Australian clinical practice guidelines for the diagnosis and management of Barrett's Esophagus and Early Esophageal Adenocarcinoma

David C. Whiteman[1], Mark Appleyard[2], Farzan Fahrtash Bahin[3,4], Yuri V. Bobryshev[5,6], Michael J Bourke[3,4], Ian Brown[7], Adrian Chung[8], Andrew Clouston[7], Emma Dickins[9], Jon Emery[10], Guy Eslick[11], Louisa G. Gordon[12], Florian Grimpen[2], Geoff Hebbard[13], Laura Holliday[9], Luke Hourigan[14], Bradley J. Kendall[1,14], Eric Y.T. Lee[3], Angelique Levert[6], Reginald V. Lord[5,6], Sarah J. Lord[5,6], Derek Maule[23], Alan Moss[10,15], Ian Norton[16], Ian Olver[9], Darren Pavey[17], Spiro Raftopoulos[18], Shan Rajendra[19], Mark Schoeman[20,21], Rajvinder Singh[21,22], Freddy Sitas[23], B Mark Smithers[14], Andrew Taylor[24], Melissa L. Thomas[5,6], Iain Thomson[14], Henry To[25], Jutta von Dincklage[9], Christine Vuletich[9], David I. Watson[8], Ian F. Yusoff[18].

[1]Cancer Control Group, QIMR Berghofer Medical Research Institute, Brisbane, Queensland, Australia

[2]Royal Brisbane and Women's Hospital, Brisbane, Queensland, Australia

[3]Westmead Hospital, Sydney, NSW, Australia

[4] Westmead Clinical School, University of Sydney, Sydney, New South Wales, Australia

[5]School of Medicine, University of Notre Dame Australia, Sydney, NSW, Australia

[6]St Vincent's Centre for Applied Medical Research, Sydney, NSW, Australia

[7]Envoi Pathology, Brisbane, Queensland, Australia

[8] Flinders University Department of Surgery, Flinders Medical Centre, Adelaide, South Australia, Australia

[9]Cancer Council Australia, Sydney, New South Wales Australia

[10]University of Melbourne, Melbourne, Victoria, Australia

[11]University of Sydney, Nepean Hospital, New South Wales, Australia

[12] Griffith University, Brisbane, Queensland, Australia

[13]Royal Melbourne Hospital, Melbourne, Victoria, Australia

[14]Princess Alexandra Hospital, University of Queensland, Brisbane, Queensland, Australia

[15]Western Health, Melbourne, Victoria, Australia

[16]Royal North Shore Hospital, Sydney, NSW, Australia

[17]Bankstown and Concord Hospitals, Sydney, NSW, Australia

[18]Sir Charles Gairdner Hospital, Perth, Western Australia, Australia

[19]Bankstown-Lidcombe Hospital, Sydney, NSW, Australia

[20]Royal Adelaide Hospital, Adelaide, South Australia, Australia

[21]University of Adelaide, Adelaide, South Australia, Australia

[22]The Lyell McEwin Hospital, Adelaide, South Australia, Australia

[23]Cancer Council New South Wales, Sydney, NSW, Australia

[24]St Vincent's Hospital, Melbourne, Victoria, Australia

[25]Peter MacCallum Cancer Institute, Melbourne, Victoria, Australia

Address for correspondence

Prof David Whiteman

Head, Cancer Control Group

QIMR Berghofer Medical Research Institute

Locked Bag 2000, Royal Brisbane and Women's Hospital, 4029

Brisbane, Queensland, Australia

Tel: +61 7 3362 0279

Fax: +61 7 3845 3502

Email: David.whiteman@qimrberghofer.edu.au

Author contributions

DCW, MA, FFB, YVB, MJB, IB, AC, AC, JE, GE, LGG, FG, GH, LH, BJK, EYTL, AL, RVL, SJL, AM, IN, DP, SR, SR, MS, RS, FS, BMB, AT, MLT, IT, HT, DIW and IFY reviewed the literature and compiled the evidence summaries. ED, LH, JvD, CV conducted systematic literature searches, screened the primary literature and collated the evidence summaries. IO provided oversight and funding and DM provided consumer input. All authors were involved in drafting and critical revision of the manuscript.

Abbreviations

APC	Argon plasma coagulation
BE	Barrett's esophagus
CLE	columnar lined esophagus
CT	computerized tomography
EAC	esophageal adenocarcinoma
ER	endoscopic resection
EUS	endoscopic ultrasound
FNA	fine needle aspirate
GEJ	gastro-esophageal junction
H pylori	*helicobacter pylori*
HGD	high grade dysplasia
LGD	low grade dysplasia
PDT	photodynamic therapy
PET	positron emission tomography
RFA	radiofrequency ablation

Abstract

Barrett's esophagus (BE), a common condition, is the only known precursor to esophageal adenocarcinoma (EAC). There is uncertainty about the best way to manage BE, since most people with BE never develop EAC and most patients diagnosed with EAC have no preceding diagnosis of BE. Moreover, there have been recent advances in knowledge and practice about the management of BE and early EAC. To aid clinical decision-making in this rapidly moving field, Cancer Council Australia convened an expert working party to identify pertinent clinical questions. The questions covered a wide range of topics including endoscopic and histologic definitions of BE and early EAC; prevalence, incidence, natural history and risk factors for BE; and methods for managing BE and early EAC. The latter considered modification of lifestyle factors; screening and surveillance strategies; and medical, endoscopic and surgical interventions. To answer each question, the working party systematically reviewed the literature and developed a set of recommendations through consensus. Evidence underpinning each recommendation was rated according to quality and applicability.

Keywords:

Barrett's esophagus; esophageal adenocarcinoma; guidelines; clinical practice

Introduction

Barrett's Esophagus (BE) is the only known precursor to esophageal adenocarcinoma (EAC), a cancer with a rapidly rising incidence. Most people with BE never develop EAC however, and most patients diagnosed with EAC have no preceding diagnosis of BE. Thus, there is uncertainty about the best way to manage this condition.

These Guidelines about BE and early EAC are aimed at gastroenterologists, pathologists, surgeons and physicians, and other members of multi-disciplinary teams to which patients with BE and EAC are referred. The Guidelines will also be relevant to primary care practitioners and patients diagnosed with this condition. The need to develop Australian guidelines for the management of BE and early EAC was identified as a priority by a strategic partnership of clinicians, researchers, patients and policy makers initiated by Cancer Council NSW in 2011.

Information covered by the Guidelines includes:

1. Endoscopic and histologic definitions of BE and early EAC
2. Prevalence, incidence, natural history and risk factors for BE
3. Management of BE and early EAC, including modification of lifestyle factors, screening, surveillance, and medical, endoscopic and surgical interventions.

The evidence summaries and recommendations are provided separately for BE without dysplasia and BE with dysplasia and/or early cancer, but do not extend to the management of invasive EAC. The recommendations contained herein should not override good clinical judgement. However they do represent consensus views of expert practitioners and accord with international practices. This publication represents a summary of more extensive material hosted on the Cancer Council Australia Wiki platform [1] which explores the reasons underlying the recommendations in more detail.

Methods

Guideline development was facilitated by Cancer Council Australia, which managed the project and provided in-kind support. No external funding was received for guideline development.

The guidelines were developed by a multidisciplinary working group and used standard methodology [2]. A series of clinical questions were developed to be answered based on systematic reviews. In consultation with the working group, systematic search strategies were developed by project officers using the PICO framework and limits and exclusion criteria were pre-defined to complete the systematic review protocol. Databases searched included The Cochrane Library, PubMed, Embase, Trip Database, Econlit, National Health Service (UK) Economic Evaluation Database, the National Guideline Clearinghouse, the National Comprehensive Cancer Network and the National Institute for Health and Clinical Excellence, Scottish Intercollegiate Guidelines Network and Canadian Medical Association. Search results were screened by project officers and relevant articles were sent to topic authors for critical appraisal with respect to level and quality of evidence, effect size, and clinical importance and relevance. The level of evidence for each article was assigned according to the National Health and Medical Research Council of Australia (NHMRC) Evidence Hierarchy (Table 1).

Each topic author summarized the relevant body of literature and then developed recommendations. Each recommendation was assigned a grade by the working group taking into account the volume, consistency, generalizability, applicability and clinical impact of the supporting evidence (Table 2). When there was insufficient evidence to make a specific recommendation but consensus amongst experts about the advisability of making a clinically relevant statement, the working group formulated “practice points” to guide clinical practice. The working group also reviewed comparable international guidelines to calibrate the recommendations.

The draft guidelines underwent public consultation in June and July 2014. Feedback was reviewed by topic authors and the working group. Subsequent changes to the draft were agreed by consensus of the working group and the final guidelines were released August, 2014. The Wiki guidelines will be reviewed annually and updated as required.

Guidelines for BE without dysplasia

What is the definition of BE and how is it described?

BE is a premalignant condition of the esophagus defined as the presence of metaplastic columnar epithelium [3] which appears endoscopically as salmon pink mucosa extending above the gastro-esophageal junction (GEJ) and into the tubular esophagus, thereby replacing the normal stratified squamous epithelium. [3 4] An accurate diagnosis of BE depends on the endoscopic recognition of the anatomic landmarks at the GEJ and squamocolumnar junction. [5] Using the Prague C & M (Circumferential and Maximal) criteria proposed by the International Working Group for the Classification of Esophagitis [6], the landmark for the GEJ is the proximal end of the gastric folds.

The metaplastic columnar mucosa can be one of three types: gastric-fundic type, cardiac type and intestinal-type. [7] There remains disagreement as to the histologic features of the columnar mucosa necessary to define BE, as reflected in the differing definitions given in European and American guidelines [8 9 10 11]. For the Australian guidelines however, the presence of intestinal metaplasia with morphologically typical goblet cells was considered necessary for the diagnosis of BE.

Biopsies from the tubular esophagus containing columnar mucosa without intestinal metaplasia should be given a descriptive diagnosis (e.g. columnar mucosa without intestinal metaplasia), but it is currently recommended that these are not diagnosed as BE until the biological significance of this entity is clarified.

Intestinal metaplasia occurring in isolation at the gastro-esophageal junction or cardia without metaplasia in the tubular esophagus is not considered BE. It may be a precursor to carcinoma, but the risk is low and surveillance is not warranted. [12, 13] However goblet cells noted in a GEJ biopsy can be confirmed to be intestinal metaplasia in columnar lined esophagus if the particular biopsy fragment shows native esophageal structures such as submucosal glands and/or ducts.

Practice points

To identify patients at increased risk of neoplastic progression, BE is defined as metaplastic columnar mucosa in the tubular esophagus, with intestinal metaplasia proven histologically.

Biopsies to confirm intestinal metaplasia should be performed when any length of possible BE is seen extending above the gastro-esophageal junction.

The extent of BE should be described using the Prague C & M Criteria.

What is the optimal tissue sampling at endoscopy for diagnosis of BE?

Intestinal metaplasia can be patchy and may not be consistently sampled with endoscopic biopsies. [14] (Level of Evidence IV). Advancements in chromoendoscopy (methylene-blue, indigo carmine, and acetic acid), endoscope digital enhancements (Narrow-Band Imaging, i-SCAN, Fujinon Intelligent Chromo Endoscopy) and enhanced-magnification have not been shown to be superior to the currently accepted practice of random four-quadrant biopsies at 2cm intervals. [15, 16 17] (Levels of evidence I, II, IV respectively), however the diagnostic yield may be higher with increasing number of biopsies. (Level of evidence IV) [18] Jumbo biopsy forceps have not been shown to be superior to standard capacity forceps in obtaining adequate biopsy samples (Level of evidence II) [19] Office-based unsedated transnasal endoscopy using pediatric biopsy forceps is well-tolerated and may emerge as a cost-effective strategy. (Level of evidence II) [[20-22]

<u>Recommendation</u>

Random four-quadrant biopsies at 2cm intervals are the mainstay for tissue sampling. (Recommendation grade B)

<u>Practice points</u>

Focal abnormalities such as ulcerated or nodular lesions should be targeted with biopsies and labeled before random biopsies from the rest of the mucosa as minor biopsy-related bleeding is common and may impair endoscopic views.

Technological advancements in chromoendoscopy, digital enhancements and enhanced-magnification complement rather than replace random four-quadrant biopsies at 2cm intervals. Biopsies obtained every 2cm should be placed into separate jars which are labeled according to the distance from the incisors, while biopsies from the gastro-esophageal junction and cardia can also be specifically labelled as such.

Are there biomarkers for the diagnosis of BE?

Numerous biomarkers have been proposed to aid the diagnosis of BE. Estimates of diagnostic accuracy have been reported for: tissue biomarkers, including cytokeratin profiling[23-29], immunohistochemical biomarkers to detect goblet cells such as mucin immunostaining[30, 31], and stress response protein AG2[32]; a serum biomarker (G17[33]); and a non-endoscopic capsule sponge device to collect cytology samples for Trefoil factor 3 immunohistochemistry (TFF3),[34, 35] (Diagnostic accuracy level of evidence II – III-3). These studies provide insufficient evidence to recommend any biomarkers to supplement or replace standard practice use of endoscopy and histopathology due to: study designs with a high risk of bias; wide variation in accuracy estimates across studies; and no comparison with current standard practice.

Recommendation

There is insufficient evidence to recommend cytokeratins, MUC, G17 or AG2 to aid BE diagnosis. (Grade D).

There is insufficient evidence to recommend the non-endoscopic capsule sponge device with TFF3 for BE screening. (Grade C).

What is the prevalence of BE in the Australian population in comparison with other populations?

Globally, the prevalence of BE is low (<5%) but is higher in selected groups such as those with gastro-esophageal reflux disease (>15%). There are no studies describing the prevalence of BE in an asymptomatic, unselected Australian population. One small study suggests a high prevalence in high-risk patient populations. [36] A data linkage study conducted in one Australian health-care region reported prevalence rates at each of three time points as 0.42% (1990), 2.3% (1998), and 4.2% (2002). [37] International studies suggest prevalence varies significantly by ethnicity (e.g. Asians <1% prevalence) and gender (more common in males).

Which factors best predict the risk of developing BE?

Risk factors for BE have been assessed in more than 50 studies. All studies have been observational, and most have been case-control studies of variable quality. From these

studies, the major risk factors identified include age [38], male sex [39], history of frequent gastro-esophageal acid reflux [40], central obesity [41], smoking [42] and family history [43]. (Level of evidence III-3, IV). A few studies have conducted serological assays comparing the prevalence of anti-*H pylori* antibodies between BE cases and controls, reporting risk reductions of about 50% for persons with past infection with *H pylori*. [44, 45] There is no evidence that alcohol consumption or dietary or nutritional factors influence risk [46, 47].

Recommendation

Clinical assessment of a person's future risk of BE should consider their age, sex, history of gastro-esophageal acid reflux, waist-hip ratio or other measures of central adiposity, smoking history, and family history of esophageal adenocarcinoma and/or BE (Grade B)

What is the incidence of neoplasia in patients with BE?

Five population-based, prospective studies with large sample sizes and complete follow-up of patients with uncomplicated BE with no dysplasia have reported progression rates to high-grade dysplasia (HGD) or adenocarcinoma of 2.2-2.6/1000 person-years (py) in Northern Ireland [48, 49], 3.3/1000 py in the Netherlands [50], 1.2/1000 py in Denmark [51] and 3/1000 py in the United Kingdom [52]. Meta-analyses of high-quality studies derived similar estimates of progression risks [53 54].

What are the risk factors for progression from non-dysplastic BE to high-grade dysplasia or adenocarcinoma?

Increased rates of progression from non-dysplastic BE to HGD or adenocarcinoma have been associated with patient factors (age, sex, smoking), endoscopic appearance (greater segment length), and aneuploidy. [48, 55-58] (Level of Evidence III-2). There is observational evidence that regular users of proton pump inhibitors (PPI), non-steroidal anti-inflammatory drugs (NSAIDs) and statins may have lower rates of progression from BE to cancer. [59-64] (Level of evidence: II, III-2, III-3)

Recommendation

Clinical assessment of future risk of high-grade dysplasia or adenocarcinoma in the setting of non-dysplastic BE should consider age, sex, smoking history and endoscopic findings (Grade C).

For which populations is screening for BE cost-effective?

In line with accepted epidemiologic practice, these guidelines reserve 'screening' to describe the process of identifying new cases of disease in an unselected population, whereas 'surveillance' describes the systematic follow-up of patients with known disease at periodic intervals as part of an early detection strategy to prevent progression to cancer.

There is no evidence to support population screening for BE. However, health economic studies generally suggest that one-off screening of 50-year old men with gastro-esophageal reflux disease might be cost-effective. Both the cytosponge [65] and ultra-thin endoscopy [66] may be more cost-effective compared to standard endoscopic screening. General population screening, even if conducted coincident with colonoscopy screening, is not cost-effective.

What is appropriate medical systemic therapy for symptoms associated with BE?

Medical systemic therapy for patients with BE aims to control symptoms and reduce the risk of complications. Uncomplicated BE is not a cause of symptoms (indeed patients with BE may have reduced sensitivity to esophageal acidification); rather these are due to the symptoms of gastro-esophageal reflux. [67] Acid suppression with proton pump inhibitors (PPI) is the most effective systemic therapy for reflux symptoms in patients with BE and will control symptoms in most patients with a durable effect over years (Level of Evidence II, IV) [68, 69] [70-72] [73-75] [76-78] Higher than standard doses of PPI may be required to control symptoms in a proportion of patients. (Level of Evidence IV) [79-81]

<u>Recommendation</u>

Symptomatic patients with BE should be treated with Proton Pump Inhibitor therapy (PPI), with the dose titrated to control symptoms. (Grade C)

Are there any medical or surgical interventions that cause regression of BE?

Regression of BE is defined by a reduction in the length or area of metaplastic columnar epithelium, however the significance of regression in BE is unclear. There are insufficient data to indicate that regression leads to reduced incidence of EAC . The degree of Barrett's regression appears largest amongst patients undergoing anti-reflux surgery although a randomized trial comparing surgical and medical therapy found no significant differences. [76]

Combined analysis of randomized trials has not demonstrated BE regression with medical therapy. [82] (Level of evidence I).

Recommendation

There is insufficient evidence to recommend the use of acid suppressive therapy for the regression of BE (Grade B).

There is insufficient evidence to recommend anti-reflux surgery for the regression of BE (Grade C).

Practice point

Acid suppressive therapy and anti-reflux surgery can be used to control symptoms and heal reflux esophagitis in patients with BE. There is insufficient evidence to recommend high dose (twice daily) acid suppressive therapy when symptom control or mucosal healing is achieved with standard dosing.

Is there a role for ablative therapy to treat BE?

Various endoscopic techniques have been investigated for eradicating BE epithelium, including those that deliver focal ablation (argon plasma coagulation (APC), laser heater probe, and endoscopic mucosal resection (EMR)) and those that ablate broad fields (photodynamic therapy (PDT) and radiofrequency ablation (RFA)).

APC is a widely available monopolar electrocautery method. Randomized trials show that medically treated patients and patients with prior fundoplication can be cleared of Barrett's mucosa whereas control patients do not show significant regression. [83-85]

PDT involves administration of a photosensitiser drug (typically oral aminolevulinic acid, or IV photofrin) and subsequent exposure of the Barrett's mucosa to a laser light. Because of

potentially severe skin sensitivity, the subject must remain in a darkened environment, restricting use of this technology to cooler climate countries.

RFA involves placement of a balloon catheter in the esophagus, through which radiofrequency energy is delivered allowing treatment of a 3cm circumferential segment of the esophagus. Side effects include chest pain, dysphagia and stricture formation. Rare complications such as bleeding and perforation have been noted. Randomized sham controlled studies have shown high levels of eradication of both non-dysplastic (>90%) and dysplastic (>90%) Barrett's mucosa. [82] Long term follow up studies show the response is durable with the majority of patients (>85%) maintaining complete eradication at five years.

Recommendation

Long term outcome studies do not yet support ablation in patients without dysplasia. (Grade B)

Are there any treatments that prevent progression of BE to cancer?

There is limited evidence to support preventive strategies. The choice of anti-reflux therapy (i.e. PPIs versus anti-reflux surgery) has not been shown to influence progression to cancer. There is interest in the use of COX inhibitors, but to date only small trials have been conducted with no clear evidence of benefit. A large randomized controlled trial is being conducted to evaluate the efficacy of aspirin to prevent the onset of cancer in patients with BE [86]. This trial is due to report in 2019.

Ablation therapies have shown benefit in randomized trials, but only in those who have already developed dysplasia. In these individuals, the risk of cancer progression appears to be reduced by approximately 50% by both PDT [87] and RFA [88-90], but cancer risk is not eliminated. The only randomized trial [91] to evaluate ablation (APC) in non-dysplastic Barrett's Esophagus, failed to show benefit for ablation.

Recommendation

Ablation of BE should remain limited to individuals with HGD in BE who are at imminent risk of developing esophageal adenocarcinoma. (Grade B)

Practice points

The treatment of gastro-esophageal reflux with either proton pump inhibitors or anti-reflux surgery has not been shown to influence progression to esophageal adenocarcinoma.

There is currently no high-quality evidence supporting the use of COX inhibitors for prevention of esophageal adenocarcinoma.

How frequently should patients with BE undergo endoscopy?

The aim of surveillance is to detect dysplasia and early cancer for early treatment. Endoscopic surveillance in patients with BE is the current standard of practice [8, 9], although there is no evidence from randomized controlled trials for its effectiveness. There is, however, indirect evidence based on earlier stage and improved survival in EAC patients detected at surveillance, although these retrospective studies are subject to potential lead and length time bias. [92, 93]

Both the British Society of Gastroenterology (BSG) and American Gastroenterological Association (AGA) have published guidelines for endoscopic surveillance of BE. [8, 9] The guidelines differ in the criteria for the diagnosis of BE with both requiring a columnar lined esophagus (CLE) but the AGA also requiring intestinal metaplasia to be present in biopsies from the CLE. This Australian guideline uses the AGA criteria for a diagnosis of BE. British and American guidelines also use the grade of dysplasia found at endoscopy to determine the timing of the subsequent surveillance endoscopy. These recommendations are based on the evidence of an increased risk of esophageal adenocarcinoma with increasing degrees of dysplasia. In those with no dysplasia, the BSG guidelines also take into account the absence of intestinal metaplasia and short-segment (<3cm) length, both of which appear to be associated with a decreased risk of malignant progression. Both guidelines recommend biopsies of any visible lesion or mucosal irregularity and quadrantic biopsies. The BSG guidelines recommend quadrantic biopsies every 2 cm in all surveillance endoscopies. The AGA guidelines recommend Seattle protocol biopsies with quadrantic biopsies every 2 cm unless there is suspected or known dysplasia where every 1 cm is recommended. These biopsy protocols have been shown to increase the detection of advanced (high grade and

early adenocarcinoma) lesions. [94, 95] However, there is low adherence to the protocols [96] resulting in lower detection rates of dysplasia. [97]

The recommendations of the Australian working group for frequency of surveillance are shown in Table 3. The diagnosis of BE requires intestinal metaplasia in biopsies from the CLE. Recommendations for CLE without intestinal metaplasia are discussed below.

Uncertainty regarding risk of low grade dysplasia progression

The optimum management of patients diagnosed with low grade dysplasia (LGD) is uncertain. There is considerable debate about the risks of progression to high grade dysplasia or cancer in this group. Population-based studies report cancer progression rates of ~0.5% p.a. [51]. In contrast, studies undertaken in academic centers in which diagnoses of LGD are made only after review by expert gastrointestinal pathologists report progression rates up to 13% p.a. [98]. Importantly, in those studies, about 85% of patients diagnosed originally with LGD were down-staged to non-dysplastic BE upon expert review. Among down-staged patients, the progression rate was ~0.5% p.a.

Endoscopic surveillance in patients with CLE without intestinal metaplasia

In patients with no intestinal metaplasia or dysplasia detected in biopsies from long-segment (≥ 3cm) CLE, endoscopic surveillance as per the protocol for long segment BE is recommended (i.e. every 2-3 years). If there is 1-<3cm of CLE without intestinal metaplasia or dysplasia, a repeat endoscopy in 3-5 years is suggested with consideration for discharge from surveillance if the repeat endoscopy with Seattle protocol biopsies again shows no intestinal metaplasia or dysplasia. In patients with CLE less than 1cm without intestinal metaplasia or dysplasia on biopsies from the CLE, no endoscopic surveillance is suggested. If dysplasia is found in any biopsies from a CLE without intestinal metaplasia, then recommendations are as per the protocols for BE with dysplasia.

Practice points

In the absence of randomized trial evidence, the frequency of surveillance endoscopy in BE can be guided by current practice guidelines.

It is advisable to undertake endoscopic surveillance in suitable patients with BE. The frequency of surveillance is based on the presence or absence of dysplasia on previous Seattle protocol biopsies and length of Barrett's Esophagus.

A diagnosis of dysplasia (indefinite, low and high grade) should be confirmed by a second, ideally an expert gastrointestinal pathologist.

Esophageal biopsies should be taken according to the Seattle protocol.

Is surveillance cost-effective for follow-up of patients with BE?

A recent systematic review [99] of seven studies [100-106] found inconsistent assessments of the value of surveillance, ranging from being cost-effective to highly cost-ineffective. Hence, surveillance of all patients with non-dysplastic BE may not be cost-effective, but this may change with identification of patients at high risk of progression to EAC .

Are there groups of patients with non-dysplastic BE that require more frequent surveillance?

Surveillance protocols for patients with BE are based on observational studies.[54, 107] However groups of patients may be identified with high rates of progression, and thus who may benefit from more frequent surveillance. Such groups include patients with longer segments of BE (≥3cm) (Level of Evidence III-2) [53, 54, 56, 107-110], as well as older patients, males and smokers. (Level of evidence II, III-2) [48, 55, 57, 111, 112]

Recommendation

Patients with Barrett's Esophagus length equal to or greater than 3cm may have intensive surveillance, possibly every two to three years following the Seattle protocol. (Grade D)

Are there groups of patients with BE that can be discharged from surveillance?

There is limited high-quality evidence to address this question with certainty, although studies are in progress which may yield risk reducing modifiers. II, III-2, III-3

Recommendation

For patients with < 1cm of columnar lined esophagus that do not have evidence of intestinal metaplasia or dysplasia on Seattle protocol biopsy of the segment, endoscopic surveillance is not recommended. (Grade C)

Practice point

Patients with evidence of “regression” of BE (i.e. reduced CLE length or absence of intestinal metaplasia), can still continue surveillance.

Patients with significant co-morbidities, or those unable to tolerate procedural intervention for dysplasia/EAC, may be considered for discharge from surveillance.

Guidelines for BE with dysplasia or early cancer

What are the endoscopic features of neoplasia (dysplasia and early cancer) within a BE segment?

Because random sampling of quadrantic biopsies every two centimeters suffers from sampling error and, at times, limited adherence [97, 113], newer modalities have been proposed including chromoendoscopy, electronic image enhancement technologies and high magnification platforms. There is limited information as to whether these methods can ultimately change patient management. Presently, high resolution white light endoscopy (HR-WLE) remains the gold standard in evaluating patients with BE although the newer modalities may be used in addition to HR-WLE to improve characterization of lesions. [114] Thus, it is important to understand the gross morphological features of dysplasia and early cancer and if available, apply some of the more advanced imaging methods.

Given the inconspicuous nature of dysplasia in BE [115], meticulous inspection and attention to subtle endoscopic anomalies using the best available imaging equipment and endoscopes are warranted. Debris and mucous should be washed off. If there is extensive peristalsis, antispasmodic agents can be used. There is some evidence that cancer preferentially occurs in the distal Barrett's segment [116] and in the two to five o'clock position in patients with shorter segments of BE (<5cm). [117]

All ulcers in BE should be monitored closely for carcinoma. Biopsies should always be taken in depressed regions and if negative, repeated after a course of PPI therapy. Visible lumps or nodules consisting of HGD suggest a more advanced lesion where more sinister pathology may be present. Suspicious lesions visualized on 'white light overview' can be interrogated further with any of the enhanced imaging techniques described above. It is not yet clear, however, whether these modalities can replace biopsies. (Figure 1)

What is the histological definition and grading of dysplasia in patients with BE?

Dysplasia is an unequivocal neoplastic transformation of the epithelial cells that is confined within the basement membrane of the metaplastic glandular tissue within which it arises. Histological features that characterize dysplasia are best identified on standard H&E stained sections and comprise cytological changes and/or architectural changes. [118, 119]

Cytological features involve nuclear changes (such as increase in size, irregular shape, increased nucleus:cytoplasmic ratio, nuclear crowding, hyperchromasia, and the presence of nucleoli) and cytoplasmic changes such as mucin depletion. Dysplastic cells exhibit increased mitotic activity, including atypical forms and surface mitoses. There is typically failure of cellular maturation toward the surface of the mucosa, although this is not always the case. [120] Goblet cell numbers are reduced and dysplastic cells may lose their normal vertical polarity.

Architectural features are irregular gland outline, variability in glandular size, gland crowding with 'back to back' pattern, and villiform surface contour. None of these cytological or architectural features are sufficient to diagnose dysplasia in isolation. Ancillary tests (e.g. p53, AMACR and Ki67 stains) have been advocated to aid the diagnosis of dysplasia, however at present, conventional H&E examination remains the gold standard.

Grading of BE dysplasia is best performed on the H&E stain. Pathologists should report BE biopsies as fitting into one of four categories. [118, 119, 121-123] The rationale for this tiered approach is to stratify patients into categories of increasing risk for development of or concurrent presence of esophageal adenocarcinoma. Many papers have shown an increasing risk ranging from small (negative for dysplasia) to significant (high grade dysplasia). [124]

1. Negative for dysplasia
2. Indefinite for dysplasia - when the pathologist believes that the biopsy is displaying some features of true dysplasia but is unable to exclude a non-neoplastic process as the cause of the abnormality. In general the consideration is whether the histological features are sufficient to diagnose low grade dysplasia. However, in some situations the pathologist is concerned that the features may represent high grade dysplasia. The concept of indefinite for high grade dysplasia/adenocarcinoma has not been studied specifically, however pathologists recognize a subgroup of indefinite for dysplasia where the cytological and/or architectural abnormality is marked but a confident diagnosis of HGD cannot be made. In some of these situations the concern is that invasive adenocarcinoma may exist.

3. Low-grade dysplasia - displays mild to moderate cytologic atypia and, at most, mild disturbance of gland architecture. The neoplastic epithelial cells are crowded, elongated and hyperchromatic. The cells generally retain their vertical polarity.
4. High-grade dysplasia - typically displays both architectural abnormality and severe cytologic atypia. Aberrant architectural features include glandular crowding, branching or budding glands, villiform, cribriform, micropapillary or cystically dilated crypt patterns. Cytological features include complete loss of cell polarity, rounded enlarged nuclei with irregular thickened nuclear membranes and conspicuous nucleoli. Typical and atypical mitotic figures are readily identified at all levels within the glands, as well as on the luminal surface.

Grading of dysplasia is subject to significant interobserver variability [125-127] , especially LGD. Interobserver variability among general histopathologists ranges from kappa values of 0.14 to 0.32. Specialist gastrointestinal histopathologists have better agreement (kappa 0.48-0.69). [128] When a diagnosis of LGD made by a general histopathologist is reviewed by an expert panel, the diagnosis is most often down-graded to 'negative for dysplasia'.

These data support the notion that all cases of BE diagnosed as dysplasia (indefinite, low or high grade) should be reviewed by at least one expert GI pathologist.

What are the histological features of early adenocarcinoma of the esophagus?

Early adenocarcinoma refers to invasion into mucosa or superficial submucosa, but not deeper (T1 in the current TNM system). Adenocarcinoma exists when there is invasion beyond the basement membrane of the epithelium. The histological features identifying that invasion has occurred include: [129, 130]

1. Single neoplastic cells or small clusters of neoplastic cells in the lamina propria.
2. Complex architectural patterns characterized by solid growth patterns, tight cribriform growth pattern, glands with acute angulation in at least one part of their outline, and a pattern of anastomosing fusion of small glands.
3. Neoplastic cells invading overlying squamous epithelium.
4. Desmoplastic stromal reaction.

Significant interobserver variability exists between pathologists in the separation of HGD from early invasive adenocarcinoma in biopsy specimens. [131] Recent studies have identified a variety of histological patterns that predict invasive adenocarcinoma including solid or cribriform growth patterns, ulceration of dysplastic epithelium, abundant neutrophils within dysplastic epithelium, dilated neoplastic glands containing necrotic debris, dysplastic glandular epithelium being incorporated into squamous epithelium. The risk of adenocarcinoma is increased with number of features present. [132]

The histological report of endoscopic mucosal resections should include data that are important for clinical management, particularly the identification of patients who should be considered for esophagectomy. These are discussed in greater detail in the guidelines for reporting esophageal and gastro-esophageal carcinomas provided by the Royal College of Pathologists of Australasia [133].

What are the best modalities for accurately staging early esophageal adenocarcinoma?

Early esophageal adenocarcinomas are those defined as intra-mucosal adenocarcinoma (T1a) or superficial submucosal adenocarcinoma (T1b). [114] A more comprehensive sub-classification of early esophageal cancers has been proposed with mucosal disease and submucosal disease divided into three categories respectively (m1-3/4, and sm1-3) based on depth of invasion.

Options for staging of early EAC include:

1. Endoscopic biopsy
2. Endoscopic resection (ER) (also known as endoscopic mucosal resection or EMR)
3. Endoscopic ultrasound (EUS) with or without fine needle aspirate (FNA)
4. Positron emission tomography-computerized tomography (PET-CT), once the diagnosis of cancer has been confirmed

Endoscopic biopsy is useful, but is subject to sampling error. ER is superior to biopsy and results in a change in diagnosis in up to 50% of patients with dysplasia or adenocarcinoma. (Level of evidence IV) [134-137] Moreover, ER allows improved pathological staging of HGD and

T1m and T1sm adenocarcinoma as compared with biopsy and endoscopic ultrasound (EUS). (Level of evidence IV) [136] [138] (Figure 2) Rates of adverse events following ER, such as perforation, bleeding and stricturing, are low when performed at expert centers. (Level of evidence IV) [138] [139, 140]. Endoscopic ultrasound is not accurate for determining the stage of early esophageal adenocarcinoma, especially distinguishing T1m from T1sm tumors. It is useful for differentiating T1 and >T1 stages. (Level of evidence IV) [141, 142] Endoscopic ultrasound and EUS-guide fine-needle aspiration (EUS-FNA) are superior to computed tomography (CT) for locoregional lymph node staging (Level of evidence IV) [143, 144]

Recommendations

Endoscopic resection is the most accurate staging modality for early esophageal adenocarcinoma for suitable lesions and where appropriate expertise is available. (Grade D)

Endoscopic ultrasound can be used prior to endoscopic resection when deeper invasion is considered likely, particularly for lesions with ulcerated or depressed morphology. (Grade D)

FDG-PET or PET/CT is not routinely indicated in staging early esophageal adenocarcinoma. It is best used for the staging of distant metastases or in cases of suspected more advanced local disease. (Grade D)

What is the appropriate management of low grade dysplasia in patients with BE?

Recent studies suggest that when the diagnosis of LGD is agreed on by two or more expert pathologists, the risk of progression to neoplasia is higher than previously reported. (Level of evidence III-2) [88, 98, 145] British and American guidelines recommend increased frequency of surveillance. [8, 9] Endoscopic ablation with a range of methods is associated with lower rates of progression to cancer. (Level of Evidence IV) [146] In particular, an RCT reported that RFA in patients with confirmed LGD have significantly lower rates of progression to cancer or HGD, although as yet there is no evidence of an overall survival benefit. (Level of Evidence II) [88]

Recommendations

The diagnosis of LGD should be confirmed by a second pathologist, ideally an expert gastrointestinal pathologist. (Grade C)

In patients with confirmed LGD, it is advised to perform rigorous high definition endoscopy or refer to an expert centre for assessment. (Grade C)

In patients with confirmed LGD, intensified endoscopic surveillance is required. Endoscopic ablation may be considered especially where low grade dysplasia is definite, multifocal and present on more than one occasion. This decision needs to be individualized, based on discussion of risk and benefits with the patient. (Grade B)

What are the goals of treatment of HGD in patients with BE?

There is no high level evidence which directly answers this question, and so the guidelines are based on expert opinion. As HGD is prone to both over- and under-staging, the first goal of management is to confirm the diagnosis.

Once HGD has been confirmed, the goal of treatment is to prevent the progression to malignancy through the removal of dysplastic tissue. More specifically the goals of treatment are:

1. The removal of all dysplastic tissue[114]
2. The removal of all Barrett's metaplasia if possible[114]
3. Preservation of normal swallowing/nutrition
4. Minimization of morbidity due to the eradication technique
5. Confirmation of the diagnosis of HGD (ie: exclusion of malignancy) through examination of resected tissue (endoscopically or surgically), where possible
6. Continued follow up in patients who have had endoscopic therapy[114]

There is no management strategy which perfectly fulfils all these criteria. Current practice favors endotherapy (ER or ablation) over surveillance or esophagectomy for HGD/T1a cancer although no randomized control trials have compared the two modalities directly. All patients should be discussed at a multidisciplinary meeting.

<u>Practice point</u>

The confirmation of HGD should act as a trigger for definitive treatment.

What is the best endoscopic treatment for HGD in patients with BE?

Endoscopic mucosal resection alters histological grade or local T stage in 48% of patients and reduces esophagectomy rates by providing an effective local therapy. ER has a high success rate (94%) for complete Barrett's excision in short segment BE. (Level of Evidence IV) [139] Radiofrequency ablation has been shown to completely eradicate HGD in 81% of patients at one year of follow-up vs 19% complete eradication in patients undergoing endoscopic surveillance alone. Similar outcomes are reported following radiofrequency ablation at two and three-years of follow-up with 95% and 96% complete eradication, respectively. (Level of Evidence II) [89, 90] (Figure 3)

Recommendations

ER should be considered for patients with intramucosal adenocarcinoma or HGD and visible/nodular lesions. (Grade D)

RFA should be considered for patients with HGD within flat segments of Barrett's esophagus. RFA is not appropriate in patients with visible abnormalities, these should be treated by ER. RFA may be the preferred treatment strategy over ER for patients with long segment BE or circumferential Barrett's due to a lower rate of stricture formation. (Grade B)

Practice point

It is advisable to refer patients with BE and dysplasia or early EAC to tertiary referral centers for management.

What is the best endoscopic management of early esophageal adenocarcinoma?

Early EAC comprises the histological tumor classification of T1a (invasion into the mucosa) and T1b (invasion into submucosa but not muscularis propria). The depth of invasion can be further stratified based on mucosal (m1-m3 / m1-m4) or submucosal (sm1-sm3) involvement. [123, 147] Endoscopic resection is the most accurate T staging modality for early EAC. (Level of Evidence IV) [137, 139] (Figure 4) The risk of lymph node involvement with T1a and T1b early EAC is 1.3-2.5% and 12-31% respectively. [148-151] Unlike locally advanced or

node-involving disease, early EAC can often be cured with surgical or endoscopic approaches. Endoscopic treatment is less morbid and expensive than esophagectomy, and is organ preserving. [152] Endoscopic mucosal resection is effective for T1a early esophageal adenocarcinoma when performed in experienced centers. Selected patients with T1b early esophageal adenocarcinoma may benefit from endoscopic resection if esophagectomy is not indicated. (Levels of Evidence II, III-2, IV) [153, 154 155-157]

Recommendations

All lesions and visible abnormalities should be staged by focal endoscopic resection. (Grade D)

If endoscopic resection of early EAC is planned, endoscopic mucosal resection is appropriate in most cases. Ablative therapies should not be used as primary endoscopic therapy for early esophageal adenocarcinoma. (Grade C)

Patients with T1a adenocarcinoma on endoscopic work-up should be offered endoscopic resection in preference to esophagectomy. (Grade D) Selected patients with T1b early EAC may also be offered endoscopic resection, but only if esophagectomy is not indicated. (Grade D)

Following resection of early esophageal adenocarcinoma the remaining Barrett's mucosa should be eradicated. Barrett's eradication options include complete endoscopic resection, radiofrequency ablation, cryotherapy and argon plasma coagulation. (Grade C)

Following resection of early esophageal adenocarcinoma the patient should undergo regular and careful surveillance examinations. (Grade C)

Practice point

Endoscopic resection of early EAC should be performed in referral centres that have integrated expertise in endoscopy, imaging, surgery, and histopathology.

Careful and dedicated endoscopic interrogation of all Barrett's mucosa is advised.

After successful endoscopic treatment for BE neoplasia, how frequently should patients undergo endoscopy?

There is no high level evidence which directly answers this question, and so the guidelines are based on expert opinion. Following endoscopic treatment for BE with neoplasia, patients should be considered for three monthly surveillance endoscopies with Seattle protocol to confirm clearance of disease. Once clearance has been achieved, consider 6 monthly endoscopic surveillance for one year, then annually. Higher risk patients may require closer surveillance endoscopy after clearance of BE neoplasia is achieved (i.e. initially 3 monthly for a year). Endoscopic resection of mucosal irregularities (nodules, depressed areas) in the squamous epithelium should be considered to clarify possible recurrent or metachronous intramucosal adenocarcinoma from subsquamous glands.

Practice point

Consider three monthly surveillance endoscopy with Seattle protocol during the endoscopic treatment phase to confirm clearance of intramucosal adenocarcinoma and residual Barrett's esophagus. Once clearance has been achieved, consider 6 monthly endoscopic surveillance for one year, then annually.

Higher risk patients may require closer surveillance endoscopy after clearance of BE neoplasia is achieved (i.e. initially 3 monthly for a year). Endoscopic resection of any nodularity in the squamous epithelium should be considered to clarify possible recurrent or metachronous cancer from subsquamous glands.

What endoscopic surveillance protocol should be followed for patients with high grade dysplasia?

Surveillance is generally not indicated for patients with HGD and therapeutic intervention must be considered instead.

How effective is endoscopic management compared with surgical management for HGD in patients with BE?

There are no randomized controlled trials comparing surgery with endoscopic treatments for HGD. Evidence therefore comes largely from non-randomized retrospective studies. These studies report that endoscopic treatment of HGD provides similar outcomes to

surgery with regard to overall survival and cancer related mortality. (Level of Evidence III-2) [153, 158-162]. In addition, the studies tend to report that compared to surgery, endoscopic treatments result in less morbidity but higher rates of local recurrence. (Level of Evidence III-2) [153, 158-162]

Recommendation

Patients with HGD in BE should be managed in centers with high volume experience of the condition. The treatment and follow-up should occur in those specialist centers. (Grade C)

Practice points

Patients with HGD in BE can be discussed at a multidisciplinary team meeting at a specialist centre.

Endoscopic treatment will be the first line treatment option for the majority of patients with HGD in Barrett's Esophagus. There will be a group of patients for whom endoscopic treatment is not appropriate or successful and they will be best treated with surgery in a specialist centre.

Acknowledgements

The guidelines development process was supported by the Cancer Council Australia (CCA). We thank the CCA guidelines team for their work in supporting this process.

References

1. Cancer Council Australia Barrett's Oesophagus Guidelines Working Party. Clinical practice guidelines for the diagnosis and management of Barrett's Oesophagus and Early Oesophageal Adenocarcinoma. 2014. http://wiki.cancer.org.au/australia/Guidelines:Barrett%27s.
2. Cancer Council Australia. Development of Clinical Practice Guidelines Using Cancer Council Australia's Cancer Guidelines Wiki. . Handbook for section authors and the guideline working party. Sydney: Cancer Council Australia; 2014.
3. Vakil N, van Zanten SV, Kahrilas P, Dent J, Jones R. The Montreal definition and classification of gastroesophageal reflux disease: a global evidence-based consensus. *The American journal of gastroenterology* 2006; **101**(8): 1900-20; quiz 43.
4. Shaheen NJ, Richter JE. Barrett's oesophagus. *Lancet* 2009; **373**(9666): 850-61.
5. Ishimura N, Amano Y, Appelman HD, et al. Barrett's esophagus: endoscopic diagnosis. *Annals of the New York Academy of Sciences* 2011; **1232**: 53-75.
6. Sharma P, Dent J, Armstrong D, et al. The development and validation of an endoscopic grading system for Barrett's esophagus: the Prague C & M criteria. *Gastroenterology* 2006; **131**(5): 1392-9.
7. Paull A, Trier JS, Dalton MD, Camp RC, Loeb P, Goyal RK. The histologic spectrum of Barrett's esophagus. *The New England journal of medicine* 1976; **295**(9): 476-80.
8. Fitzgerald RC, di Pietro M, Ragunath K, et al. British Society of Gastroenterology guidelines on the diagnosis and management of Barrett's oesophagus. *Gut* 2014; **63**(1): 7-42.
9. Spechler SJ, Sharma P, Souza RF, Inadomi JM, Shaheen NJ. American Gastroenterological Association medical position statement on the management of Barrett's esophagus. *Gastroenterology* 2011; **140**(3): 1084-91.
10. Spechler SJ, Sharma P, Souza RF, Inadomi JM, Shaheen NJ. American Gastroenterological Association technical review on the management of Barrett's esophagus. *Gastroenterology* 2011; **140**(3): e18-52; quiz e13.
11. Wang KK, Sampliner RE. Updated guidelines 2008 for the diagnosis, surveillance and therapy of Barrett's esophagus. *The American journal of gastroenterology* 2008; **103**(3): 788-97.
12. Jung KW, Talley NJ, Romero Y, et al. Epidemiology and natural history of intestinal metaplasia of the gastroesophageal junction and Barrett's esophagus: a population-based study. *The American journal of gastroenterology* 2011; **106**(8): 1447-55; quiz 56.

13. Sharma P, Weston AP, Morales T, Topalovski M, Mayo MS, Sampliner RE. Relative risk of dysplasia for patients with intestinal metaplasia in the distal oesophagus and in the gastric cardia. *Gut* 2000; **46**(1): 9-13.
14. Endlicher E, Rummele P, Beer S, et al. Barrett's esophagus: a discrepancy between macroscopic and histological diagnosis. *Endoscopy* 2005; **37**(11): 1131-5.
15. Ferguson DD, DeVault KR, Krishna M, Loeb DS, Wolfsen HC, Wallace MB. Enhanced magnification-directed biopsies do not increase the detection of intestinal metaplasia in patients with GERD. *The American journal of gastroenterology* 2006; **101**(7): 1611-6.
16. Ngamruengphong S, Sharma VK, Das A. Diagnostic yield of methylene blue chromoendoscopy for detecting specialized intestinal metaplasia and dysplasia in Barrett's esophagus: a meta-analysis. *Gastrointestinal endoscopy* 2009; **69**(6): 1021-8.
17. Admad NZ, Ahmed A. A meta-analysis of randomized controlled trials comparing methylene blue-directed biopsies with random biopsies in the surveillance of Barrett's esophagus. *Esophagus* 2010; **7**(4): 207-13.
18. Harrison R, Perry I, Haddadin W, et al. Detection of intestinal metaplasia in Barrett's esophagus: an observational comparator study suggests the need for a minimum of eight biopsies. *The American journal of gastroenterology* 2007; **102**(6): 1154-61.
19. Gonzalez S, Yu WM, Smith MS, et al. Randomized comparison of 3 different-sized biopsy forceps for quality of sampling in Barrett's esophagus. *Gastrointestinal endoscopy* 2010; **72**(5): 935-40.
20. Garcia RT, Cello JP, Nguyen MH, et al. Unsedated ultrathin EGD is well accepted when compared with conventional sedated EGD: a multicenter randomized trial. *Gastroenterology* 2003; **125**(6): 1606-12.
21. Jobe BA, Hunter JG, Chang EY, et al. Office-based unsedated small-caliber endoscopy is equivalent to conventional sedated endoscopy in screening and surveillance for Barrett's esophagus: a randomized and blinded comparison. *The American journal of gastroenterology* 2006; **101**(12): 2693-703.
22. Shariff MK, Bird-Lieberman EL, O'Donovan M, et al. Randomized crossover study comparing efficacy of transnasal endoscopy with that of standard endoscopy to detect Barrett's esophagus. *Gastrointestinal endoscopy* 2012; **75**(5): 954-61.
23. El-Zimaity HM, Graham DY. Cytokeratin subsets for distinguishing Barrett's esophagus from intestinal metaplasia in the cardia using endoscopic biopsy specimens. *The American journal of gastroenterology* 2001; **96**(5): 1378-82.

24. Kurtkaya-Yapicier O, Gencosmanoglu R, Avsar E, Bakirci N, Tozun N, Sav A. The utility of cytokeratins 7 and 20 (CK7/20) immunohistochemistry in the distinction of short-segment Barrett esophagus from gastric intestinal metaplasia: Is it reliable? *BMC clinical pathology* 2003; **3**(1): 5.
25. Mohammed IA, Streutker CJ, Riddell RH. Utilization of cytokeratins 7 and 20 does not differentiate between Barrett's esophagus and gastric cardiac intestinal metaplasia. *Modern pathology : an official journal of the United States and Canadian Academy of Pathology, Inc* 2002; **15**(6): 611-6.
26. Ormsby AH, Vaezi MF, Richter JE, et al. Cytokeratin immunoreactivity patterns in the diagnosis of short-segment Barrett's esophagus. *Gastroenterology* 2000; **119**(3): 683-90.
27. Schilling D, Spiethoff A, Rosenbaum A, et al. Does Cytokeratin7/20 immunoreactivity help to distinguish Barrett's esophagus from gastric intestinal metaplasia? Results of a prospective study of 75 patients. *Pathology, research and practice* 2005; **200**(11-12): 801-5.
28. White NM, Gabril M, Ejeckam G, et al. Barrett's esophagus and cardiac intestinal metaplasia: two conditions within the same spectrum. *Canadian journal of gastroenterology = Journal canadien de gastroenterologie* 2008; **22**(4): 369-75.
29. Yim HJ, Lee SW, Choung RS, et al. Is cytokeratin immunoreactivity useful in the diagnosis of short-segment Barrett's oesophagus in Korea? *European journal of gastroenterology & hepatology* 2005; **17**(6): 611-6.
30. Glickman JN, Shahsafaei A, Odze RD. Mucin core peptide expression can help differentiate Barrett's esophagus from intestinal metaplasia of the stomach. *The American journal of surgical pathology* 2003; **27**(10): 1357-65.
31. McIntire MG, Soucy G, Vaughan TL, Shahsafaei A, Odze RD. MUC2 is a highly specific marker of goblet cell metaplasia in the distal esophagus and gastroesophageal junction. *The American journal of surgical pathology* 2011; **35**(7): 1007-13.
32. Groome M, Lindsay J, Ross PE, Cotton JP, Hupp TR, Dillon JF. Use of oesophageal stress response proteins as potential biomarkers in the screening for Barrett's oesophagus. *European journal of gastroenterology & hepatology* 2008; **20**(10): 961-5.
33. Sipponen P, Vauhkonen M, Helske T, Kaariainen I, Harkonen M. Low circulating levels of gastrin-17 in patients with Barrett's esophagus. *World journal of gastroenterology : WJG* 2005; **11**(38): 5988-92.
34. Kadri SR, Lao-Sirieix P, O'Donovan M, et al. Acceptability and accuracy of a non-endoscopic screening test for Barrett's oesophagus in primary care: cohort study. *BMJ (Clinical research ed)* 2010; **341**: c4372.

35. Lao-Sirieix P, Boussioutas A, Kadri SR, et al. Non-endoscopic screening biomarkers for Barrett's oesophagus: from microarray analysis to the clinic. *Gut* 2009; **58**(11): 1451-9.
36. Nandurkar S, Talley NJ, Martin CJ, Ng TH, Adams S. Short segment Barrett's oesophagus: prevalence, diagnosis and associations. *Gut* 1997; **40**(6): 710-5.
37. Kendall BJ, Whiteman DC. Temporal changes in the endoscopic frequency of new cases of Barrett's esophagus in an Australian health region. *The American journal of gastroenterology* 2006; **101**(6): 1178-82.
38. Corley DA, Kubo A, Levin TR, et al. Race, ethnicity, sex and temporal differences in Barrett's oesophagus diagnosis: a large community-based study, 1994-2006. *Gut* 2009; **58**(2): 182-8.
39. Cook MB, Wild CP, Forman D. A systematic review and meta-analysis of the sex ratio for Barrett's esophagus, erosive reflux disease, and nonerosive reflux disease. *American journal of epidemiology* 2005; **162**(11): 1050-61.
40. Taylor JB, Rubenstein JH. Meta-analyses of the effect of symptoms of gastroesophageal reflux on the risk of Barrett's esophagus. *The American journal of gastroenterology* 2010; **105**(8): 1729, 30-7; quiz 38.
41. Singh S, Sharma AN, Murad MH, et al. Central adiposity is associated with increased risk of esophageal inflammation, metaplasia, and adenocarcinoma: a systematic review and meta-analysis. *Clinical gastroenterology and hepatology : the official clinical practice journal of the American Gastroenterological Association* 2013; **11**(11): 1399-412.e7.
42. Cook MB, Shaheen NJ, Anderson LA, et al. Cigarette smoking increases risk of Barrett's esophagus: an analysis of the Barrett's and Esophageal Adenocarcinoma Consortium. *Gastroenterology* 2012; **142**(4): 744-53.
43. Chak A, Lee T, Kinnard MF, et al. Familial aggregation of Barrett's oesophagus, oesophageal adenocarcinoma, and oesophagogastric junctional adenocarcinoma in Caucasian adults. *Gut* 2002; **51**(3): 323-8.
44. Corley DA, Kubo A, Levin TR, et al. Helicobacter pylori infection and the risk of Barrett's oesophagus: a community-based study. *Gut* 2008; **57**(6): 727-33.
45. Thrift AP, Pandeya N, Smith KJ, et al. Helicobacter pylori infection and the risks of Barrett's oesophagus: a population-based case-control study. *International journal of cancer Journal international du cancer* 2012; **130**(10): 2407-16.
46. Anderson LA, Cantwell MM, Watson RG, et al. The association between alcohol and reflux esophagitis, Barrett's esophagus, and esophageal adenocarcinoma. *Gastroenterology* 2009; **136**(3): 799-805.

47. Thrift AP, Pandeya N, Smith KJ, et al. Lifetime alcohol consumption and risk of Barrett's Esophagus. *The American journal of gastroenterology* 2011; **106**(7): 1220-30.
48. Bhat S, Coleman HG, Yousef F, et al. Risk of malignant progression in Barrett's esophagus patients: results from a large population-based study. *Journal of the National Cancer Institute* 2011; **103**(13): 1049-57.
49. Murray L, Watson P, Johnston B, Sloan J, Mainie IM, Gavin A. Risk of adenocarcinoma in Barrett's oesophagus: population based study. *BMJ (Clinical research ed)* 2003; **327**(7414): 534-5.
50. Schouten LJ, Steevens J, Huysentruyt CJ, et al. Total cancer incidence and overall mortality are not increased among patients with Barrett's esophagus. *Clinical gastroenterology and hepatology : the official clinical practice journal of the American Gastroenterological Association* 2011; **9**(9): 754-61.
51. Hvid-Jensen F, Pedersen L, Drewes AM, Sorensen HT, Funch-Jensen P. Incidence of adenocarcinoma among patients with Barrett's esophagus. *The New England journal of medicine* 2011; **365**(15): 1375-83.
52. Alexandropoulou K, van Vlymen J, Reid F, Poullis A, Kang JY. Temporal trends of Barrett's oesophagus and gastro-oesophageal reflux and related oesophageal cancer over a 10-year period in England and Wales and associated proton pump inhibitor and H2RA prescriptions: a GPRD study. *European journal of gastroenterology & hepatology* 2013; **25**(1): 15-21.
53. Thomas T, Abrams KR, De Caestecker JS, Robinson RJ. Meta analysis: Cancer risk in Barrett's oesophagus. *Alimentary pharmacology & therapeutics* 2007; **26**(11-12): 1465-77.
54. 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**(7): 970-6.
55. Coleman HG, Bhat S, Johnston BT, McManus D, Gavin AT, Murray LJ. Tobacco smoking increases the risk of high-grade dysplasia and cancer among patients with Barrett's esophagus. *Gastroenterology* 2012; **142**(2): 233-40.
56. Coleman HG, Bhat SK, Murray LJ, et al. Symptoms and endoscopic features at barrett's esophagus diagnosis: implications for neoplastic progression risk. *The American journal of gastroenterology* 2014; **109**(4): 527-34.
57. de Jonge PJ, van Blankenstein M, Looman CW, Casparie MK, Meijer GA, Kuipers EJ. Risk of malignant progression in patients with Barrett's oesophagus: a Dutch nationwide cohort study. *Gut* 2010; **59**(8): 1030-6.

58. Reid BJ, Levine DS, Longton G, Blount PL, Rabinovitch PS. Predictors of progression to cancer in Barrett's esophagus: baseline histology and flow cytometry identify low- and high-risk patient subsets. *The American journal of gastroenterology* 2000; **95**(7): 1669-76.

59. Kastelein F, Spaander MC, Biermann K, Steyerberg EW, Kuipers EJ, Bruno MJ. Nonsteroidal anti-inflammatory drugs and statins have chemopreventative effects in patients with Barrett's esophagus. *Gastroenterology* 2011; **141**(6): 2000-8; quiz e13-4.

60. Kastelein F, Spaander MC, Steyerberg EW, et al. Proton pump inhibitors reduce the risk of neoplastic progression in patients with Barrett's esophagus. *Clinical gastroenterology and hepatology : the official clinical practice journal of the American Gastroenterological Association* 2013; **11**(4): 382-8.

61. Nguyen DM, El-Serag HB, Henderson L, Stein D, Bhattacharyya A, Sampliner RE. Medication usage and the risk of neoplasia in patients with Barrett's esophagus. *Clinical gastroenterology and hepatology : the official clinical practice journal of the American Gastroenterological Association* 2009; **7**(12): 1299-304.

62. Kantor ED, Onstad L, Blount PL, Reid BJ, Vaughan TL. Use of statin medications and risk of esophageal adenocarcinoma in persons with Barrett's esophagus. *Cancer epidemiology, biomarkers & prevention : a publication of the American Association for Cancer Research, cosponsored by the American Society of Preventive Oncology* 2012; **21**(3): 456-61.

63. Singh S, Garg SK, Singh PP, Iyer PG, El-Serag HB. Acid-suppressive medications and risk of oesophageal adenocarcinoma in patients with Barrett's oesophagus: a systematic review and meta-analysis. *Gut* 2014; **63**(8): 1229-37.

64. Singh S, Singh AG, Singh PP, Murad MH, Iyer PG. Statins are associated with reduced risk of esophageal cancer, particularly in patients with Barrett's esophagus: a systematic review and meta-analysis. *Clinical gastroenterology and hepatology : the official clinical practice journal of the American Gastroenterological Association* 2013; **11**(6): 620-9.

65. Benaglia T, Sharples LD, Fitzgerald RC, Lyratzopoulos G. Health benefits and cost effectiveness of endoscopic and nonendoscopic cytosponge screening for Barrett's esophagus. *Gastroenterology* 2013; **144**(1): 62-73.e6.

66. Nietert PJ, Silverstein MD, Mokhashi MS, et al. Cost-effectiveness of screening a population with chronic gastroesophageal reflux. *Gastrointestinal endoscopy* 2003; **57**(3): 311-8.

67. Johnson DA, Winters C, Spurling TJ, Chobanian SJ, Cattau EL, Jr. Esophageal acid sensitivity in Barrett's esophagus. *Journal of clinical gastroenterology* 1987; **9**(1): 23-7.

68. Malesci A, Savarino V, Zentilin P, et al. Partial regression of Barrett's esophagus by long-term therapy with high-dose omeprazole. *Gastrointestinal endoscopy* 1996; **44**(6): 700-5.

69. Sontag SJ, Schnell TG, Chejfec G, Kurucar C, Karpf J, Levine G. Lansoprazole heals erosive reflux oesophagitis in patients with Barrett's oesophagus. *Alimentary pharmacology & therapeutics* 1997; **11**(1): 147-56.

70. Fass R, Sampliner RE, Malagon IB, et al. Failure of oesophageal acid control in candidates for Barrett's oesophagus reversal on a very high dose of proton pump inhibitor. *Alimentary pharmacology & therapeutics* 2000; **14**(5): 597-602.

71. Ortiz A, Martinez de Haro LF, Parrilla P, Molina J, Bermejo J, Munitiz V. 24-h pH monitoring is necessary to assess acid reflux suppression in patients with Barrett's oesophagus undergoing treatment with proton pump inhibitors. *The British journal of surgery* 1999; **86**(11): 1472-4.

72. Yeh RW, Gerson LB, Triadafilopoulos G. Efficacy of esomeprazole in controlling reflux symptoms, intraesophageal, and intragastric pH in patients with Barrett's esophagus. *Diseases of the esophagus : official journal of the International Society for Diseases of the Esophagus / ISDE* 2003; **16**(3): 193-8.

73. Attwood SE, Lundell L, Hatlebakk JG, et al. Medical or surgical management of GERD patients with Barrett's esophagus: the LOTUS trial 3-year experience. *Journal of gastrointestinal surgery : official journal of the Society for Surgery of the Alimentary Tract* 2008; **12**(10): 1646-54; discussion 54-5.

74. Frazzoni M, Savarino E, Manno M, et al. Reflux patterns in patients with short-segment Barrett's oesophagus: a study using impedance-pH monitoring off and on proton pump inhibitor therapy. *Alimentary pharmacology & therapeutics* 2009; **30**(5): 508-15.

75. Watson JT, Moawad FJ, Veerappan GR, et al. The dose of omeprazole required to achieve adequate intraesophageal acid suppression in patients with gastroesophageal junction specialized intestinal metaplasia and Barrett's esophagus. *Digestive diseases and sciences* 2013; **58**(8): 2253-60.

76. Parrilla P, Martinez de Haro LF, Ortiz A, et al. Long-term results of a randomized prospective study comparing medical and surgical treatment of Barrett's esophagus. *Annals of surgery* 2003; **237**(3): 291-8.

77. Sampliner RE. Effect of up to 3 years of high-dose lansoprazole on Barrett's esophagus. *The American journal of gastroenterology* 1994; **89**(10): 1844-8.

78. Zaninotto G, Parente P, Salvador R, et al. Long-term follow-up of Barrett's epithelium: medical versus antireflux surgical therapy. *Journal of gastrointestinal surgery : official journal of the Society for Surgery of the Alimentary Tract* 2012; **16**(1): 7-14; discussion -5.

79. Basu KK, Bale R, West KP, de Caestecker JS. Persistent acid reflux and symptoms in patients with Barrett's oesophagus on proton-pump inhibitor therapy. *European journal of gastroenterology & hepatology* 2002; **14**(11): 1187-92.

80. Frazzoni M, Manno M, De Micheli E, Savarino V. Efficacy in intra-oesophageal acid suppression may decrease after 2-year continuous treatment with proton pump inhibitors. *Digestive and liver disease : official journal of the Italian Society of Gastroenterology and the Italian Association for the Study of the Liver* 2007; **39**(5): 415-21.

81. Sharma P, Sampliner RE, Camargo E. Normalization of esophageal pH with high-dose proton pump inhibitor therapy does not result in regression of Barrett's esophagus. *The American journal of gastroenterology* 1997; **92**(4): 582-5.

82. Rees JR, Lao-Sirieix P, Wong A, Fitzgerald RC. Treatment for Barrett's oesophagus. *The Cochrane database of systematic reviews* 2010; (1): Cd004060.

83. Ackroyd R, Tam W, Schoeman M, Devitt PG, Watson DI. Prospective randomized controlled trial of argon plasma coagulation ablation vs. endoscopic surveillance of patients with Barrett's esophagus after antireflux surgery. *Gastrointestinal endoscopy* 2004; **59**(1): 1-7.

84. Bright T, Watson DI, Tam W, et al. Prospective randomized trial of argon plasma coagulation ablation versus endoscopic surveillance of Barrett's esophagus in patients treated with antisecretory medication. *Digestive diseases and sciences* 2009; **54**(12): 2606-11.

85. Bright T, Watson DI, Tam W, et al. Randomized trial of argon plasma coagulation versus endoscopic surveillance for barrett esophagus after antireflux surgery: late results. *Annals of surgery* 2007; **246**(6): 1016-20.

86. Jankowski J. A Phase III, Randomized, Study of Aspirin and Esomeprazole Chemoprevention in Barrett's Metaplasia (AspECT). NCT00357682. 2005. http://clinicaltrials.gov/show/NCT003576822014).

87. 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. *Gastrointestinal endoscopy* 2005; **62**(4): 488-98.

88. Phoa KN, van Vilsteren FG, Weusten BL, et al. Radiofrequency ablation vs endoscopic surveillance for patients with Barrett esophagus and low-grade dysplasia: a randomized clinical trial. *Jama* 2014; **311**(12): 1209-17.

89. Shaheen NJ, Overholt BF, Sampliner RE, et al. Durability of radiofrequency ablation in Barrett's esophagus with dysplasia. *Gastroenterology* 2011; **141**(2): 460-8.

90. Shaheen NJ, Sharma P, Overholt BF, et al. Radiofrequency ablation in Barrett's esophagus with dysplasia. *The New England journal of medicine* 2009; **360**(22): 2277-88.

91. Sie C, Bright T, Schoeman M, et al. Argon plasma coagulation ablation versus endoscopic surveillance of Barrett's esophagus: late outcomes from two randomized trials. *Endoscopy* 2013; **45**(11): 859-65.
92. Cooper GS, Kou TD, Chak A. Receipt of previous diagnoses and endoscopy and outcome from esophageal adenocarcinoma: a population-based study with temporal trends. *The American journal of gastroenterology* 2009; **104**(6): 1356-62.
93. Rubenstein JH, Sonnenberg A, Davis J, McMahon L, Inadomi JM. Effect of a prior endoscopy on outcomes of esophageal adenocarcinoma among United States veterans. *Gastrointestinal endoscopy* 2008; **68**(5): 849-55.
94. Fitzgerald RC, Saeed IT, Khoo D, Farthing MJ, Burnham WR. Rigorous surveillance protocol increases detection of curable cancers associated with Barrett's esophagus. *Digestive diseases and sciences* 2001; **46**(9): 1892-8.
95. Reid BJ, Blount PL, Feng Z, Levine DS. Optimizing endoscopic biopsy detection of early cancers in Barrett's high-grade dysplasia. *The American journal of gastroenterology* 2000; **95**(11): 3089-96.
96. Ramus JR, Gatenby PA, Caygill CP, Winslet MC, Watson A. Surveillance of Barrett's columnar-lined oesophagus in the UK: endoscopic intervals and frequency of detection of dysplasia. *European journal of gastroenterology & hepatology* 2009; **21**(6): 636-41.
97. Abrams JA, Kapel RC, Lindberg GM, et al. Adherence to biopsy guidelines for Barrett's esophagus surveillance in the community setting in the United States. *Clinical gastroenterology and hepatology : the official clinical practice journal of the American Gastroenterological Association* 2009; **7**(7): 736-42; quiz 10.
98. Curvers WL, ten Kate FJ, Krishnadath KK, et al. Low-grade dysplasia in Barrett's esophagus: overdiagnosed and underestimated. *The American journal of gastroenterology* 2010; **105**(7): 1523-30.
99. Hirst NG, Gordon LG, Whiteman DC, Watson DI, Barendregt JJ. Is endoscopic surveillance for non-dysplastic Barrett's esophagus cost-effective? Review of economic evaluations. *Journal of gastroenterology and hepatology* 2011; **26**(2): 247-54.
100. Das A, Wells C, Kim HJ, Fleischer DE, Crowell MD, Sharma VK. An economic analysis of endoscopic ablative therapy for management of nondysplastic Barrett's esophagus. *Endoscopy* 2009; **41**(5): 400-8.
101. Garside R, Pitt M, Somerville M, Stein K, Price A, Gilbert N. Surveillance of Barrett's oesophagus: exploring the uncertainty through systematic review, expert workshop and

economic modelling. *Health technology assessment (Winchester, England)* 2006; **10**(8): 1-142, iii-iv.

102. Inadomi JM, Sampliner R, Lagergren J, Lieberman D, Fendrick AM, Vakil N. Screening and surveillance for Barrett esophagus in high-risk groups: a cost-utility analysis. *Annals of internal medicine* 2003; **138**(3): 176-86.

103. Inadomi JM, Somsouk M, Madanick RD, Thomas JP, Shaheen NJ. A cost-utility analysis of ablative therapy for Barrett's esophagus. *Gastroenterology* 2009; **136**(7): 2101-14.e1-6.

104. Provenzale D, Schmitt C, Wong JB. Barrett's esophagus: a new look at surveillance based on emerging estimates of cancer risk. *The American journal of gastroenterology* 1999; **94**(8): 2043-53.

105. Sonnenberg A, Fennerty MB. Medical decision analysis of chemoprevention against esophageal adenocarcinoma. *Gastroenterology* 2003; **124**(7): 1758-66.

106. Sonnenberg A, Soni A, Sampliner RE. Medical decision analysis of endoscopic surveillance of Barrett's oesophagus to prevent oesophageal adenocarcinoma. *Alimentary pharmacology & therapeutics* 2002; **16**(1): 41-50.

107. Yousef F, Cardwell C, Cantwell MM, Galway K, Johnston BT, Murray L. The incidence of esophageal cancer and high-grade dysplasia in Barrett's esophagus: a systematic review and meta-analysis. *American journal of epidemiology* 2008; **168**(3): 237-49.

108. Anaparthy R, Gaddam S, Kanakadandi V, et al. Association between length of Barrett's esophagus and risk of high-grade dysplasia or adenocarcinoma in patients without dysplasia. *Clinical gastroenterology and hepatology : the official clinical practice journal of the American Gastroenterological Association* 2013; **11**(11): 1430-6.

109. Rugge M, Zaninotto G, Parente P, et al. Barrett's esophagus and adenocarcinoma risk: the experience of the North-Eastern Italian Registry (EBRA). *Annals of surgery* 2012; **256**(5): 788-94; discussion 94-5.

110. Sikkema M, Looman CW, Steyerberg EW, et al. Predictors for neoplastic progression in patients with Barrett's Esophagus: a prospective cohort study. *The American journal of gastroenterology* 2011; **106**(7): 1231-8.

111. Gatenby PA, Caygill CP, Ramus JR, Charlett A, Watson A. Barrett's columnar-lined oesophagus: demographic and lifestyle associations and adenocarcinoma risk. *Digestive diseases and sciences* 2008; **53**(5): 1175-85.

112. Verbeek RE, van Oijen MG, ten Kate FJ, et al. Surveillance and follow-up strategies in patients with high-grade dysplasia in Barrett's esophagus: a Dutch population-based study. *The American journal of gastroenterology* 2012; **107**(4): 534-42.

113. Mandal A, Playford RJ, Wicks AC. Current practice in surveillance strategy for patients with Barrett's oesophagus in the UK. *Alimentary pharmacology & therapeutics* 2003; **17**(10): 1319-24.

114. Bennett C, Vakil N, Bergman J, et al. Consensus statements for management of Barrett's dysplasia and early-stage esophageal adenocarcinoma, based on a Delphi process. *Gastroenterology* 2012; **143**(2): 336-46.

115. Cameron AJ, Carpenter HA. Barrett's esophagus, high-grade dysplasia, and early adenocarcinoma: a pathological study. *The American journal of gastroenterology* 1997; **92**(4): 586-91.

116. Theisen J, Stein HJ, Feith M, et al. Preferred location for the development of esophageal adenocarcinoma within a segment of intestinal metaplasia. *Surgical endoscopy* 2006; **20**(2): 235-8.

117. Kariyawasam VC, Bourke MJ, Hourigan LF, et al. Circumferential location predicts the risk of high-grade dysplasia and early adenocarcinoma in short-segment Barrett's esophagus. *Gastrointestinal endoscopy* 2012; **75**(5): 938-44.

118. Odze RD. Diagnosis and grading of dysplasia in Barrett's oesophagus. *Journal of clinical pathology* 2006; **59**(10): 1029-38.

119. Voltaggio L, Montgomery EA, Lam-Himlin D. A clinical and histopathologic focus on Barrett esophagus and Barrett-related dysplasia. *Archives of pathology & laboratory medicine* 2011; **135**(10): 1249-60.

120. Lomo LC, Blount PL, Sanchez CA, et al. Crypt dysplasia with surface maturation: a clinical, pathologic, and molecular study of a Barrett's esophagus cohort. *The American journal of surgical pathology* 2006; **30**(4): 423-35.

121. Brown IS, Whiteman DC, Lauwers GY. Foveolar type dysplasia in Barrett esophagus. *Modern pathology : an official journal of the United States and Canadian Academy of Pathology, Inc* 2010; **23**(6): 834-43.

122. Rugge M, Correa P, Dixon MF, et al. Gastric dysplasia: the Padova international classification. *The American journal of surgical pathology* 2000; **24**(2): 167-76.

123. Schlemper RJ, Riddell RH, Kato Y, et al. The Vienna classification of gastrointestinal epithelial neoplasia. *Gut* 2000; **47**(2): 251-5.

124. Anaparthy R, Sharma P. Progression of Barrett oesophagus: role of endoscopic and histological predictors. *Nature reviews Gastroenterology & hepatology* 2014; **11**(9): 525-34.

125. Kerkhof M, van Dekken H, Steyerberg EW, et al. Grading of dysplasia in Barrett's oesophagus: substantial interobserver variation between general and gastrointestinal pathologists. *Histopathology* 2007; **50**(7): 920-7.
126. Montgomery E, Bronner MP, Goldblum JR, et al. Reproducibility of the diagnosis of dysplasia in Barrett esophagus: a reaffirmation. *Human pathology* 2001; **32**(4): 368-78.
127. Reid BJ, Haggitt RC, Rubin CE, et al. Observer variation in the diagnosis of dysplasia in Barrett's esophagus. *Human pathology* 1988; **19**(2): 166-78.
128. 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* 2014.
129. Appelman HD. Adenocarcinoma in Barrett mucosa treated by endoscopic mucosal resection. *Archives of pathology & laboratory medicine* 2009; **133**(11): 1793-7.
130. Goldblum JR. Controversies in the diagnosis of Barrett esophagus and Barrett-related dysplasia: one pathologist's perspective. *Archives of pathology & laboratory medicine* 2010; **134**(10): 1479-84.
131. Downs-Kelly E, Mendelin JE, Bennett AE, et al. Poor interobserver agreement in the distinction of high-grade dysplasia and adenocarcinoma in pretreatment Barrett's esophagus biopsies. *The American journal of gastroenterology* 2008; **103**(9): 2333-40; quiz 41.
132. Zhu W, Appelman HD, Greenson JK, et al. A histologically defined subset of high-grade dysplasia in Barrett mucosa is predictive of associated carcinoma. *American journal of clinical pathology* 2009; **132**(1): 94-100.
133. Kumarasinghe M, Brown I, Raftopoulos S, et al. Standardised reporting protocol for endoscopic resection for Barrett oesophagus associated neoplasia: expert consensus recommendations. *Pathology-Journal of the RCPA* 2014; **46**(6): 473-80.
134. Ayers K, Shi C, Washington K, Yachimski P. Expert pathology review and endoscopic mucosal resection alters the diagnosis of patients referred to undergo therapy for Barrett's esophagus. *Surgical endoscopy* 2013; **27**(8): 2836-40.
135. Conio M, Repici A, Cestari R, et al. Endoscopic mucosal resection for high-grade dysplasia and intramucosal carcinoma in Barrett's esophagus: an Italian experience. *World journal of gastroenterology : WJG* 2005; **11**(42): 6650-5.
136. Mino-Kenudson M, Brugge WR, Puricelli WP, et al. Management of superficial Barrett's epithelium-related neoplasms by endoscopic mucosal resection: clinicopathologic analysis of 27 cases. *The American journal of surgical pathology* 2005; **29**(5): 680-6.

137. Wani S, Abrams J, Edmundowicz SA, et al. Endoscopic mucosal resection results in change of histologic diagnosis in Barrett's esophagus patients with visible and flat neoplasia: a multicenter cohort study. *Digestive diseases and sciences* 2013; **58**(6): 1703-9.

138. Larghi A, Lightdale CJ, Memeo L, Bhagat G, Okpara N, Rotterdam H. EUS followed by EMR for staging of high-grade dysplasia and early cancer in Barrett's esophagus. *Gastrointestinal endoscopy* 2005; **62**(1): 16-23.

139. Moss A, Bourke MJ, Hourigan LF, et al. Endoscopic resection for Barrett's high-grade dysplasia and early esophageal adenocarcinoma: an essential staging procedure with long-term therapeutic benefit. *The American journal of gastroenterology* 2010; **105**(6): 1276-83.

140. Nurkin SJ, Nava HR, Yendamuri S, et al. Outcomes of endoscopic resection for high-grade dysplasia and esophageal cancer. *Surgical endoscopy* 2014; **28**(4): 1090-5.

141. Chemaly M, Scalone O, Durivage G, et al. Miniprobe EUS in the pretherapeutic assessment of early esophageal neoplasia. *Endoscopy* 2008; **40**(1): 2-6.

142. Young PE, Gentry AB, Acosta RD, Greenwald BD, Riddle M. Endoscopic ultrasound does not accurately stage early adenocarcinoma or high-grade dysplasia of the esophagus. *Clinical gastroenterology and hepatology : the official clinical practice journal of the American Gastroenterological Association* 2010; **8**(12): 1037-41.

143. Pech O, May A, Gunter E, Gossner L, Ell C. The impact of endoscopic ultrasound and computed tomography on the TNM staging of early cancer in Barrett's esophagus. *The American journal of gastroenterology* 2006; **101**(10): 2223-9.

144. Vazquez-Sequeiros E, Wiersema MJ, Clain JE, et al. Impact of lymph node staging on therapy of esophageal carcinoma. *Gastroenterology* 2003; **125**(6): 1626-35.

145. von Rahden BH, Stein HJ, Weber A, et al. Critical reappraisal of current surveillance strategies for Barrett's esophagus: analysis of a large German Barrett's database. *Diseases of the esophagus : official journal of the International Society for Diseases of the Esophagus / ISDE* 2008; **21**(8): 685-9.

146. Wani S, Puli SR, Shaheen NJ, et al. Esophageal adenocarcinoma in Barrett's esophagus after endoscopic ablative therapy: a meta-analysis and systematic review. *The American journal of gastroenterology* 2009; **104**(2): 502-13.

147. The Paris endoscopic classification of superficial neoplastic lesions: esophagus, stomach, and colon: November 30 to December 1, 2002. *Gastrointestinal endoscopy* 2003; **58**(6 Suppl): S3-43.

148. Dunbar KB, Spechler SJ. The risk of lymph-node metastases in patients with high-grade dysplasia or intramucosal carcinoma in Barrett's esophagus: a systematic review. *The American journal of gastroenterology* 2012; **107**(6): 850-62; quiz 63.

149. Griffin SM, Burt AD, Jennings NA. Lymph node metastasis in early esophageal adenocarcinoma. *Annals of surgery* 2011; **254**(5): 731-6; discussion 6-7.

150. Leers JM, DeMeester SR, Oezcelik A, et al. The prevalence of lymph node metastases in patients with T1 esophageal adenocarcinoma a retrospective review of esophagectomy specimens. *Annals of surgery* 2011; **253**(2): 271-8.

151. Sepesi B, Watson TJ, Zhou D, et al. Are endoscopic therapies appropriate for superficial submucosal esophageal adenocarcinoma? An analysis of esophagectomy specimens. *Journal of the American College of Surgeons* 2010; **210**(4): 418-27.

152. Pohl H, Sonnenberg A, Strobel S, Eckardt A, Rosch T. Endoscopic versus surgical therapy for early cancer in Barrett's esophagus: a decision analysis. *Gastrointestinal endoscopy* 2009; **70**(4): 623-31.

153. Pech O, Bollschweiler E, Manner H, Leers J, Ell C, Holscher AH. Comparison between endoscopic and surgical resection of mucosal esophageal adenocarcinoma in Barrett's esophagus at two high-volume centers. *Annals of surgery* 2011; **254**(1): 67-72.

154. Pouw RE, van Vilsteren FG, Peters FP, et al. Randomized trial on endoscopic resection-cap versus multiband mucosectomy for piecemeal endoscopic resection of early Barrett's neoplasia. *Gastrointestinal endoscopy* 2011; **74**(1): 35-43.

155. Ell C, May A, Pech O, et al. Curative endoscopic resection of early esophageal adenocarcinomas (Barrett's cancer). *Gastrointestinal endoscopy* 2007; **65**(1): 3-10.

156. Pacifico RJ, Wang KK, Wongkeesong LM, Buttar NS, Lutzke LS. Combined endoscopic mucosal resection and photodynamic therapy versus esophagectomy for management of early adenocarcinoma in Barrett's esophagus. *Clinical gastroenterology and hepatology : the official clinical practice journal of the American Gastroenterological Association* 2003; **1**(4): 252-7.

157. Tian J, Prasad GA, Lutzke LS, Lewis JT, Wang KK. Outcomes of T1b esophageal adenocarcinoma patients. *Gastrointestinal endoscopy* 2011; **74**(6): 1201-6.

158. Bennett C, Green S, Decaestecker J, et al. Surgery versus radical endotherapies for early cancer and high-grade dysplasia in Barrett's oesophagus. *The Cochrane database of systematic reviews* 2012; **11**: Cd007334.

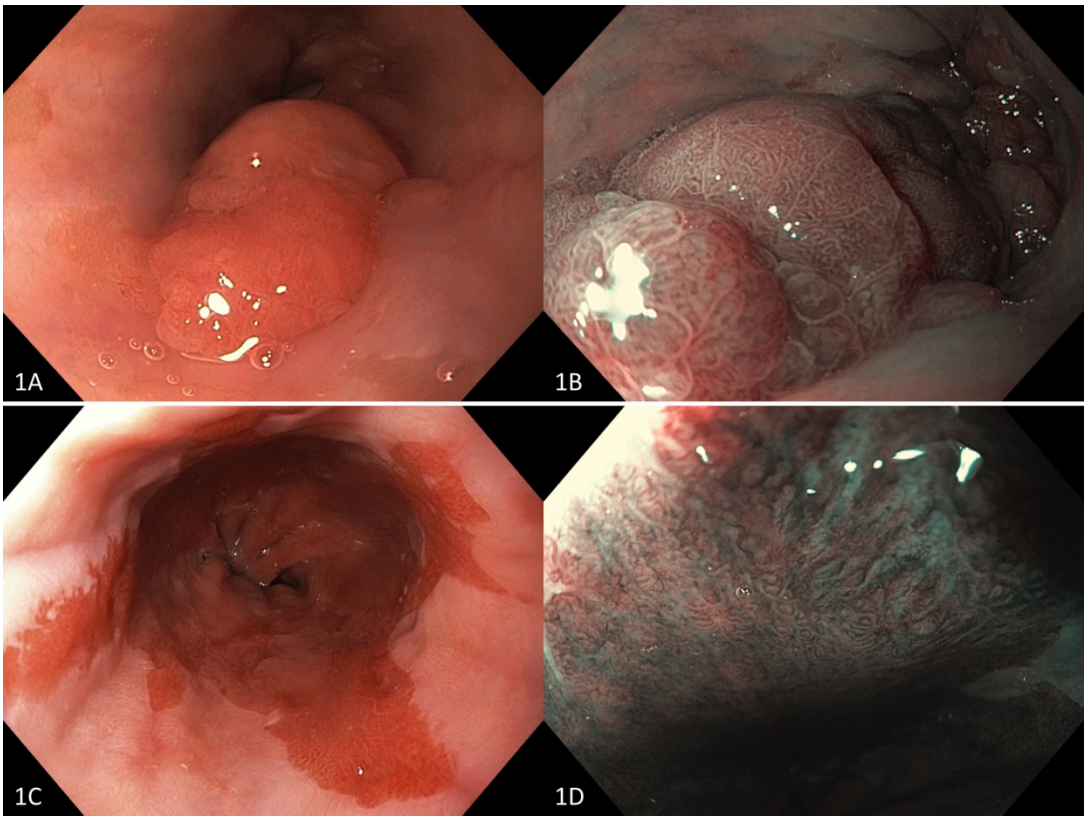
159. Menon D, Stafinski T, Wu H, Lau D, Wong C. Endoscopic treatments for Barrett's esophagus: a systematic review of safety and effectiveness compared to esophagectomy. *BMC gastroenterology* 2010; **10**: 111.

160. Prasad GA, Wang KK, Buttar NS, et al. Long-term survival following endoscopic and surgical treatment of high-grade dysplasia in Barrett's esophagus. *Gastroenterology* 2007; **132**(4): 1226-33.

161. Schembre DB, Huang JL, Lin OS, Cantone N, Low DE. Treatment of Barrett's esophagus with early neoplasia: a comparison of endoscopic therapy and esophagectomy. *Gastrointestinal endoscopy* 2008; **67**(4): 595-601.

162. Wu J, Pan YM, Wang TT, Gao DJ, Hu B. Endotherapy versus surgery for early neoplasia in Barrett's esophagus: a meta-analysis. *Gastrointestinal endoscopy* 2014; **79**(2): 233-41.e2.

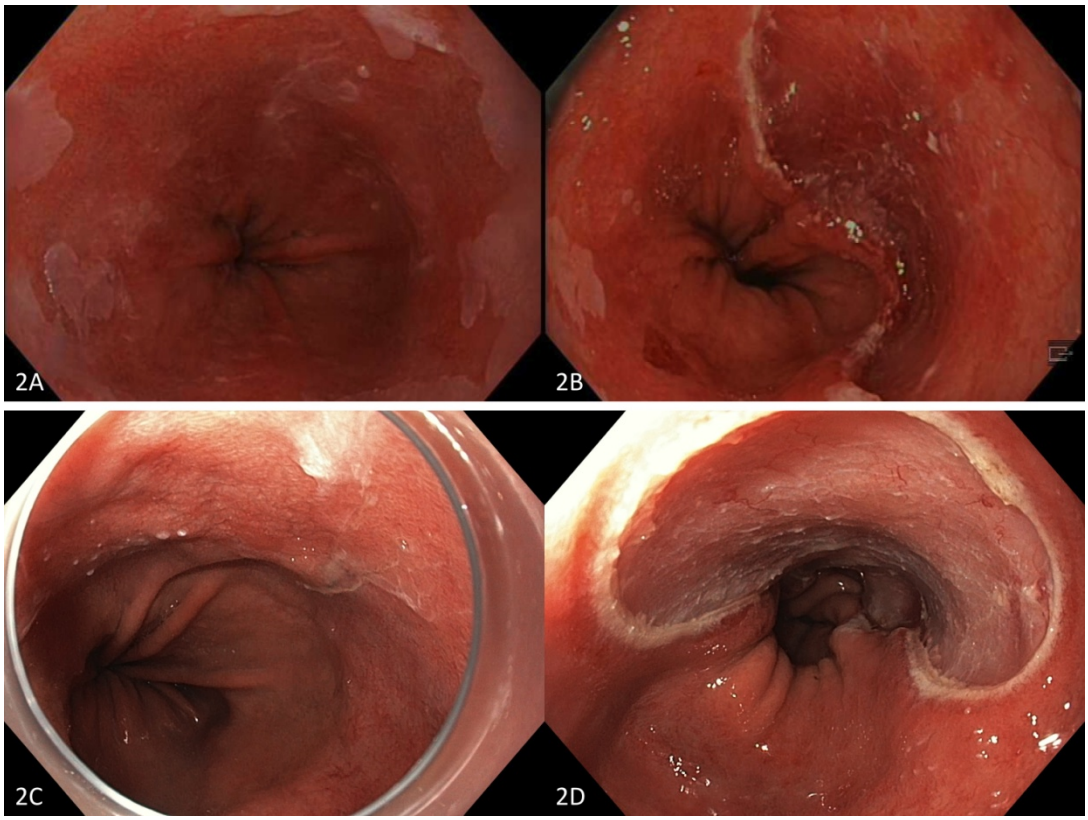
Figure 1 –



(1A) –C0M3 Barrett's esophagus containing a 2x1 cm (Paris 0–Is) lesion at 6 o'clock in white light and in (1B) as seen with narrow band imaging.

(1C) – Flat C2M4 Barrett's esophagus (1D) – Closer examination using narrow band imaging reveals a focal area with irregular capillary and mucosal pattern at 12 o'clock

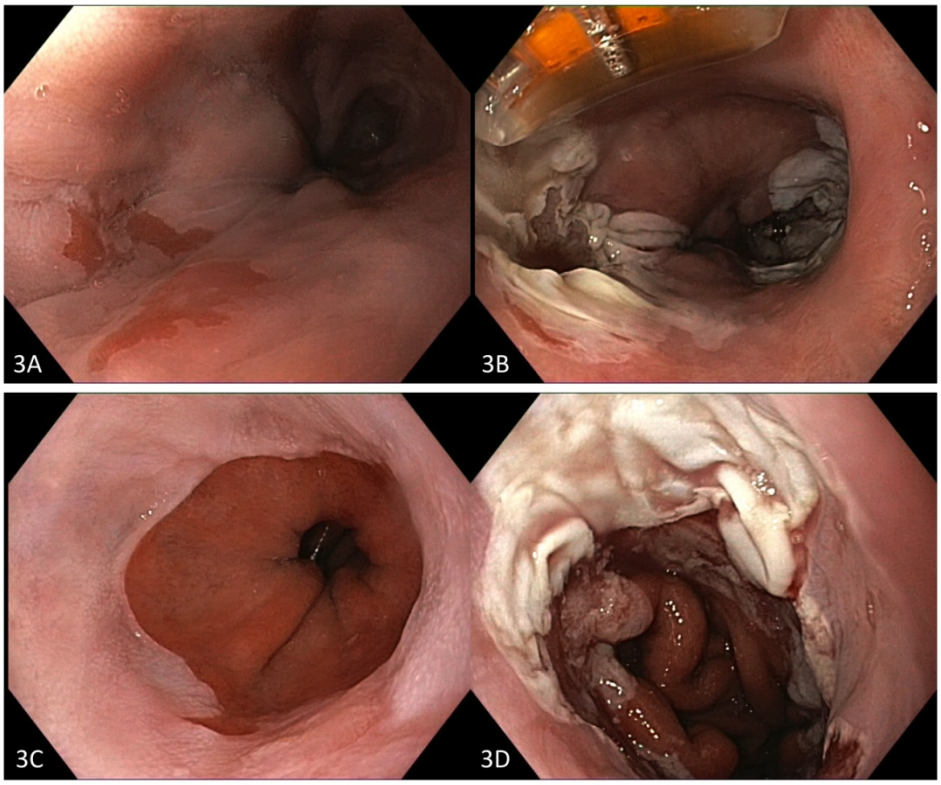
Figure 2 –



(2A)- C3M4 Barrett's esophagus. After careful inspection a focal abnormality was noted at 2 o'clock. (2B)- Focal endoscopic mucosal resection was performed for staging confirming high grade dysplasia

(2C)- C7M8 Barrett's esophagus. Using a distal attachment cap for improved visualisation, nodular lesion with slight depression (Paris 0–IIa+IIc) noted at 12-2 o'clock. (2D)- This area is completely excised by endoscopic mucosal resection. Histology confirmed Barrett's esophagus with high grade dysplasia and focal area of intramucosal adenocarcinoma (M1-T1a)

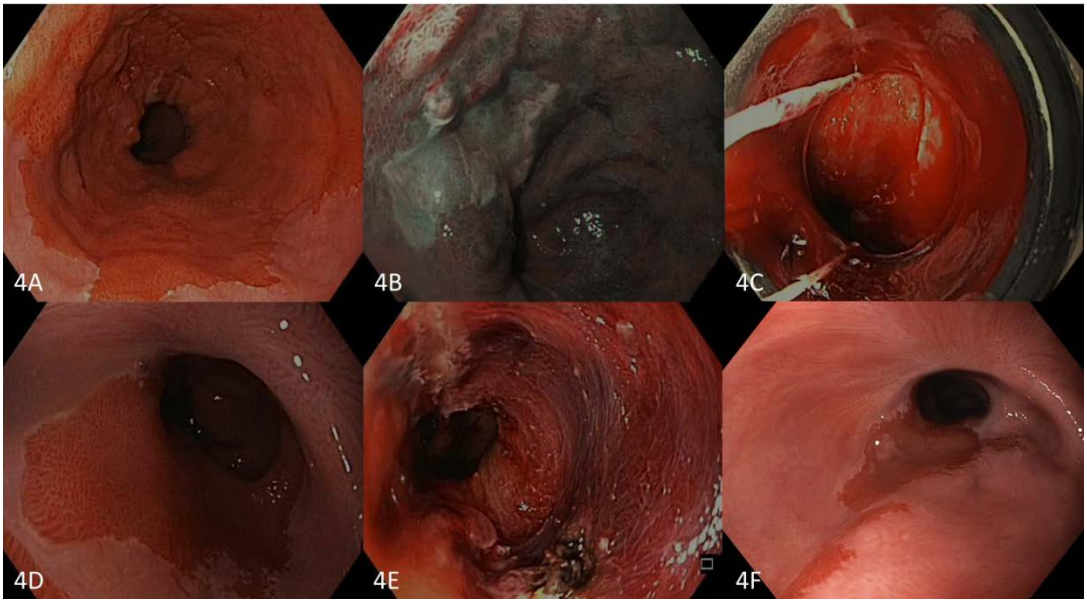
Figure 3 –



(3A)- C5M7 Barrett's esophagus with high grade dysplasia previously treated by endoscopic mucosal resection and radiofrequency ablation – residual disease remaining at 7 o'clock proximally and 12-4 o'clock distally. (3B)- Focal radiofrequency ablation to sites of residual Barrett's mucosa.

(3C)- C2M4 Barrett's esophagus previously treated by radiofrequency ablation for flat high grade dysplasia. (3D)- Residual Barrett's mucosa is treated by focal radiofrequency ablation.

Figure 4 –



(4A)- C4M5 Barrett's esophagus with diffuse nodular mucosa between 9 and 2 o'clock.

(4B)- Close up examination using narrow band imaging discloses irregular mucosa with abnormal capillary and pit patterns.

(4C)- The abnormal area is removed by multiband mucosectomy, this revealed intramucosal adenocarcinoma (T1a)

(4D)- On progress examination at 6 weeks neosquamous epithelium is seen in the area of excision.

(4E)- Further stepwise complete endoscopic resection for the residual Barretts mucosa is performed resulting in a hemi-circumferential mucosal defect.

(4F)- 6 weeks following the previous resection there is extensive neo-squamous re-epithelialisation of the distal esophagus. A small residual segment of Barrett's mucosa remains. The patient had low grade dysphagia from this stricture which was easily treated with Savary dilation.

Table 1: Hierarchy of evidence recommendation†

Level	Description
I	A systematic review of level II studies
II	A randomized controlled trial (intervention) or a prospective cohort study (etiology)
III-1	A pseudo-randomized controlled trial (intervention) or all or none design (etiology)
III-2	A comparative study with concurrent controls (intervention) or a retrospective cohort study (etiology)
III-3	A comparative study without concurrent controls (intervention) or a case-control study (etiology)
IV	Case series with either post-test or pre-test/post-test outcomes or a cross-sectional study

†adapted from the National Health and Medical Research Council of Australia

Table 2: Body of evidence recommendation †

Grade	Description
A	Body of evidence can be trusted to guide practice
B	Body of evidence can be trusted to guide practice in most situations
C	Body of evidence provides some support for recommendation(s) but care should be taken in its application
D	Body of evidence is weak and recommendation must be applied with caution
Practice point	Where no good-quality evidence is available but there is consensus among Expert working group members, so-called “Practice points” are given

†adapted from the National Health and Medical Research Council of Australia

Table 3: Recommended frequency of endoscopic surveillance of patients with BO

NO DYSPLASIA † ON ENDOSCOPIC ASSESSMENT AND SEATTLE PROTOCOL BIOPSY ‡	
Short (<3cm) segment	Repeat endoscopy in 3-5 years.
Long (≥ 3cm) segment	Repeat endoscopy in 2-3 years.

† If there has been previous low grade dysplasia, see **low grade dysplasia** protocol.
‡ **Seattle protocol** - biopsy of any mucosal irregularity and quadrantic biopsies every 2cm unless know or suspected dysplasia then quadrantic biopsies every 1 cm.

INDEFINITE FOR DYSPLASIA ON BIOPSY

The changes of **indefinite for dysplasia** on biopsy should be confirmed by a second pathologist, ideally an expert gastrointestinal pathologist. If **indefinite for dysplasia** is confirmed, then the following endoscopic surveillance is recommended:

1. Repeat endoscopy in **6 months** with Seattle protocol biopsies for suspected dysplasia (biopsy of any mucosal irregularity and quadrantic biopsies every 1cm) on maximal acid suppression.
2. If repeat shows **no dysplasia** then follow as per non-dysplastic protocol.
3. If repeat shows **low grade** or **high grade dysplasia** or **adenocarcinoma** then follow protocols for these respective conditions.
4. If repeat again shows confirmed **indefinite for dysplasia**, then repeat endoscopy in 6 months with Seattle protocol biopsies for suspected dysplasia.

LOW GRADE DYSPLASIA ON BIOPSY

The changes of **low grade dysplasia** on biopsy should be confirmed by a second pathologist, ideally an expert gastrointestinal pathologist. If **low grade dysplasia** is confirmed, then the following endoscopic surveillance is recommended:

1. Repeat endoscopy every **6 months** with Seattle protocol biopsies for dysplasia (biopsy of any mucosal irregularity and quadrantic biopsies every 1cm).
2. If two consecutive 6 monthly endoscopies with Seattle dysplasia biopsy protocol show **no dysplasia**, then consider reverting to a less frequent follow up schedule.

HIGH GRADE DYSPLASIA OR ADENOCARCINOMA ON BIOPSY

Referral to a centre that has integrated expertise in endoscopy, imaging, surgery and histopathology.