk BE.

There is a lot of evidence on the effectiveness of ablation of residual BE after ER [116, 121, 134, 135]. In addition, endoscopic BE ablation is associated with few AEs. Moreover, the risk of recurrence is significantly higher if only ER is performed compared with ER followed by APC or RFA. Despite robust evidence, one should bear in mind that the majority of studies mix patients with a visible lesion and patients with flat dysplasia.

In BE centers with experience in BE management, close surveillance after ER of a dysplastic lesion/EAC in BE appears to be a valid alternative to ablation in patients who are frail or have multiple co-morbidities. A Dutch study reported on the follow-up of 94 patients with untreated residual BE (median C2M5) after ER of a lesion with LGD, HGD, or EAC [136]. During a median follow-up period of 21 months, 17 patients (18%) developed HGD or EAC: all were curatively treated endoscopically and none progressed to advanced cancer. Therefore, for all individual patients, the benefit of ablation after ER of a BE lesion should be weighed against the risks (especially strictures), costs, and the burden to the patient.

RECOMMENDATION 14

a ESGE recommends the use of endoscopic mucosal resection (EMR) for ≤20-mm visible lesions with low probability of submucosal invasion (Paris type 0-IIa, 0-IIb) and for larger or multifocal benign (dysplastic) lesions.
Strong recommendation, high quality evidence.

b ESGE suggests the use of endoscopic submucosal dissection (ESD) for lesions suspicious for submucosal invasion (Paris type 0-Is, 0-IIc), for malignant lesions of >20 mm, and for lesions in scarred/fibrotic areas.
Weak recommendation, low quality of evidence.

Recommendation 14 is derived from "Endoscopic submucosal dissection for superficial gastrointestinal lesions: European Society of Gastrointestinal Endoscopy (ESGE) Guideline – Update 2022" [137]. For further discussion and supportive evidence, please refer to that guideline.

> ## RECOMMENDATION 15
> ESGE recommends endoscopic resection as curative treatment for T1a Barrett's cancer with well/moderate differentiation and no signs of (lympho)vascular invasion.
> Strong recommendation, high level of evidence.

Low risk intramucosal (T1a) cancer arising in BE, with well or moderate differentiation and no (lympho)vascular invasion, is associated with a low risk of lymph node metastasis (LNM). Local ER can therefore be considered as curative treatment, with a very favorable safety profile [138]. Furthermore, endoscopic treatment carries a minimal risk of complications compared with invasive surgery [138].

No randomized trials have been performed comparing ER and surgery for the treatment of low risk T1a cancer [139]; one meta-analysis is available [140]. This study included seven studies involving 870 patients, 510 treated endoscopically and 360 treated with esophagectomy. The meta-analysis showed that there was no significant difference between endoscopic therapy and esophagectomy in the neoplasia remission rate (relative risk [RR] 0.96), or overall survival rates at 1 year (RR 0.99), 3 years (RR 1.03), and 5 years (RR 1.00). Endoscopic therapy was associated with a higher dysplasia recurrence rate (RR 9.50) and fewer major AEs (RR 0.38).

> ## RECOMMENDATION 16
> ESGE suggests that low risk submucosal (T1b) esophageal adenocarcinoma (i. e. submucosal invasion depth ≤ 500 µm AND no [lympho]vascular invasion AND no poor tumor differentiation) can be treated by endoscopic resection, provided that adequate follow-up with gastroscopy, endoscopic ultrasound (EUS), and computed tomography (CT)/positrion emission tomography-computed tomography (PET-CT) is performed in expert centers.
> Weak recommendation, low quality of evidence.

It has been demonstrated, in several retrospective cohort studies, that the risk of LNM for T1b EAC with an infiltration depth into the submucosa of up to 500 µm and without any other risk factors (poor differentiation grade [G3], lymph [L1] or blood vessel infiltration [V1]) is very low and usually below the mortality rate of esophagectomy in experienced centers [141–145]. A recent publication by Nieuwenhuis et al., with a median follow-up of 29 months, reported an annual risk of 0.7 % for metastases in low risk T1b EAC [146]. In older studies, the risk for LNM was around 2 % [141–143]. Therefore, ER can be considered curative treatment and esophagectomy is not necessary.

However, oncologic staging at the time of diagnosis and follow-up including gastroscopy (to detect local recurrence), EUS (to detect LNM at an early, yet curable, stage), and CT/PET-CT is mandatory in these patients. Given the low incidence of LNM in this patient population, the fact that not all patients are surgical candidates, and ethical considerations regarding patient preference, a prospective randomized study comparing endoscopic treatment with esophagectomy will not be feasible. In all available retrospective studies, cancer-specific survival is however similar for T1b EAC treated endoscopically or surgically, suggesting no clear benefit of surgical resection over ER for low risk T1b EAC [147].

> ## RECOMMENDATION 17
> ESGE suggests that mucosal (T1a) esophageal adenocarcinoma with (lympho)vascular invasion and/or poor tumor differentiation should be considered as high risk. Complete staging and consideration of additional treatments (chemotherapy and/or radiotherapy and/or surgery) or strict endoscopic follow-up should be undertaken on an individual basis in a multidisciplinary discussion.
> Weak recommendation, very low level of evidence.

Data on the clinical impact of high risk T1a EACs are scarce. High risk T1a is defined as the presence of poor differentiation grade and/or (lympho)vascular invasion in the resection specimen. Only small retrospective cohort studies are available, reporting a risk for LNM of around 20 % [138, 146, 148, 149]. In a recent multicenter retrospective study, lymph node and/or distal metastases were diagnosed in 5/25 patients (20 %) after ER and follow-up for high risk T1a EAC, with a medium interval between ER and the detection of metastases of 31 months [146]. Therefore, complete oncologic staging with gastroscopy, EUS, and CT/PET-CT at the time of diagnosis, and discussion in a multidisciplinary team meeting is recommended. Depending on patient characteristics and patient preference, chemotherapy and/or radiotherapy and/or surgery, or a conservative approach consisting of an intensified follow-up with gastroscopy, EUS, and CT/PET-CT in the setting of an expert center can be considered.

RECOMMENDATION 18
ESGE suggests that submucosal (T1b) esophageal adeno-carcinoma with deep submucosal invasion (tumor invasion >500 μm into the submucosa), and/or (lympho) vascular invasion, and/or a poor tumor differentiation should be considered high risk. Complete staging and consideration of additional treatments (chemotherapy and/or radiotherapy and/or surgery) or strict endoscopic follow-up should be undertaken on an individual basis in a multidisciplinary discussion.
Strong recommendation, low quality of evidence.

High risk features for T1b EAC are deep submucosal tumor invasion (>500 μm), the presence of poor differentiation grade, and (lympho)vascular invasion in the resection specimen. Several retrospective studies are available on the risk of LNM after ER of high risk T1b EAC [144, 146, 150, 151]. In these studies, LNM rates ranging between 0 and 31 % have been reported. Data suggest that the risk increases with an increasing number of risk factors in the resection specimen [148, 150, 152].

Complete staging with EUS and CT/PET-CT at the time of diagnosis is crucial to identify patients with synchronous LNM. In the absence of these (i.e. for pT1bN0M0 disease), the decision on further management should be guided by patient characteristics (co-morbidity, surgical risk) and patient preference. After discussion in a multidisciplinary team meeting, chemotherapy and/or radiotherapy and/or surgery, or a conservative approach consisting of intensified follow-up with EGD, EUS, and CT/PET-CT in the setting of an expert center can be considered.

In an ongoing European multicenter prospective cohort study (NCT03222635), the conservative approach consisting of intensive follow-up by gastroscopy, in addition to EUS every 3 months in the first 2 years and every 6 months in years 3–5 after ER, combined with repeated CT/PET-CT at 12 months is being evaluated. Interim analysis after a median follow-up duration of 22 months showed LNM in 6/120 patients (5 %) [153]. All these patients could be treated by rescue therapy (esophagectomy with or without neoadjuvant chemoradiotherapy or a selective surgical resection of the affected lymph nodes). This study has a predefined follow-up period of 5 years and the final results are awaited. Nevertheless, these results suggest that this strategy of watchful waiting after ER of high risk T1b EAC might select patients in need of invasive (surgical) treatment, while preventing unnecessary surgery in the majority of patients.

▶ **Fig. 2** provides an algorithm for the management of patients with BE and dysplasia or EAC.

7.1 Tumor budding

Tumor buds are usually defined as isolated single cancer cells or clusters of up to four cancer cells located at the invasion front (peritumoral budding) or within the tumor (intratumoral budding). Tumor budding has prognostic significance in several carcinomas [154].

The assessment of tumor buds could help identify high risk patients who had initially been treated by ER but who might benefit from more extended therapy or close follow-up. Data on tumor budding in EAC are very sparse. The studies are small, retrospective, and use different definitions and criteria for the quantification of tumor budding. Nevertheless, they indicate a positive correlation between tumor budding and aggressive clinical behavior [155–160]. Owing to the lack of solid data, ESGE does not however recommend routine use of tumor budding in the assessment of endoscopically treated EAC.

8 Management after endoscopic eradication therapy of BE

RECOMMENDATION 19
ESGE recommends adequate acid suppression treatment during and after endoscopic eradication therapy of BE.
Strong recommendation, very low quality of evidence.

Acid reflux is the driving force in the initial development of BE and adequate acid suppression treatment is therefore considered a cornerstone of patient management after eradication of BE [127, 135, 161–172], even though controlled studies in the post-EET surveillance context are lacking. Based on the available evidence, no recommendation can be made on the optimal PPI dose, or as to whether fundoplication is a more appropriate treatment in select patients. Based however on common practice in BE expert centers, we recommend double-dose PPI (equivalent to omeprazole 40 mg b.i.d.) during EET. During follow-up, the dose may be adjusted based on patient symptoms while maintaining mucosal healing. Fundoplication after EET has only been described in two small retrospective series [173, 174]. As fundoplication can result in adequate reflux control, the risks and benefits of surgical reflux management may be discussed with patients as an alternative to a lifelong PPI.

RECOMMENDATION 20
a ESGE recommends that the first endoscopic follow-up after successful EET of BE is performed in an expert center.
Strong recommendation, very low quality of evidence.

b ESGE recommends careful inspection of the neo-squamocolumnar junction and neo-squamous epithelium with high definition white-light endoscopy and virtual chromoendoscopy during post-EET surveillance, to detect recurrent dysplasia.
Strong recommendation, very low level of evidence.

Recommendation 20 is continued on the next page.
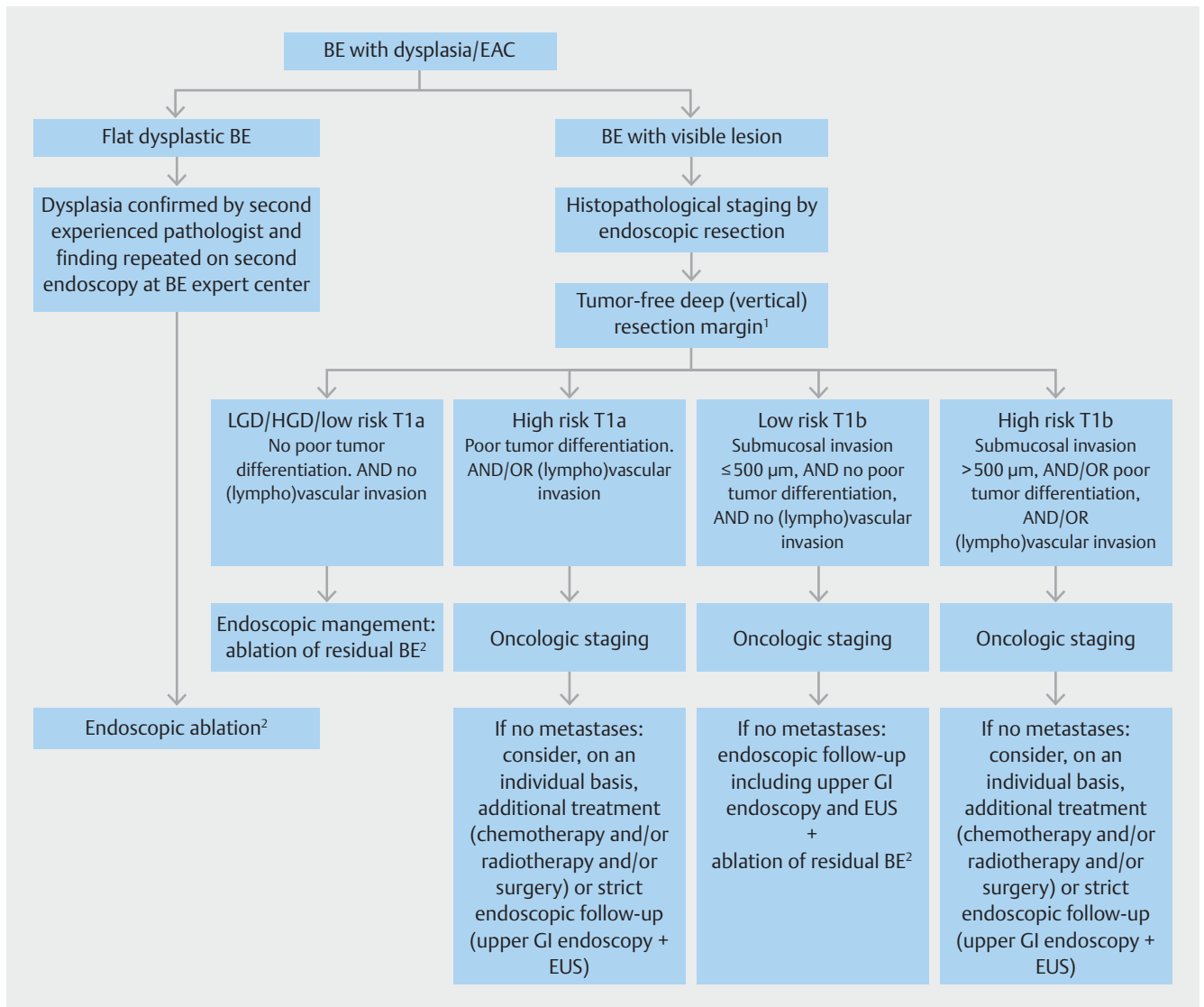
▶ **Fig. 2** Flowchart showing the recommended treatment of Barret esophagus (BE)-related neoplasia.
EAC, esophageal adenocarcinoma; LGD, low grade dysplasia; HGD, high grade dysplasia; GI, gastrointestinal; EUS, endoscopic ultrasound.
[1] For cases with a tumor-positive deep (vertical) resection margin: discuss in a multidisciplinary team meeting, and strongly consider nonendoscopic additional treatment.
[2] In selected cases, strict endoscopic follow-up can be considered (please refer to the text).

c ESGE recommends against routine four-quadrant biopsies of neo-squamous epithelium after successful EET of BE.
Strong recommendation, low level of evidence.

d ESGE suggests, after successful EET, obtaining four-quadrant random biopsies just distal to a normal-appearing neo-squamocolumnar junction to detect dysplasia in the absence of visible lesions.
Weak recommendation, low level of evidence.

e ESGE recommends targeted biopsies are obtained where there is a suspicion of recurrent BE in the tubular esophagus, or where there are visible lesions suspicious for dysplasia.
Strong recommendation, very low level of evidence.

Successful EET is defined as the absence of visible residual BE epithelium after EET. Four-quadrant biopsies just below (<5 mm) the neo-squamocolumnar junction are generally obtained at this point to rule out persisting invisible dysplasia.

Retrospective cohort analyses have indicated that the risk of dysplasia/EAC recurrence following successful EET varies

between 1% and 2% [127, 161, 172, 173, 162, 164–166, 168–171]. Because the majority of recurrences are detected within the first 2 years after EET, it is desirable to perform the first follow-up in an expert center, to allow adequate inspection and detection of residual or recurrent BE and/or dysplasia [115, 127, 175, 176]. Careful inspection of the tubular esophagus and neo-squamocolumnar junction are critically important to detect any recurrent BE or dysplastic lesions. High resolution WLE is recommended to increase dysplasia detection. Likewise, although no studies are available that have formally assessed the use of virtual chromoendoscopy during post-EET surveillance, studies have reported that small areas of columnar mucosa in the tubular esophagus are more readily detected when using virtual chromoendoscopy [177].

The diagnostic yield of biopsies obtained just distal to a normal-appearing neo-squamocolumnar junction has been examined in long-running prospective studies from expert centers. In the largest series reporting on follow-up after EET of BE with dysplasia, all high grade recurrences were detected as visible lesions during endoscopy [170]. Endoscopically invisible recurrences in the cardia were found in about 1% of patients. Given that the diagnostic yield of biopsies appears to be minimal in expert hands, random quadrant biopsies of the proximal cardia have been abandoned in some expert centers [178]. However, as the neo-squamocolumnar junction can be difficult to assess endoscopically and because this is a site where visible and invisible recurrences can occur, we recommend that, in centers with no expertise in EET, quadrant biopsies are taken just distal to the neo-squamocolumnar junction to rule out invisible dysplasia, which may require additional treatment or stricter follow-up [170, 176, 179].

IM at the neo-squamocolumnar junction detected during post-EET surveillance is of no clinical relevance, as this finding is not reproducible between patient visits, nor does it portend an increased risk of recurrent neoplasia [170, 178, 180]. IM in a normal-appearing neo-squamocolumnar junction therefore does not warrant additional treatment or stricter follow-up.

ESGE recommends against obtaining routine four-quadrant biopsies from the neo-squamous epithelium if there are no visible abnormalities. High quality studies have shown that the diagnostic yield of these biopsies is very low [165, 170, 177]. Routine four-quadrant biopsies do however add to the costs and have a negative impact on the environmental footprint; they should therefore be avoided [64].

Biopsies are recommended for histopathologic correlation where there is suspicion of recurrent BE in the tubular esophagus or where there are visible lesions suspicious for dysplasia. Ablation history, biopsy location, and endoscopic assessment should be clearly documented on the histopathology requisition form to aid histopathologic assessment.

> **RECOMMENDATION 21**
> After successful EET, ESGE recommends:
> **a** using the term "recurrence of BE" where there is endoscopic evidence of columnar epithelium in the tubular esophagus – intestinal metaplasia in a normal-appearing neo-squamocolumnar junction should not be considered recurrence of BE
> **b** using the term "recurrence of dysplasia" where biopsies show low or high grade dysplasia, and "recurrence of cancer" where biopsies show cancer.
> Strong recommendation, very low quality of evidence.

Successful EET is defined as a situation in which the esophagus does not show any visible BE (either circumferential, or tongues or islands of columnar epithelium), in combination with a normal-appearing Z-line without any visible abnormalities, after EET has been applied.

Harmonized definitions of recurrence after EET of BE are key in clinical practice and in research settings. Recurrence risks for BE or dysplasia can only be reliably communicated with patients if the definition of recurrence is defined unequivocally in the literature. The definitions proposed here are grounded in clinical relevance, either provoking stricter follow-up or additional treatment.
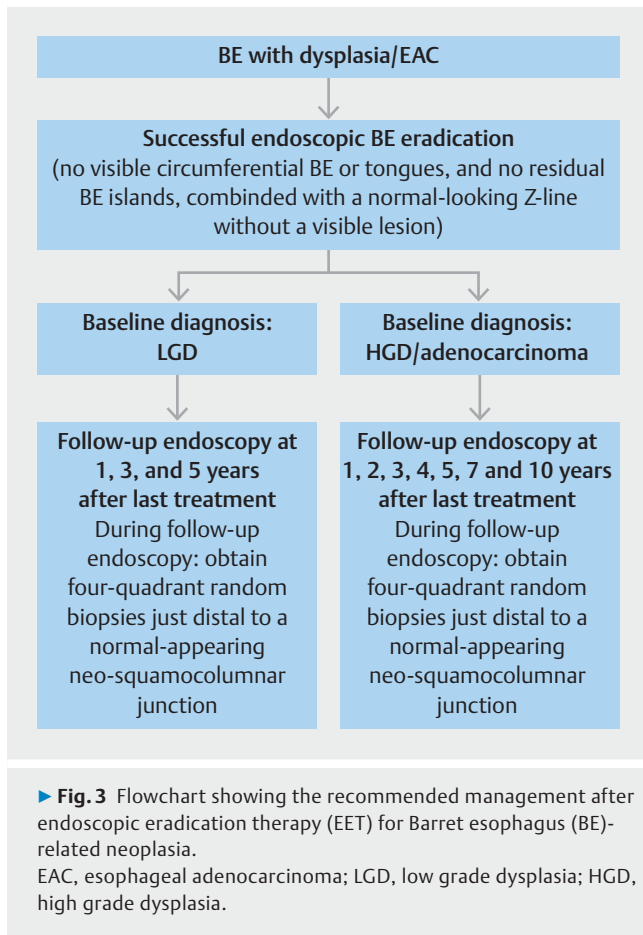
> **RECOMMENDATION 22**
> After successful EET, ESGE recommends the following surveillance intervals:
> - For patients with a baseline diagnosis of HGD or EAC: at 1, 2, 3, 4, 5, 7, and 10 years after last treatment, after which surveillance may be stopped.
> - For patients with a baseline diagnosis of LGD: at 1, 3, and 5 years after last treatment, after which surveillance may be stopped.
> Strong recommendation, low quality of evidence.

Cotton and co-workers have reported model projections for optimal surveillance based on baseline diagnoses during the first 5 years after successful EET [181]. For patients with HGD or EAC as their baseline diagnosis, surveillance visits after 0.25, 0.5, 1, 2, 3, 4, and 5 years after achieving complete eradication of IM were recommended. For patients with LGD as their baseline diagnosis, surveillance visits after 1 and 3 years were advised. Two recent nationwide studies on long-term efficacy of EET have reported low recurrence risks during long-term surveillance after successful treatment for Barrett-related dysplasia/EAC [115, 170]. The majority of recurrences were detected in the first 2 years after successful treatment, varying between (on average) 12 and 31 months after treatment [115, 170, 175, 176, 179], leading to our recommendation for less aggressive surveillance in the first year after successful EET (▶ **Fig. 3**).

| BE with dysplasia/EAC |
| Successful endoscopic BE eradication (no visible circumferential BE or tongues, and no residual BE islands, combined with a normal-looking Z-line without a visible lesion) |

| Baseline diagnosis: LGD | Baseline diagnosis: HGD/adenocarcinoma |

| Follow-up endoscopy at 1, 3, and 5 years after last treatment. During follow-up endoscopy: obtain four-quadrant random biopsies just distal to a normal-appearing neo-squamocolumnar junction | Follow-up endoscopy at 1, 2, 3, 4, 5, 7 and 10 years after last treatment. During follow-up endoscopy: obtain four-quadrant random biopsies just distal to a normal-appearing neo-squamocolumnar junction |

▶ **Fig. 3** Flowchart showing the recommended management after endoscopic eradication therapy (EET) for Barret esophagus (BE)-related neoplasia.
EAC, esophageal adenocarcinoma; LGD, low grade dysplasia; HGD, high grade dysplasia.

There are no data available that address the issue of an upper age limit for post-EET BE surveillance. Late recurrences are rare and mortality risk due to causes other than EAC can be substantial in this patient population [115, 127, 170, 175]. Therefore, it is likely that the clinical return of long-term post-EET surveillance declines with age; however, at this moment, an exact age cutoff is neither supported nor refuted by the literature. The guideline working group feels that age alone should not drive post-EET surveillance decisions in healthy individuals and using age as the sole factor for post-EET surveillance decision-making is crude and insufficient. In determining whether post-EET surveillance should be offered, patients and clinicians should discuss and individualize management decisions depending on the anticipated benefits and competing health concerns. ESGE recommends surveillance may be safely stopped 5 years after successful treatment of BE with LGD, and 10 years after successful treatment of BE with HGD/EAC.

9 Centralization

In accordance with the 2017 ESGE Position Statement on the endoscopic management of BE [1], the working group recommends referring all patients with BE ≥10 cm, a confirmed diagnosis of LGD, HGD, or early cancer to a BE expert center for surveillance and/or treatment. A BE expert center should meet the following requirements: (i) annual case load of ≥10 NEW patients with endoscopic treatment for HGD or early carcinoma per BE expert endoscopist; (ii) endoscopic and histologic care is provided by endoscopists and pathologists who have followed additional training in this field (either by courses or guest visits) – a minimum of 30 supervised cases of ER and 30 cases of endoscopic ablation should be performed to acquire competence in technical skills, management pathways, and complications; (iii) patients with BE dysplasia/cancer are discussed in multidisciplinary meetings with gastroenterologists, surgeons, oncologists, and pathologists; (iv) access to experienced esophageal surgery; (v) all patients with BE are registered prospectively in a database (▶ **Table 1**).

Disclaimer

The legal disclaimer for ESGE guidelines [182] applies to this guideline.

Acknowledgments

The authors wish to thank the external reviewers Prof. Cesare Hassan, Humanitas University Milan, and Prof. Jacques Bergman, Amsterdam University Medical Centers, for their critical review and appraisal of this Guideline.

Competing interests

References

[1] Weusten B, Bisschops R, Coron E et al. Endoscopic management of Barrett's esophagus: European Society of Gastrointestinal Endoscopy (ESGE) Position Statement. Endoscopy 2017; 49: 191–198

[2] Dumonceau JM, Hassan C, Riphaus A et al. European Society of Gastrointestinal Endoscopy (ESGE) guideline development policy. Endoscopy 2012; 44: 626–629

[3] Atkins D, Best D, Briss P et al. Grading quality of evidence and strength of recommendations. BMJ 2004; 328: 1490

[4] Ronkainen J, Aro P, Storskrubb T et al. Prevalence of Barrett's Esophagus in the general population: an endoscopic study. Gastroenterology 2005; 129: 1825–1831

[5] Marques de Sa I, Marcos P, Sharma P et al. The global prevalence of Barrett's esophagus: A systematic review of the published literature. United Eur Gastroenterol J 2020; 8: 1086–1105

[6] Marques de Sá I, Leal C, Silva J et al. Prevalence of Barrett's esophagus in a Southern European country: a multicenter study. Eur J Gastroenterol Hepatol 2021; 33: E939–E943

[7] Eusebi LH, Cirota GG, Zagari RM et al. Global prevalence of Barrett's oesophagus and oesophageal cancer in individuals with gastro-oesophageal reflux: a systematic review and meta-analysis. Gut 2021; 70: 456–463

[8] Westhoff B, Brotze S, Weston A et al. The frequency of Barrett's esophagus in high-risk patients with chronic GERD. Gastrointest Endosc 2005; 61: 226–231

[9] Zagari RM, Fuccio L, Wallander MA et al. Gastro-oesophageal reflux symptoms, oesophagitis and Barrett's oesophagus in the general population: the Loiano-Monghidoro study. Gut 2008; 57: 1354–1359

[10] Fitzgerald RC, di Pietro M, O'Donovan M et al. Cytosponge-trefoil factor 3 versus usual care to identify Barrett's oesophagus in a primary care setting: a multicentre, pragmatic, randomised controlled trial. Lancet 2020; 396: 333–344

[11] Desai TK, Krishnan K, Samala N et al. The incidence of oesophageal adenocarcinoma in non-dysplastic Barrett's oesophagus: a meta-analysis. Gut 2012; 61: 970–976

[12] Klaver E, Bureo Gonzalez A, Mostafavi N et al. Barrett's esophagus surveillance in a prospective Dutch multi-center community-based cohort of 985 patients demonstrates low risk of neoplastic progression. United Eur Gastroenterol J 2021; 9: 929–937

[13] Kastelein F, van Olphen SH, Steyerberg EW et al. Impact of surveillance for Barrett's oesophagus on tumour stage and survival of patients with neoplastic progression. Gut 2016; 65: 548–554

[14] National Institute for Health and Care Excellence (NICE). Gastro-oesophageal reflux disease and dyspepsia in adults: investigation and management. Clinical Guideline 184. London, UK: NICE; 2019

[15] Dunbar KB, Souza RF, Spechler SJ. The effect of proton pump inhibitors on Barrett's esophagus. Gastroenterol Clin North Am 2015; 44: 415–424

[16] Singh S, Garg SK, Singh PP et al. Acid-suppressive medications and risk of oesophageal adenocarcinoma in patients with Barrett's oesophagus: a systematic review and meta-analysis. Gut 2014; 63: 1229–1237

[17] Hu Q, Sun TT, Hong J et al. Proton pump inhibitors do not reduce the risk of esophageal adenocarcinoma in patients with Barrett's esophagus: a systematic review and meta-analysis. PLoS One 2017; 12: e0169691

[18] Li L, Cao Z, Zhang C et al. Risk of esophageal adenocarcinoma in patients with Barrett's esophagus using proton pump inhibitors: A systematic review with meta-analysis and sequential trial analysis. Transl Cancer Res 2021; 10: 1620–1627

[19] Chen Y, Sun C, Wu Y et al. Do proton pump inhibitors prevent Barrett's esophagus progression to high-grade dysplasia and esophageal adenocarcinoma? An updated meta-analysis. J Cancer Res Clin Oncol 2021; 147: 2681–2691

[20] Jankowski JAZ, de Caestecker J, Love SB et al. Esomeprazole and aspirin in Barrett's oesophagus (AspECT): a randomised factorial trial. Lancet 2018; 392: 400–408

[21] Krishnamoorthi R, Singh S, Ragunathan K et al. Factors associated with progression of Barrett's esophagus: a systematic review and meta-analysis. Clin Gastroenterol Hepatol 2018; 16: 1046–1055.e8

[22] Malfertheiner P, Kandulski A, Venerito M. Proton-pump inhibitors: understanding the complications and risks. Nat Rev Gastroenterol Hepatol 2017; 14: 697–710

[23] Moayyedi P, Eikelboom JW, Bosch J et al. Safety of proton pump inhibitors based on a large, multi-year, randomized trial of patients receiving rivaroxaban or aspirin. Gastroenterology 2019; 157: 682–691.e2

[24] Hamel C, Ahmadzai N, Beck A et al. Screening for esophageal adenocarcinoma and precancerous conditions (dysplasia and Barrett's esophagus) in patients with chronic gastroesophageal reflux disease with or without other risk factors: Two systematic reviews and one overview of reviews to info. Syst Rev 2020; 9: 1–25

[25] Rubenstein JH, Inadomi JM. Cost-effectiveness of screening, surveillance, and endoscopic eradication therapies for managing the burden of esophageal adenocarcinoma. Gastrointest Endosc Clin N Am 2021; 31: 77–90

[26] Sami SS, Moriarty JP, Rosedahl JK et al. Comparative cost effectiveness of reflux-based and reflux-independent strategies for Barrett's esophagus screening. Am J Gastroenterol 2021; 116: 1620–1631

[27] Qumseya BJ, Bukannan A, Gendy S et al. Systematic review and meta-analysis of prevalence and risk factors for Barrett's esophagus. Gastrointest Endosc 2019; 90: 707–717 e1

[28] Sawas T, Zamani SA, Killcoyne S et al. Limitations of heartburn and other societies' criteria in Barrett's screening for detecting de novo esophageal adenocarcinoma. Clin Gastroenterol Hepatol 2022; 20: 1709–1718

[29] Nguyen TH, Thrift AP, Rugge M et al. Prevalence of Barrett's esophagus and performance of societal screening guidelines in an unreferred primary care population of U.S. veterans. Gastrointest Endosc 2021; 93: 409–419 e1

[30] Rubenstein JH, McConnell D, Waljee AK et al. Validation and comparison of tools for selecting individuals to screen for Barrett's esophagus and early neoplasia. Gastroenterology 2020; 158: 2082–2092

[31] Kadri PSR, Lao-Sirieix I, O'Donovan M et al. Acceptability and accuracy of a non-endoscopic screening test for Barrett's oesophagus in primary care: Cohort study. BMJ 2010; 341: 595

[32] Ross-Innes CS, Debiram-Beecham I, O'Donovan M et al. Evaluation of a minimally invasive cell sampling device coupled with assessment of trefoil factor 3 expression for diagnosing Barrett's esophagus: a multi-center case–control study. PLoS Med 2015; 12: e1001780

[33] Zhou Z, Kalatskaya I, Russell D et al. Combined EsophaCap cytology and MUC2 immunohistochemistry for screening of intestinal metaplasia, dysplasia and carcinoma. Clin Exp Gastroenterol 2019; 12: 219–229

[34] Wang Z, Kambhampati S, Cheng Y et al. Methylation biomarker panel performance in esophacap cytology samples for diagnosing Barrett's esophagus: A prospective validation study. Clin Cancer Res 2019; 25: 2127–2135

[35] Moinova HR, LaFramboise T, Lutterbaugh JD et al. Identifying DNA methylation biomarkers for non-endoscopic detection of Barrett's esophagus. Sci Transl Med 2018; 10: 1–12

[36] Iyer PG, Taylor WR, Johnson ML et al. Highly discriminant methylated DNA markers for the non-endoscopic detection of Barrett's esophagus. Am J Gastroenterol 2018; 113: 1156–1166

[37] Iyer PG, Taylor WR, Johnson ML et al. Accurate nonendoscopic detection of Barrett's esophagus by methylated DNA markers: a multisite case control study. Am J Gastroenterol 2020; 115: 1201–1209

[38] Iyer PG, Taylor WR, Slettedahl SW et al. Validation of a methylated DNA marker panel for the nonendoscopic detection of Barrett's esophagus in a multisite case-control study. Gastrointest Endosc 2021; 94: 498–505

[39] Gehrung M, Crispin-Ortuzar M, Berman AG et al. Triage-driven diagnosis of Barrett's esophagus for early detection of esophageal adenocarcinoma using deep learning. Nat Med 2021; 27: 833–841

[40] Benaglia T, Sharples LD, Fitzgerald RC et al. Health benefits and cost effectiveness of endoscopic and nonendoscopic cytosponge screening for Barrett's esophagus. Gastroenterology 2013; 144: 62–73.e6

[41] Swart N, Maroni R, Muldrew B et al. Economic evaluation of Cytosponge®-trefoil factor 3 for Barrett esophagus: A cost-utility analysis of randomised controlled trial data. EClinicalMedicine 2021; 37: 100969

[42] Chettouh H, Mowforth O, Galeano-Dalmau N et al. Methylation panel is a diagnostic biomarker for Barrett's oesophagus in endoscopic biopsies and non-endoscopic cytology specimens. Gut 2018; 67: 1942–1949

[43] Sami SS, Subramanian V, Butt WM et al. High definition versus standard definition white light endoscopy for detecting dysplasia in patients with Barrett's esophagus. Dis Esophagus 2015; 28: 742–749

[44] Wolfsen HC, Crook JE, Krishna M et al. Prospective, controlled tandem endoscopy study of narrow band imaging for dysplasia detection in Barrett's esophagus. Gastroenterology 2008; 135: 24–31

[45] Sharma P, Hawes RH, Bansal A et al. Standard endoscopy with random biopsies versus narrow band imaging targeted biopsies in Barrett's oesophagus: A prospective, international, randomised controlled trial. Gut 2013; 62: 15–21

[46] Coletta M, Sami SS, Nachiappan A et al. Acetic acid chromoendoscopy for the diagnosis of early neoplasia and specialized intestinal metaplasia in Barrett's esophagus: a meta-analysis. Gastrointest Endosc 2016; 83: 57–67.e1

[47] Longcroft-Wheaton G, Fogg C, Chedgy F et al. A feasibility trial of Acetic acid-targeted Biopsies versus nontargeted quadrantic biopsies during BArrett's surveillance: the ABBA trial. Endoscopy 2020; 52: 29–36

[48] Messmann H, Bisschops R, Antonelli G et al. Expected value of artificial intelligence in gastrointestinal endoscopy: European Society of Gastrointestinal Endoscopy (ESGE) Position Statement. Endoscopy 2022; 54: 1211–1231

[49] Nieuwenhuis EA, van Munster SN, Curvers WL et al. Impact of expert center endoscopic assessment of confirmed low grade dysplasia diagnosed in community hospitals. Endoscopy 2022; 54: 639–644

[50] Visrodia K, Singh S, Krishnamoorthi R et al. Magnitude of missed esophageal adenocarcinoma after Barrett's esophagus diagnosis: a systematic review and meta-analysis. Gastroenterology 2016; 150: 599–607.e7

[51] Ebigbo A, Mendel R, Probst A et al. Real-time use of artificial intelligence in the evaluation of cancer in Barrett's oesophagus. Gut 2020; 69: 615–616

[52] Hashimoto R, Requa J, Dao T et al. Artificial intelligence using convolutional neural networks for real-time detection of early esophageal neoplasia in Barrett's esophagus (with video). Gastrointest Endosc 2020; 91: 1264–1271.e1

[53] de Groof AJ, Struyvenberg MR, Fockens KN et al. Deep learning algorithm detection of Barrett's neoplasia with high accuracy during live endoscopic procedures: a pilot study (with video). Gastrointest Endosc 2020; 91: 1242–1250

[54] Arribas J, Antonelli G, Frazzoni L et al. Standalone performance of artificial intelligence for upper GI neoplasia: a meta-analysis. Gut 2020; 70: 1458–1468

[55] Lui TKL, Tsui VWM, Leung WK. Accuracy of artificial intelligence-assisted detection of upper GI lesions: a systematic review and meta-analysis. Gastrointest Endosc 2020; 92: 821–830.e9

[56] Bisschops R, Areia M, Coron E et al. Performance measures for upper gastrointestinal endoscopy: a European Society of Gastrointestinal Endoscopy (ESGE) Quality Improvement Initiative. Endoscopy 2016; 48: 843–864

[57] Gupta N, Gaddam S, Wani SB et al. Longer inspection time is associated with increased detection of high-grade dysplasia and esophageal adenocarcinoma in Barrett's esophagus. Gastroenterol Endosc 2012; 76: 531–538

[58] Vithayathil M, Modolell I, Ortiz-Fernandez-Sordo J et al. The effect of procedural time on dysplasia detection rate during endoscopic surveillance of Barrett's esophagus. Endoscopy 2023; 55: 491–498

[59] Pouw RE, Barret M, Biermann K et al. Endoscopic tissue sampling - Part 1: Upper gastrointestinal and hepatopancreatobiliary tracts. European Society of Gastrointestinal Endoscopy (ESGE) Guideline. Endoscopy 2021; 53: 1174–1188

[60] Wani S, Williams JL, Komanduri S et al. Endoscopists systematically undersample patients with long-segment Barrett's esophagus: an analysis of biopsy sampling practices from a quality improvement registry. Gastrointest Endosc 2019; 90: 732–741.e3

[61] Westerveld D, Khullar V, Mramba L et al. Adherence to quality indicators and surveillance guidelines in the management of Barrett's esophagus: a retrospective analysis. Endosc Int Open 2018; 6: E300–E307

[62] Antony A, Pohanka C, Keogh S et al. Adherence to quality indicators in endoscopic surveillance of Barrett's esophagus and correlation to dysplasia detection rates. Clin Res Hepatol Gastroenterol 2018; 42: 591–596

[63] Abela JE, Going JJ, Mackenzie JF et al. Systematic four-quadrant biopsy detects Barrett's dysplasia in more patients than nonsystematic biopsy. Am J Gastroenterol 2008; 103: 850–855

[64] Rodríguez de Santiago E, Dinis-Ribeiro M, Pohl H et al. Reducing the environmental footprint of gastrointestinal endoscopy: European Society of Gastrointestinal Endoscopy (ESGE) and European Society of Gastroenterology and Endoscopy Nurses and Associates (ESGENA) Position Statement. Endoscopy 2022; 54: 797–826

[65] Rubenstein JH, Vakil N, Inadomi JM. The cost-effectiveness of biomarkers for predicting the development of oesophageal adenocarcinoma. Aliment Pharmacol Ther 2005; 22: 135–146

[66] Gordon LG, Mayne GC, Hirst NG et al. Cost-effectiveness of endoscopic surveillance of non-dysplastic Barrett's esophagus. Gastrointest Endosc 2014; 79: 242–256

[67] Das A, Callenberg KM, Styn MA et al. Endoscopic ablation is a cost-effective cancer preventative therapy in patients with Barrett's esophagus who have elevated genomic instability. Endosc Int Open 2016; 04: E549–E559

[68] Hao J, Critchley-Thorne R, Diehl DL et al. A cost-effectiveness analysis of an adenocarcinoma risk prediction multi-biomarker assay for patients with Barrett's esophagus. Clinicoecon Outcomes Res 2019; 11: 623–635

[69] Redston M, Noffsinger A, Kim A et al. Abnormal TP53 predicts risk of progression in patients with Barrett's esophagus regardless of a diagnosis of dysplasia. Gastroenterology 2022; 162: 468–481

[70] Weaver JMJ, Ross-Innes CS, Shannon N et al. Ordering of mutations in preinvasive disease stages of esophageal carcinogenesis. Nat Genet 2014; 46: 837–843

[71] Skacel M, Petras RE, Rybicki LA et al. p53 expression in low grade dysplasia in Barrett's esophagus: Correlation with interobserver agreement and disease progression. Am J Gastroenterol 2002; 97: 2508–2513

[72] Kaye PV, Haider SA, Ilyas M et al. Barrett's dysplasia and the Vienna classification: Reproducibility, prediction of progression and impact of consensus reporting and p53 immunohistochemistry. Histopathology 2009; 54: 699–712

[73] Kaye PV, Ilyas M, Soomro I et al. Dysplasia in Barrett's oesophagus: p53 immunostaining is more reproducible than haematoxylin and eosin diagnosis and improves overall reliability, while grading is poorly reproducible. Histopathology 2016; 69: 431–440

[74] Toon C, Allanson B, Leslie C et al. Patterns of p53 immunoreactivity in non-neoplastic and neoplastic Barrett's mucosa of the oesophagus : in-depth evaluation in endoscopic mucosal resections. Pathology 2022; 51: 253–260

[75] van der Wel MJ, Duits LC, Pouw RE et al. Improved diagnostic stratification of digitised Barrett's oesophagus biopsies by p53 immunohistochemical staining. Histopathology 2018; 72: 1015–1023

[76] van der Wel MJ, Coleman HG, Bergman JJGHM et al. Histopathologist features predictive of diagnostic concordance at expert level among a large international sample of pathologists diagnosing Barrett's dysplasia using digital pathology. Gut 2020; 69: 811–822

[77] Januszewicz W, Pilonis ND, Sawas T et al. The utility of P53 immunohistochemistry in the diagnosis of Barrett's oesophagus with indefinite for dysplasia. Histopathology 2022; 80: 1081–1090

[78] Kinra P, Gahlot GPS, Yadav R et al. Histological assessment & use of immunohistochemical markers for detection of dysplasia in Barrett's esophageal mucosa. Pathol Res Pract 2018; 214: 993–999

[79] Vithayathil M, Modolell I, Ortiz-Fernandez-Sordo J et al. Image-enhanced endoscopy and molecular biomarkers vs Seattle protocol to diagnose dysplasia in Barrett's esophagus. Clin Gastroenterol Hepatol 2022; 20: 2514–2523.e3

[80] Iyer PG, Codipilly DC, Chandar AK et al. Prediction of progression in Barrett's esophagus using a tissue systems pathology test : a pooled analysis of international multicenter studies. Clin Gastroenterol Hepatol 2022; 20: 2772–2779.e8

[81] Eluri S, Brugge WR, Daglilar ES et al. The presence of genetic mutations at key loci predicts progression to esophageal adenocarcinoma in Barrett's esophagus. Am J Gastroenterol 2015; 110: 828–834

[82] Eluri S, Klaver E, Duits LC et al. Validation of a biomarker panel in Barrett's esophagus to predict progression to esophageal adenocarcinoma. Dis Esophagus 2018; 31: 1–6

[83] Khara HS, Jackson SA, Nair S et al. Assessment of mutational load in biopsy tissue provides additional information about genomic instability to histological classifications of Barrett's esophagus. J Gastrointest Canc 2014; 45: 137–145

[84] Trindade AJ, Mckinley MJ, Alshelleh M et al. Mutational load may predict risk of progression in patients with Barrett's oesophagus and indefinite for dysplasia : a pilot study. BMJ Open Gastroenterol 2019; 6: e000268

[85] Altaf K, Xiong J, de la Iglesia D et al. Meta-analysis of biomarkers predicting risk of malignant progression in Barrett's oesophagus. Br J Surg 2017; 104: 493–502

[86] Hadjinicolaou AV, van Munster SN, Achilleos A et al. Aneuploidy in targeted endoscopic biopsies outperforms other tissue biomarkers in the prediction of histologic progression of Barrett's oesophagus: A multi-centre prospective cohort study. EBioMedicine 2020; 56: 102765

[87] Douville C, Moinova HR, Thota PN et al. Massively parallel sequencing of esophageal brushings enables an aneuploidy-based classification of patients with Barrett's esophagus. Gastroenterology 2021; 160: 2043–2054

[88] Killcoyne S, Gregson E, Wedge DC et al. Genomic copy number predicts esophageal cancer years before transformation. Nat Med 2020; 26: 1726–1732

[89] Pilonis ND, Killcoyne S, Tan WK et al. Use of a Cytosponge biomarker panel to prioritise endoscopic Barrett's oesophagus surveillance: a cross-sectional study followed by a real-world prospective pilot. Lancet Oncol 2022; 23: 270–278

[90] Campos VJ, Mazzini GS, Juchem JF et al. Neutrophil-lymphocyte ratio as a marker of progression from non-dysplastic Barrett's esophagus to esophageal adenocarcinoma: a cross-sectional retrospective study. J Gastrointest Surg 2020; 24: 8–18

[91] Peleg N, Schmilovitz-Weiss H, Shamah S et al. Neutrophil to lymphocyte ratio and risk of neoplastic progression in patients with Barrett's esophagus. Endoscopy 2021; 53: 774–781

[92] Shah AK, Hartel G, Brown I et al. Evaluation of serum glycoprotein biomarker candidates for detection of esophageal adenocarcinoma and surveillance of Barrett's esophagus. Mol Cell Proteomics 2018; 17: 2324–2334

[93] Maddalo G, Fassan M, Cardin R et al. Squamous cellular carcinoma antigen serum determination as a biomarker of Barrett esophagus and esophageal cancer - a phase III study. J Clin Gastroenterol 2018; 52: 401–406

[94] Risques RA, Vaughan TL, Li X et al. Leukocyte telomere length predicts cancer risk in Barrett's esophagus. Cancer Epidemiol Biomarkers Prev 2007; 16: 2649–2655

[95] Rumiato E, Boldrin E, Malacrida S et al. Detection of genetic alterations in cfDNA as a possible strategy to monitor the neoplastic progression of Barrett's esophagus. Transl Res 2017; 190: 16–24.e1

[96] Codipilly DC, Chandar AK, Singh S et al. The effect of endoscopic surveillance in patients with Barrett's esophagus: a systematic review and meta-analysis. Gastroenterology 2018; 154: 2068–2086 e5

[97] Vissapragada R, Bulamu NB, Brumfitt C et al. Improving cost-effectiveness of endoscopic surveillance for Barrett's esophagus by reducing low-value care: a review of economic evaluations. Surg Endosc 2021; 35: 5905–5917

[98] Kastelein F, van Olphen S, Steyerberg EW et al. Surveillance in patients with long-segment Barrett's oesophagus: a cost-effectiveness analysis. Gut 2015; 64: 864–871

[99] Hamade N, Vennelaganti S, Parasa S et al. Lower annual rate of progression of short-segment vs long-segment Barrett's esophagus to esophageal adenocarcinoma. Clin Gastroenterol Hepatol 2019; 17: 864–868

[100] Chandrasekar VT, Hamade N, Desai M et al. Significantly lower annual rates of neoplastic progression in short- compared to long-segment non-dysplastic Barrett's esophagus: a systematic review and meta-analysis. Endoscopy 2019; 51: 665–672

[101] Pohl H, Pech O, Arash H et al. Length of Barrett's oesophagus and cancer risk: implications from a large sample of patients with early oesophageal adenocarcinoma. Gut 2016; 65: 196–201

[102] Thota PN, Vennalaganti P, Vennelaganti S et al. Low risk of high-grade dysplasia or esophageal adenocarcinoma among patients with Barrett's esophagus less than 1 cm (irregular Z Line) within 5 years of index endoscopy. Gastroenterology 2017; 152: 987–992

[103] Omidvari AH, Hazelton WD, Lauren BN et al. The optimal age to stop endoscopic surveillance of patients with Barrett's esophagus based on sex and comorbidity: a comparative cost-effectiveness analysis. Gastroenterology 2021; 161: 487–494 e4

[104] Schölvinck DW, van der Meulen K, Bergman JJGHM et al. Detection of lesions in dysplastic Barrett's esophagus by community and expert endoscopists. Endoscopy 2017; 49: 113–120

[105] Tsoi EH, Mahindra P, Cameron G et al. Barrett's esophagus with low-grade dysplasia: high rate of upstaging at Barrett's esophagus referral units suggests progression rates may be overestimated. Gastrointest Endosc 2021; 94: 902–908

[106] Curvers WL, ten Kate FJ, Krishnadath KK et al. Low-grade dysplasia in Barrett's esophagus: overdiagnosed and underestimated. Am J Gastroenterol 2010; 105: 1523–1530

[107] Duits LC, Phoa KN, Curvers WL et al. Barrett's oesophagus patients with low-grade dysplasia can be accurately risk-stratified after histological review by an expert pathology panel. Gut 2015; 64: 700–706

[108] Qumseya BJ, Wani S, Gendy S et al. Disease progression in Barrett's low-grade dysplasia with radiofrequency ablation compared with surveillance: systematic review and meta-analysis. Clin Syst Rev 2017; 112: 849–865

[109] Duits LC, van der Wel MJ, Cotton CC et al. Patients With Barrett's esophagus and confirmed persistent low-grade dysplasia are at increased risk for progression to neoplasia. Gastroenterology 2017; 152: 993–1001

[110] Song KY, Henn AJ, Gravely AA et al. Persistent confirmed low-grade dysplasia in Barrett's esophagus is a risk factor for progression to high-grade dysplasia and adenocarcinoma in a US Veterans cohort. Dis Esophagus 2020; 33: 1–7

[111] Desai M, Saligram S, Gupta N et al. Efficacy and safety outcomes of multimodal endoscopic eradication therapy in Barrett's esophagus-related neoplasia: a systematic review and pooled analysis. Gastrointest Endosc 2017; 85: 482–495

[112] van Vilsteren FGI, Pouw RE, Seewald S et al. Stepwise radical endoscopic resection versus radiofrequency ablation for Barrett's oesophagus with high-grade dysplasia or early cancer: a multicentre randomised trial. Gut 2011; 60: 765–773

[113] Phoa KN, van Vilsteren FGI, Weusten BLAM et al. Radiofrequency ablation vs endoscopic surveillance for patients with Barrett esophagus and low-grade dysplasia. JAMA 2014; 311: 1209–1217

[114] Pasricha S, Bulsiewicz WJ, Hathorn KE et al. Durability and predictors of successful radiofrequency ablation for Barrett's esophagus. Clin Gastroenterol Hepatol 2014; 12: 1840–1847

[115] Wolfson P, Ho KMA, Wilson A et al. Endoscopic eradication therapy for Barrett's esophagus–related neoplasia: a final 10-year report from the UK National HALO Radiofrequency Ablation Registry. Gastrointest Endosc 2022; 96: 223–233

[116] Peerally MF, Bhandari P, Ragunath K et al. Radiofrequency ablation compared with argon plasma coagulation after endoscopic resection of high-grade dysplasia or stage T1 adenocarcinoma in Barrett's esophagus : a randomized pilot study (BRIDE). Gastrointest Endosc 2019; 89: 680–689

[117] Manner H, Rabenstein T, Pech O et al. Ablation of residual Barrett's epithelium after endoscopic resection: a randomized long-term follow-up study of argon plasma coagulation vs. surveillance (APE study). . Endoscopy 2014; 46: 6–12

[118] Thota PN, Arora Z, Dumot JA et al. Cryotherapy and radiofrequency ablation for eradication of Barrett's esophagus with dysplasia or intramucosal cancer. Dig Dis Sci 2018; 63: 1311–1319

[119] Ghorbani S, Tsai FC, Greenwald BD et al. Safety and efficacy of endoscopic spray cryotherapy for Barrett's dysplasia: results of the National Cryospray Registry. Dis Esophagus 2016; 29: 241–247

[120] Shaheen NJ, Greenwald BD, Peery AF et al. Safety and efficacy of endoscopic spray cryotherapy for Barrett's esophagus with high-grade dysplasia. Gastrointest Endosc 2010; 71: 680–685

[121] Knabe M, Beyna T, Bergman J et al. Hybrid APC in combination with resection for the endoscopic treatment of neoplastic Barrett's esophagus : a prospective , multicenter study. Am J Gastroenterol 2022; 117: 110–119

[122] Canto MI, Trindade AJ, Abrams J et al. Multifocal cryoballoon ablation for eradication of Barrett's esophagus-related neoplasia: a prospective multicenter clinical trial. Am J Gastroenterol 2020; 115: 1879–1890

[123] Shaheen NJ, Sharma P, Overholt BF et al. Radiofrequency ablation in Barrett's esophagus with dysplasia. NEJM 2009; 360: 2277–2288

[124] Pouw RE, Klaver E, Phoa KN et al. Radiofrequency ablation for low-grade dysplasia in Barrett's esophagus: long-term outcome of a randomized trial. Gastrointest Endosc 2020; 92: 569–574

[125] Barret M, Pioche M, Terris B et al. Endoscopic radiofrequency ablation or surveillance in patients with Barrett's oesophagus with confirmed grade dysplasia : a multicentre randomised trial. Gut 2021; 70: 1014–1022

[126] Wronska E, Polkowski M, Orlowska J et al. Argon plasma coagulation for Barrett's esophagus with low-grade dysplasia: a randomized trial with long-term follow-up on the impact of power setting and proton pump inhibitor dose. Endoscopy 2021; 53: 123–132

[127] Cotton CC, Wolf WA, Overholt BF et al. Late recurrence of Barrett's esophagus after complete eradication of intestinal metaplasia is rare: final report from ablation in intestinal metaplasia containing dysplasia trial. Gastroenterology 2017; 153: 681–688

[128] Overholt BF, Lightdale CJ, Wang KK et al. Photodynamic therapy with porfimer sodium for ablation of high-grade dysplasia in Barrett's esophagus: international, partially blinded, randomized phase III trial. Gastrointest Endosc 2005; 62: 488–498

[129] Overholt BF, Wang KK, Burdick JS et al. Five-year efficacy and safety of photodynamic therapy with Photofrin in Barrett's high-grade dysplasia. Gastrointest Endosc 2007; 66: 460–468

[130] Orman ES, Li NAN, Shaheen NJ. Efficacy and durability of radiofrequency ablation for Barrett's esophagus: systematic review and meta-analysis. Clin Gastroenterol Hepatol 2013; 11: 1245–1255

[131] Tariq R, Enslin S, Hayat M et al. Efficacy of cryotherapy as a primary endoscopic ablation modality for dysplastic Barrett's esophagus and early esophageal neoplasia: a systematic review and meta-analysis. Cancer Control 2020; 27: 1–9

[132] May A, Gossner L, Pech O et al. Local endoscopic therapy for intraepithelial high-grade neoplasia and early adenocarcinoma in Barrett's oesophagus: acute-phase and intermediate results of a new treatment approach. Eur J Gastroenterol Hepatol 2002; 14: 1085–1091

[133] Pech O, Behrens A, May A et al. Long-term results and risk factor analysis for recurrence after curative endoscopic therapy in 349 patients with high-grade intraepithelial neoplasia and mucosal adenocarcinoma in Barrett's oesophagus. Gut 2008; 57: 1200–1206

[134] Manner H, May A, Miehlke S et al. Ablation of nonneoplastic Barrett's mucosa using argon plasma coagulation with concomitant esomeprazole therapy (APBANEX): a prospective multicenter evaluation. Am J Gastroenterol 2006; 101: 1762–1769

[135] Phoa KN, Pouw RE, Bisschops R et al. Multimodality endoscopic eradication for neoplastic Barrett oesophagus: results of an European multicentre study (EURO-II). Gut 2016; 65: 555–562

[136] van Munster SN, Nieuwenhuis EA, Weusten BLAM et al. Endoscopic resection without subsequent ablation therapy for early Barrett's neoplasia: endoscopic findings and long-term mortality. J Gastrointest Surg 2021; 25: 67–76

[137] Pimentel-Nunes P, Libânio D, Bastiaansen BAJ et al. Endoscopic submucosal dissection for superficial gastrointestinal lesions: European Society of Gastrointestinal Endoscopy (ESGE) Guideline – Update 2022. Endoscopy 2022; 54: 591–622

[138] Pech O, May A, Manner H et al. Long-term efficacy and safety of endoscopic resection for patients with mucosal adenocarcinoma of the esophagus. Gastroenterology 2014; 146: 652–660

[139] Bennett C, Green S, DeCaestecker J et al. Surgery versus radical endotherapies for early high-grade dysplasia in Barrett's oesophagus. Cochrane Libr 2020; 5: CD007334

[140] Wu J, Pan YM, Wang TT et al. Endotherapy versus surgery for early neoplasia in Barrett's esophagus: a meta-analysis. Gastrointest Endosc 2014; 79: 233–241

[141] Manner H, May A, Pech O et al. Early Barrett's carcinoma with "low-risk" submucosal invasion: long-term results of endoscopic resection with a curative intent. Am J Gastroenterol 2008; 103: 2589–2597

[142] Manner H, Pech O, Heldmann Y et al. Efficacy, safety, and long-term results of endoscopic treatment for early stage adenocarcinoma of the esophagus with low-risk sm1 invasion. Clin Exp Gastroenterol 2013; 11: 630–635

[143] Manner H, Pech O, Heldmann Y et al. The frequency of lymph node metastasis in early-stage adenocarcinoma of the esophagus with incipient submucosal invasion (pT1b sm1) depending on histological risk patterns. Surg Endosc 2015; 29: 1888–1896

[144] Schölvinck D, Künzli H, Meijer S et al. Management of patients with T1b esophageal adenocarcinoma: a retrospective cohort study on patient management and risk of metastatic disease. Surg Endosc 2016; 30: 4102–4113

[145] Saunders JH, Al-zubaidi S, Waller RC et al. The management and long-term outcomes of endoscopic and surgical treatment of early esophageal adenocarcinoma. Dis Esophagus 2020; 33: 1–10

[146] Nieuwenhuis EA, van Munster SN, Meijer SL et al. Analysis of metastases rates during follow-up after endoscopic resection of early "high-risk" esophageal adenocarcinoma Short. Gastrointest Endosc 2022; 96: 237–247

[147] Wang W, Chen D, Sang Y et al. Endoscopic resection versus esophagectomy for patients with small-sized T1N0 esophageal cancer: A propensity-matched study. Clin Res Hepatol Gastroenterol 2021; 45: 101543

[148] Boys JA, Worrell SG, Chandrasoma P et al. Can the risk of lymph node metastases be gauged in endoscopically resected submucosal esophageal adenocarcinomas? a multi-center study. J Gastrointest Surg 2016; 20: 6–12

[149] Oetzmann von Sochaczewski C, Haist T, Pauthner M et al. Infiltration depth is the most relevant risk factor for overall metastases in early esophageal adenocarcinoma. World J Surg 2020; 44: 1192–1199

[150] Manner H, Wetzka J, May A et al. Early-stage adenocarcinoma of the esophagus with mid to deep submucosal invasion (pT1b sm2-3): the frequency of lymph-node metastasis depends on macroscopic and histological risk patterns. Dis Esophagus 2017; 30: 1–11

[151] Künzli HT, Belghazi K, Pouw RE et al. Endoscopic management and follow-up of patients with a submucosal esophageal adenocarcinoma. United Eur Gastroenterol J 2018; 6: 669–677

[152] Gotink AW, van de Ven SEM, ten Kate FJC et al. Individual risk calculator to predict lymph node metastases in patients with submucosal (T1b) esophageal adenocarcinoma: A multicenter cohort study. Endoscopy 2022; 54: 109–117

[153] Chan MW, Nieuwenhuis E, Jansen M et al. Endoscopic follow-up of radically resected submucosal adenocarcinoma in Barrett's esophagus: interim results of an ongoing prospective, International, multicenter cohort registry (PREFER trial). Gastrointest Endosc 2023; 97: AB967

[154] Lugli A, Zlobec I, Berger MD et al. Tumour budding in solid cancers. Nat Rev Clin Oncol 2021; 18: 101–115

[155] Thies S, Guldener L, Slotta-huspenina J et al. Impact of peritumoral and intratumoral budding in esophageal adenocarcinomas. Hum Pathol 2016; 52: 1–8

[156] Lohneis P, Rohmann J, Gebauer F et al. International Tumor Budding Consensus Conference criteria determine the prognosis of oesophageal adenocarcinoma with poor response to neoadjuvant treatment. Pathol Res Pract 2022; 232: 153844

[157] Dhingra S, Bahdi F, May SB et al. Clinicopathologic correlations of superficial esophageal adenocarcinoma in endoscopic submucosal dissection specimens. Diagn Pathol 2021; 16: 111

[158] Lohneis P, Hieggelke L, Gebauer F et al. Tumor budding assessed according to the criteria of the International Tumor Budding Consensus Conference determines prognosis in resected esophageal adenocarcinoma. Virchows Arch 2021; 478: 393–400

[159] Landau MS, Hastings SM, Foxwell TJ et al. Tumor budding is associated with an increased risk of lymph node metastasis and poor prognosis in superficial esophageal adenocarcinoma. Mod Pathol 2014; 27: 1578–1589

[160] Brown M, Sillah K, Griffiths EA et al. Tumour budding and a low host inflammatory response are associated with a poor prognosis in oesophageal and gastro-oesophageal junction cancers. Histopathology 2010; 56: 893–899

[161] Sharma P, Wani S, Weston AP et al. A randomised controlled trial of ablation of Barrett's oesophagus with multipolar electrocoagulation versus argon plasma coagulation in combination with acid suppression: Long term results. Gut 2006; 55: 1233–1239

[162] Kobayashi R, Calo NC, Marcon N et al. Predictors of recurrence of dysplasia or cancer in patients with dysplastic Barrett's esophagus following complete eradication of dysplasia: a single-center retrospective cohort study. Surg Endosc 2022; 36: 5041–5048

[163] Basu KK, Pick B, Bale R et al. Efficacy and one year follow up of argon plasma coagulation therapy for ablation of Barrett's oesophagus: Factors determining persistence and recurrence of Barrett's epithelium. Gut 2002; 51: 776–780

[164] Gupta M, Iyer PG, Lutzke L et al. Recurrence of esophageal intestinal metaplasia after endoscopic mucosal resection and radiofrequency ablation of Barrett's esophagus: Results from a us multicenter consortium. Gastroenterology 2013; 145: 79–86

[165] Phoa KN, Pouw RE, van Vilsteren FGI et al. Remission of Barrett's esophagus with early neoplasia 5 years after radiofrequency ablation with endoscopic resection: A Netherlands cohort study. Gastroenterology 2013; 145: 96–104

[166] Ramay FH, Cui Q, Greenwald BD. Outcomes after liquid nitrogen spray cryotherapy in Barrett's esophagus-associated high-grade dysplasia and intramucosal adenocarcinoma: 5-year follow-up. Gastrointest Endosc 2017; 86: 626–632

[167] Dulai PS, Pohl H, Levenick JM et al. Radiofrequency ablation for long- and ultralong-segment Barrett's esophagus: A comparative long-term follow-up study. Gastrointest Endosc 2013; 77: 534–541

[168] Komanduri S, Kahrilas PJ, Krishnan K et al. Recurrence of Barrett's esophagus is rare following endoscopic eradication therapy coupled with effective reflux control. Am J Gastroenterol 2017; 112: 556–566

[169] Guarner-Argente C, Buoncristiano T, Furth EE et al. Long-term outcomes of patients with Barrett's esophagus and high-grade dysplasia or early cancer treated with endoluminal therapies with intention to complete eradication. Gastrointest Endosc 2013; 77: 190–199

[170] van Munster S, Nieuwenhuis E, Weusten BLAM et al. Long-term outcomes after endoscopic treatment for Barrett's neoplasia with radiofrequency ablation ± endoscopic resection: Results from the national Dutch database in a 10-year period. Gut 2022; 71: 265–276

[171] Konda VJA, Gonzalez Haba Ruiz M, Koons A et al. Complete endoscopic mucosal resection is effective and durable treatment for Barrett's-associated neoplasia. Clin Gastroenterol Hepatol 2014; 12: 2002–2010.e2

[172] Fleischer DE, Overholt BF, Sharma VK et al. Endoscopic radiofrequency ablation for Barretts esophagus: 5-year outcomes from a prospective multicenter trial. Endoscopy 2010; 42: 781–789

[173] Madisch A, Miehlke S, Bayerdoerffer E et al. Long-term follow-up after complete ablation of Barrett's esophagus with argon plasma coagulation. World J Gastroenterol 2005; 11: 1182–1186

[174] O'Connell K, Velanovich V. Effects of Nissen fundoplication on endoscopic endoluminal radiofrequency ablation of Barrett's esophagus. Surg Endosc 2011; 25: 830–834

[175] Wani S, Han S, Kushnir V et al. Recurrence is rare following complete eradication of intestinal metaplasia in patients with Barrett's esophagus and peaks at 18 months. Clin Gastroenterol Hepatol 2020; 18: 2609–2617

[176] Omar M, Thaker AM, Wani S et al. Anatomic location of Barrett's esophagus recurrence after endoscopic eradication therapy: development of a simplified surveillance biopsy strategy. Gastrointest Endosc 2019; 90: 395–403

[177] Pouw RE, Visser M, Odze RD et al. Pseudo-buried Barrett's post radiofrequency ablation for Barrett's esophagus, with or without prior endoscopic resection. Endoscopy 2014; 46: 105–109

[178] Frederiks CN, van Munster SN, Nieuwenhuis EA et al. Clinical relevance of random biopsies from the esophagogastric junction after complete eradication of Barrett's esophagus is low. Clin Gastroenterol Hepatol 2023; 21: 2260–2269.e9

[179] Guthikonda A, Cotton CC, Madanick RD et al. Clinical outcomes following recurrence of intestinal metaplasia after successful treatment of Barrett's esophagus with radiofrequency ablation. Am J Gastroenterol 2017; 112: 87–94

[180] Solfisburg QS, Sami SS, Gabre J et al. Clinical significance of recurrent gastroesophageal junction intestinal metaplasia after endoscopic eradication of Barrett's esophagus. Gastrointest Endosc 2021; 93: 1250–1257

[181] Cotton CC, Haidry R, Thrift AP et al. Development of evidence-based surveillance intervals after radiofrequency ablation of Barrett's esophagus. Gastroenterology 2018; 155: 316–326

[182] Hassan C, Ponchon T, Bisschops R et al. European Society of Gastrointestinal Endoscopy (ESGE) Publications Policy – Update 2020. Endoscopy 2020; 52: 123–126