

**6.01.33 Wireless Capsule Endoscopy for Gastrointestinal (GI) Disorders**

Original Policy Date: February 13, 2002 Effective Date: February 1, 2024

Section: 6.0 Radiology Page: Page 1 of 58

**Policy Statement**

- I. Wireless capsule endoscopy of the small bowel may be considered **medically necessary** when **both** of the following conditions are met:
  - A. When the procedure is NOT intended for **all** of the below:
    1. To evaluate of the extent of involvement of known Crohn disease or ulcerative colitis
    2. To evaluate the esophagus, in individuals with gastroesophageal reflux or other esophageal pathologies
    3. To evaluate other gastrointestinal (GI)diseases and conditions not presenting with GI bleeding, including but not limited to, celiac sprue, irritable bowel syndrome, lynch syndrome (risk for hereditary nonpolyposis colorectal cancer), portal hypertensive enteropathy, small bowel neoplasm, screening for colonic polyps or cancer and unexplained chronic abdominal pain
    4. For Initial evaluation of individuals with acute upper GI bleeding
    5. To evaluate individuals with evidence of lower GI bleeding and major risks for colonoscopy or moderate sedation
    6. To evaluate individuals following incomplete colonoscopy
  - B. If the procedure is intended for **any** of the below:
    1. Suspected small bowel bleeding, and **both** of the following:
      - a. Inconclusive upper gastrointestinal (GI) endoscopy during the current episode of illness
      - b. Inconclusive lower GI endoscopy (colonoscopy) during the current episode of illness
    2. Initial diagnosis in individuals with suspected Crohn disease without evidence of disease on conventional diagnostic tests (such as small bowel follow-through [SBFT] and upper and lower endoscopy)
    3. Established diagnosis of Crohn disease, with unexpected change(s) in the course of disease or response to treatment, suggesting the initial diagnosis may be incorrect and reexamination may be indicated
    4. For surveillance of the small bowel in individuals with hereditary GI polyposis syndromes, including familial adenomatous polyposis and Peutz-Jeghers syndrome
- II. Wireless Capsule Endoscopy is considered **investigational** if the patient's situation does not meet the criteria above.
- III. The patency capsule is considered **investigational**, including use to evaluate patency of the GI tract before wireless capsule endoscopy.
- IV. Magnetic capsule endoscopy is considered **investigational** for the evaluation of individuals with unexplained upper abdominal complaints and all other indications.

**NOTE:** Refer to [Appendix A](#) to see the policy statement changes (if any) from the previous version.

**Policy Guidelines**

Suspected small bowel bleeding, previously referred to as obscure gastrointestinal (GI) tract bleeding is defined as recurrent or persistent iron-deficiency anemia: positive fecal occult blood test; or visible bleeding with no bleeding source found at original endoscopy.

**Coding**

The following CPT code specifically describes the use of the capsule camera:

- **91110:** Gastrointestinal tract imaging, intraluminal (e.g., capsule endoscopy), esophagus through ileum, with interpretation and report

The following CPT code is also specific to capsule endoscopy of the esophagus alone:

- **91111:** Gastrointestinal tract imaging, intraluminal (e.g., capsule endoscopy), esophagus with interpretation and report

The following is a category III CPT code for capsule endoscopy of the esophagus and stomach:

- **0651T:** Magnetically controlled capsule endoscopy, esophagus through stomach, including intraprocedural positioning of capsule, with interpretation and report

This new Category I code was created to replace Category III code 0355T:

- **91113:** Gastrointestinal tract imaging, intraluminal (e.g., capsule endoscopy), colon, with interpretation and report

**Description**

The wireless capsule endoscopy (CE) uses a noninvasive device to visualize segments of the gastrointestinal (GI) tract. Patients swallow a capsule that records images of the intestinal mucosa as it passes through the GI tract. The capsule is collected after being excreted and images are interpreted.

**Related Policies**

- N/A

**Benefit Application**

Benefit determinations should be based in all cases on the applicable contract language. To the extent there are any conflicts between these guidelines and the contract language, the contract language will control. Please refer to the member's contract benefits in effect at the time of service to determine coverage or non-coverage of these services as it applies to an individual member.

Some state or federal mandates (e.g., Federal Employee Program [FEP]) prohibits plans from denying Food and Drug Administration (FDA)-approved technologies as investigational. In these instances, plans may have to consider the coverage eligibility of FDA-approved technologies on the basis of medical necessity alone.

**Regulatory Status**

Table 1 summarizes various wireless CE devices with clearance by the FDA.

Code used: NEZ

**Table 1. Wireless Capsule Endoscopy Devices Cleared by the U.S. Food and Drug Administration**

Device	Manufacturer	Date Cleared	510(k) No.	Indication
Pillcam SB 3 Capsule Endoscopy System, Pillcam	Given Imaging Ltd.	8/27/2021	K211684	For visualization of the small bowel mucosa. It may be used in the visualization and monitoring of: lesions that may indicate Crohn's disease not detected by upper and lower endoscopy; lesions that may be a source of obscure bleeding not detected by upper and lower endoscopy; lesions that

Device	Manufacturer	Date Cleared	510(k) No.	Indication
<b>Software 9.0e</b>				may be potential causes of iron deficiency anemia not detected by upper and lower endoscopy.
<b>NaviCam Stomach Capsule System</b>	AnX Robotica, Inc.	5/22/2020	K203192	For visualization of the stomach of adults ( $\geq 22$ years) with a body mass index $< 38$ . The system can be used in clinics and hospitals, including emergency room settings.
<b>CapsoCam Plus (SV-3)</b>	CapsoVision Inc.	4/19/2019	K183192	For visualization of the small bowel mucosa in adults. It may be used as a tool in the detection of abnormalities of the small bowel.
<b>Olympus Small Intestinal Capsule Endoscope System</b>	Olympus Medical Systems Corp.	3/5/2019	K183053	For visualization of the small intestine mucosa.
<b>MiroCam Capsule Endoscope System</b>	IntroMedic Co. Ltd.	11/8/2018	K180732	May be used as a tool in the detection of abnormalities of the small bowel and this device is indicated for adults and children from 2 years of age.
<b>Olympus Small Intestinal Capsule Endoscope System</b>	Olympus Medical Systems Corp.	3/13/2018	K173459	May be used in the visualization and monitoring of lesions that may indicate Crohn's disease not detected by upper and lower endoscopy. - It may be used in the visualization and monitoring of lesions that may be a source of obscure bleeding (either overt or occult) not detected by upper and lower endoscopy. It may be used in the visualization and monitoring of lesions that may be potential causes of iron deficiency anemia (IDA) not detected by upper and lower endoscopy. The Red Color Detection Function is intended to mark frames of the video suspected of containing blood or red areas.
<b>PillCam Patency System</b>	Given Imaging Ltd.	3/8/2018	K180171	Intended to verify adequate patency of the gastrointestinal tract prior to administration of the PillCam video capsule in patients with known or suspected strictures.
<b>MiroCam Capsule Endoscope System</b>	IntroMedic Co. Ltd.	1/30/2018	K170438	For visualization of the small intestine mucosa.
<b>PillCam SBC capsule endoscopy system</b>	Given Imaging Ltd.	9/1/2017	K170210	For visualization of the small intestine mucosa.
<b>PilCam Desktop Software 9.0</b>				
<b>RAPID Web</b>	Given Imaging Ltd.	5/26/2017	K170839	Intended for visualization of the small bowel mucosa.
<b>AdvanCE capsule endoscope delivery device</b>	United States Endoscopy Group Inc.	3/10/2017	K163495	Intended for visualization of the small bowel mucosa.
<b>Olympus Small Intestinal Capsule Endoscope System</b>	OLYMPUS MEDICAL SYSTEMS CORP.	1/19/2017	K163069	Intended for visualization of the small bowel mucosa.

Device	Manufacturer	Date Cleared	510(k) No.	Indication
<b>CapsoCam Plus (SV-3) Capsule Endoscope System</b>	CapsoVision Inc	10/21/2016	K161773	Intended for visualization of the small bowel mucosa.
<b>CapsoCam (SV-1)</b>	CapsoVision Inc.	2/9/2016	K151635	For use in diagnosing disorders of the small bowel, esophagus, and colon.
<b>PillCam COLON2</b>	Given® Imaging	1/14/2016	K153466	Detection of colon polyps in patients after an incomplete colonoscopy and a complete evaluation of the colon was not technically possible, and for detection of colon polyps in patients with evidence of GI bleeding of lower GI origin with major risks for colonoscopy or moderate sedation, but who could tolerate colonoscopy or moderate sedation in the event a clinically significant colon abnormality was identified on capsule endoscopy.
<b>Mirocam Capsule Endoscope System</b>	INTROMEDIC CO. LTD	3/17/2015	K143663	Intended for visualization of the small bowel mucosa.
<b>Endocapsule Software 10; Endocapsule Software 10 Light</b>	Olympus Medical Systems Corp.	2/8/2015	K142680	Intended for visualization of the small bowel mucosa.

GI: gastrointestinal.

## Rationale

### Background

#### Wireless Capsule Endoscopy

Wireless capsule endoscopy (CE) is performed using the PillCam Given Diagnostic Imaging System (previously called M2A), which is a disposable imaging capsule manufactured by Given Imaging. The capsule measures 11 by 30 mm and contains video imaging, self-illumination, and image transmission modules, as well as a battery supply that lasts up to 8 hours. The indwelling camera takes images at a rate of 2 frames per second as peristalsis carries the capsule through the gastrointestinal tract. The average transit time from ingestion to evacuation is 24 hours. The device uses wireless radio transmission to send the images to a receiving recorder device that the patient wears around the waist. This receiving device also contains localizing antennae sensors that can roughly gauge where the image was taken over the abdomen. Images are then downloaded onto a workstation for viewing and processing.

Capsule endoscopy has been proposed as a method for identifying Crohn disease. There is no single criterion standard diagnostic test for Crohn disease; rather, diagnosis is based on a constellation of findings.<sup>1</sup> Thus it is difficult to determine the diagnostic characteristics of various tests used to diagnose the condition and difficult to determine a single comparator diagnostic test to CE.

#### Magnetic Capsule Endoscopy

The U.S. Food and Drug Administration (FDA) approved a novel magnetically maneuvered CE system (NaviCam™; AnX Robotica, Inc.) in May 2020.<sup>2</sup> This system consists of a single-use ingestible capsule and magnet linked to a physician-operated console. The capsule contains a camera that wirelessly captures images of the desired anatomy. The console allows the operator to control the motion and direction of the capsule, ensuring visualization of the entire stomach. The system is non-invasive, does not require sedation, and has a procedural time of approximately 15 to 20 minutes. The capsule leaves the body in 24 hours on average but may take as long as 2 weeks. The device is

contraindicated for use in patients with gastrointestinal obstruction, stenosis, fistula, or those with dysphagia. Other contraindications include patients with cardiac pacemakers or other implantable electronic medical devices as well as pregnant women, those <22 years of age, and those with a body mass index  $\geq 38$ .

### **Literature Review**

Evidence reviews assess whether a medical test is clinically useful. A useful test provides information to make a clinical management decision that improves the net health outcome. That is, the balance of benefits and harms is better when the test is used to manage the condition than when another test or no test is used to manage the condition.

The first step in assessing a medical test is to formulate the clinical context and purpose of the test. The test must be technically reliable, clinically valid, and clinically useful for that purpose. Evidence reviews assess the evidence on whether a test is clinically valid and clinically useful. Technical reliability is outside the scope of these reviews, and credible information on technical reliability is available from other sources.

Promotion of greater diversity and inclusion in clinical research of historically marginalized groups (e.g., People of Color [African-American, Asian, Black, Latino and Native American]; LGBTQIA (Lesbian, Gay, Bisexual, Transgender, Queer, Intersex, Asexual); Women; and People with Disabilities [Physical and Invisible]) allows policy populations to be more reflective of and findings more applicable to our diverse members. While we also strive to use inclusive language related to these groups in our policies, use of gender-specific nouns (e.g., women, men, sisters, etc.) will continue when reflective of language used in publications describing study populations.

### **Suspected Small Bowel Bleeding**

#### **Clinical Context and Test Purpose**

The purpose of wireless capsule endoscopy (CE) for patients who have suspected small bowel bleeding is to confirm a diagnosis and inform a decision to proceed to appropriate treatment. The following PICO was used to select literature to inform this review.

#### ***Populations***

The relevant population of interest is patients with suspected small bowel bleeding. Suspected small bowel bleeding, previously referred to as obscure gastrointestinal (GI) tract bleeding, is defined as bleeding from the GI tract that persists or recurs without an obvious etiology after imaging with upper and lower endoscopy and radiologic evaluation of the small bowel. Recurrent or persistent iron-deficiency anemia, positive fecal occult blood test, or visible bleeding with no bleeding source found at original endoscopy are other indicators of obscure GI tract bleeding. Examples of etiologies for small bowel bleeding include angiodysplasia, tumor, medication-induced, infections, Crohn disease (CD), Meckel diverticulum, Zollinger-Ellison syndrome, vasculitis, radiation enteritis, jejunal diverticula, and chronic mesenteric ischemia.

#### ***Interventions***

The intervention of interest is wireless CE.

#### ***Comparators***

The following practice is currently being used to diagnose small bowel bleeding: a standard workup without wireless CE and, with or without direct endoscopic procedures or specialized GI imaging. A "true" reference standard for suspected small bowel bleeding is difficult or impossible to achieve because the bleeding source may resolve, and invasive techniques (e.g., surgery) cannot be justifiably used.

**Outcomes**

The outcomes of interest for diagnostic accuracy include test validity (ie, sensitivity, specificity). The primary outcomes of interest are symptoms and disease status that would change due to patient management decisions following wireless CE.

Wireless CE would be performed prior to surgical exploration if conventional endoscopy has been inconclusive. Follow-up for further diagnostic evaluation and surveillance for recurrence of symptoms would be immediate to weeks if no etiology is identified. Follow-up of weeks to months would be based on the disease condition identified by CE.

**Study Selection Criteria**

Below are selection criteria for studies to assess whether a test is clinically valid.

- The study population represents the population of interest. Eligibility and selection are described.
- The test is compared with a credible reference standard.
- If the test is intended to replace or be an adjunct to an existing test; it should also be compared with that test.
- Studies should report sensitivity, specificity, and predictive values. Studies that completely report true- and false-positive results are ideal. Studies reporting other measures (e.g., receiver operator curve, area under the receiver operator curve, c-statistic, likelihood ratios) may be included but are less informative.
- Studies should also report reclassification of the diagnostic or risk category.

**Clinically Valid**

A test must detect the presence or absence of a condition, the risk of developing a condition in the future, or treatment response (beneficial or adverse).

**Review of Evidence****Systematic Reviews**

Tables 2 and 3 summarize the characteristics and results of selected systematic reviews, which have evaluated a number of case series that compared the diagnostic accuracy of CE with alternative procedures such as intraoperative endoscopy or mesenteric angiography.

**Table 2. Characteristics of Systematic Reviews Evaluating Capsule Endoscopy for Iron-Deficient Anemia**

Study	Dates	Trials	Participants	N (Range)	Design	QUADAS Assessment of Included Trials
Koulaouzidis et al (2012) <sup>5</sup>	2004-2011	24	Patients with iron-deficiency anemia who had SBCE and at least 1 lower and upper GI endoscopy prior to CE	1960 (35 to 652)	Observational	Low-to-moderate quality

CE: capsule endoscopy; GI: gastrointestinal; QUADAS: Quality Assessment of Diagnostic Accuracy Studies; SBCE: small bowel capsule endoscopy.

**Table 3. Results of Systematic Reviews Evaluating Capsule Endoscopy for Iron-Deficient Anemia**

Study	Overall Diagnostic Yield <sup>a</sup>	Diagnostic Yield of Patients With IDA <sup>b</sup>	$P$ , %	Diagnostic Yield, n (%) <sup>c</sup>
Koulaouzidis et al (2012) <sup>5</sup>				
Total N	1960	264		<ul style="list-style-type: none"> <li>• Angioectasias: 293 (45.9)</li> <li>• Inflammatory lesions: 126 (19.7)</li> <li>• Polyp/mass lesions: 42 (6.6)</li> <li>• Not classified: 177 (27.7)</li> </ul>

Study	Overall Diagnostic Yield <sup>a</sup>	Diagnostic Yield of Patients With IDA <sup>b</sup>	$P$ , %	Diagnostic Yield, n (%) <sup>c</sup>
<b>Pooled effect (95% CI), %</b>	47 (42 to 52)	66.6 (61.0 to 72.3)	78.8	
<b>p</b>			<.001	

CI: confidence interval; IDA: iron-deficient anemia; SBCE: small bowel capsule endoscopy.

<sup>a</sup> Per-patient analysis.

<sup>b</sup> From 4 studies (n=264 patients; 13.47% of total).

<sup>c</sup> Patients with positive SBCE findings.

### Randomized Controlled Trials

A small randomized controlled trial (RCT) compared CE with mesenteric angiography in patients with acute melena or hematochezia. While CE had a higher diagnostic yield, secondary outcomes such as transfusion, hospitalization, and mortality did not differ significantly between groups. Tables 4 and 5 summarize the characteristics and results of selected RCTs.

**Table 4. Characteristics of RCT Evaluating Capsule Endoscopy for Obscure GI Bleeding**

Study	Countries	Sites	Dates	Participants	Interventions	
					Active	Comparator
<b>Leung et al (2012)<sup>6</sup></b>	China	1	2005-2007	Consecutive adults with active overt obscure GI bleeding	30 randomized to CE	30 randomized to mesenteric angiography

CE: capsule endoscopy; GI: gastrointestinal; RCT: randomized controlled trial.

**Table 5. Results of RCT Evaluating Capsule Endoscopy for Obscure GI Bleeding**

Study	Diagnostic Yield (95% CI), % <sup>a</sup>	Rebleeding Rates (95% CI), %	Hospitalization Rate, n (%)	Transfusion Rate, n (%)	Mean Follow-Up (SD), mo
<b>Leung et al (2012)<sup>6</sup></b>					
<b>CE</b>	53.3 (36.1 to 69.8)	16.7 (7.3 to 33.6)	5 (16.7)	3 (10)	48.5 (20.9)
<b>Angiography</b>	20 (9.5 to 37.3)	33.3 (19.2 to 51.2)	5 (16.7)	3 (10)	
<b>Difference</b>	33.3 (8.9 to 52.8)	16.7 (-5.3 to 36.8)			
<b>p</b>	.016	.23	1.0	1.0	

CI: confidence interval; CE: capsule endoscopy; GI: gastrointestinal; RCT: randomized controlled trial; SD: standard deviation.

<sup>a</sup> Percentage identified with a high probability of bleeding.

The purpose of the limitations tables (Tables 6 and 7) is to display notable limitations identified in each study. This information is synthesized as a summary of the body of evidence following each table and provides the conclusions on the sufficiency of the evidence supporting the position statement.

**Table 6. Study Relevance Limitations of RCT Evaluating Capsule Endoscopy for Obscure GI Bleeding**

Study	Population <sup>a</sup>	Intervention <sup>b</sup>	Comparator <sup>c</sup>	Outcomes <sup>d</sup>	Duration of Follow-Up <sup>e</sup>
<b>Leung et al (2012)<sup>6</sup></b>	2. It is possible patients with moderate bleeding would not undergo angiography in a clinical setting 4. Patients with overt but nonmassive bleeding may not be ideal for CE or angiography		2. A criterion standard is lacking for evaluation of obscure GI bleeding		

CE: capsule endoscopy; GI: gastrointestinal; RCT: randomized controlled trial.

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.

<sup>a</sup> Population key: 1. Intended use population unclear; 2. Clinical context is unclear; 3. Study population is unclear; 4. Study population not representative of intended use.

<sup>b</sup> Intervention key: 1. Classification thresholds not defined; 2. Version used unclear; 3. Not intervention of interest.

<sup>c</sup> Comparator key: 1. Classification thresholds not defined; 2. Not compared to credible reference standard; 3. Not compared to other tests in use for same purpose.

<sup>d</sup> Outcomes key: 1. Study does not directly assess a key health outcome; 2. Evidence chain or decision model not explicated; 3. Key clinical validity outcomes not reported (sensitivity, specificity, and predictive values); 4. Reclassification of diagnostic or risk categories not reported; 5. Adverse events of the test not described (excluding minor discomforts and inconvenience of venipuncture or noninvasive tests).

<sup>e</sup> Follow-Up key: 1. Follow-up duration not sufficient with respect to natural history of disease (true-positives, true-negatives, false-positives, false-negatives cannot be determined).

**Table 7. Study Design and Conduct Limitations of RCT Evaluating Capsule Endoscopy for Obscure GI Bleeding**

Study	Allocation <sup>a</sup>	Blinding <sup>b</sup>	Selective Reporting <sup>c</sup>	Follow-Up <sup>d</sup>	Power <sup>e</sup>	Statistical <sup>f</sup>
Leung et al (2012) <sup>6</sup> .					3. Study underpowered to detect significant difference in clinical outcome	

GI: gastrointestinal; RCT: randomized controlled trial.

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.

<sup>a</sup> Allocation key: 1. Participants not randomly allocated; 2. Allocation not concealed; 3. Allocation concealment unclear; 4. Inadequate control for selection bias.

<sup>b</sup> Blinding key: 1. Not blinded to treatment assignment; 2. Not blinded outcome assessment; 3. Outcome assessed by treating physician.

<sup>c</sup> Selective Reporting key: 1. Not registered; 2. Evidence of selective reporting; 3. Evidence of selective publication.

<sup>d</sup> Follow-Up key: 1. High loss to follow-up or missing data; 2. Inadequate handling of missing data; 3. High number of crossovers; 4. Inadequate handling of crossovers; 5. Inappropriate exclusions; 6. Not intent to treat analysis (per protocol for noninferiority trials).

<sup>e</sup> Power key: 1. Power calculations not reported; 2. Power not calculated for primary outcome; 3. Power not based on clinically important difference.

<sup>f</sup> Statistical key: 1. Intervention is not appropriate for outcome type: (a) continuous; (b) binary; (c) time to event; 2. Intervention is not appropriate for multiple observations per patient; 3. Confidence intervals and/or p values not reported; 4. Comparative treatment effects not calculated.

### Case Series

Tables 8 and 9 summarize the characteristics and results of selected case series.

**Table 8. Characteristics of Case Series Evaluating Capsule Endoscopy for Obscure GI Bleeding**

Study	Country	Participants	Treatment Delivery	Follow-Up (Range), mo
Hartmann et al (2005) <sup>7</sup> .	Germany	47 patients >18 y with obscure GI bleeding	Patients received CE and criterion standard, intraoperative endoscopy	NR
Pennazio et al (2004) <sup>8</sup> .	Italy	100 patients ≥18 y with obscure GI bleeding	51 patients received CE and PE before or after the procedure	Mean: 18 (5 to 25)

CE: capsule endoscopy; GI: gastrointestinal; NR: not reported; PE: push enteroscopy.

**Table 9. Results of Case Series Evaluating Capsule Endoscopy for Obscure GI Bleeding**

Study	Treatment	Locating Bleeding With CE, %		Diagnostic Yield for Positive Lesions, %	PPV of CE, %	NPV of CE %
		Sensitivity	Specificity <sup>a</sup>			
Hartmann et al (2005) <sup>7</sup> .	CE and intraoperative endoscopy	95	75	Both procedures: 76.6	95	86
Pennazio (2004) <sup>8</sup> .	CE and PE	89	95	67 (95% CI, 54 to 80)	97	82.6

CE: capsule endoscopy; CI: confidence interval; GI: gastrointestinal; NPV: negative predictive value; PE: push enteroscopy; PPV: positive predictive value.

<sup>a</sup> CE results confirmed by intraoperative endoscopy or other reference standards.



**Clinically Useful**

A test is clinically useful if the use of the results informs management decisions that improve the net health outcome of care. The net health outcome can be improved if patients receive correct therapy, more effective therapy, or avoid unnecessary therapy or testing.

**Direct Evidence**

Direct evidence of clinical utility is provided by studies that have compared health outcomes for patients managed with and without the test. Because these are intervention studies, the preferred evidence would be from RCTs.

**Chain of Evidence**

Indirect evidence on clinical utility rests on clinical validity. If the evidence is insufficient to demonstrate test performance, no inferences can be made about clinical utility.

Based on evidence that CE isolates the source of bleeding at least as well as other diagnostic tools and that few diagnostic options are available to patients with suspected small bowel bleeding, a chain of evidence can be constructed to support the clinical utility of CE for this indication.

**Section Summary: Suspected Small Bowel Bleeding**

A small RCT compared CE with mesenteric angiography in patients with acute melena or hematochezia. While CE had a higher diagnostic yield, secondary outcomes such as transfusion, hospitalization, and mortality did not differ significantly between groups. A large number of uncontrolled studies have evaluated the use of CE in the evaluation of patients with suspected small bowel bleeding. These studies have consistently reported that a substantial proportion of patients receive a definitive diagnosis following this test when there are few other diagnostic options. A meta-analysis of 24 studies estimated that the diagnostic yield in this patient population was approximately half of the included patients and was higher in patients with documented iron-deficiency anemia. Capsule endoscopy appears to locate the source of bleeding at least as well as other diagnostic methods and direct treatment to the source of bleeding.

**Suspected Crohn Disease****Clinical Context and Test Purpose**

The purpose of wireless CE for patients with suspected CD is to confirm a diagnosis and inform a decision to proceed to appropriate treatment.

The following PICO was used to select literature to inform this review.

***Populations***

The relevant population of interest is individuals with suspected CD. Crohn disease is 1 of the 2 types of inflammatory bowel disease. Crohn disease can involve the entire GI tract and is characterized by transmural inflammation.

***Interventions***

The test being considered is wireless CE.

***Comparators***

The following tests are currently being used to diagnose CD: ileocolonoscopy, barium small bowel follow-through, computed tomography enterography (CTE), and magnetic resonance enterography (MRE).

***Outcomes***

The general outcomes of interest are test validity, other test performance measures, symptoms, and change in disease status.

The diagnosis of CD requires confirmatory imaging when the disease is prominent on the differential diagnosis list. The imaging study would be performed and promptly followed by appropriate treatment. Crohn disease is a chronic condition requiring long-term follow-up.

### Study Selection Criteria

Below are selection criteria for studies to assess whether a test is clinically valid.

- The study population represents the population of interest. Eligibility and selection are described.
- The test is compared with a credible reference standard.
- If the test is intended to replace or be an adjunct to an existing test; it should also be compared with that test.
- Studies should report sensitivity, specificity, and predictive values. Studies that completely report true- and false-positive results are ideal. Studies reporting other measures (e.g., receiver operator curve, area under the receiver operator curve, c-statistic, likelihood ratios) may be included but are less informative.
- Studies should also report reclassification of the diagnostic or risk category.

### Clinically Valid

A test must detect the presence or absence of a condition, the risk of developing a condition in the future, or treatment response (beneficial or adverse).

### Review of Evidence

#### Systematic Reviews

Results from a meta-analysis by Choi et al (2017), which compared CE with various modalities for diagnosing CD, are summarized in Tables 10 and 11. The reference standards varied for the selected studies, so quantitative data were not synthesized for diagnostic accuracy. In the pooled analysis, in patients with suspected CD, the sensitivity of CE ranged from 89.6% to 92.0% and the specificity was 100%.

**Table 10. Characteristics of Systematic Reviews Assessing the Diagnostic Yield of Capsule Endoscopy versus Other Modalities<sup>a</sup>**

Study	Dates	Trials	Participants	N (Range)	Design
Choi et al (2017) <sup>9</sup> .	2002-2013	24	Patients with suspected or established CD	NR	RCT, nonrandomized, and diagnostic accuracy studies

CD: Crohn disease; NR: not reported; RCT: randomized controlled trial.

<sup>a</sup>Other modalities include small bowel follow-through, enteroclysis, computed tomography enterography, and magnetic resonance enterography.

**Table 11. Results of Systematic Reviews Assessing the Diagnostic Yield of Capsule Endoscopy versus Other Modalities**

Study	CE vs. SBFT <sup>a</sup>	CE vs. EC <sup>b</sup>	CE vs. CTE <sup>b</sup>	CE vs. MRE <sup>b</sup>
Choi et al (2017) <sup>9</sup> .				
N	94			
Diagnostic yield, %	66 vs. 21.3	75.7 vs. 29.4	72.5 vs. 22.5	85.7 vs. 100
Weighted incremental yield (95% CI)	0.44 (0.29 to 0.59)	0.50 (0.21 to 0.79)	0.36 (0.18 to 0.90)	-0.16 (-0.63 to 0.32)
P, %	30	52	68	44

CE: capsule endoscopy; CI: confidence interval; CTE: computed tomography enterography; EC: enteroclysis; MRE: magnetic resonance enterography; SBFT: small bowel follow-through.

<sup>a</sup> From 4 studies (3 included in meta-analysis).

<sup>b</sup> From 2 studies.

### **Clinically Useful**

A test is clinically useful if the use of the results informs management decisions that improve the net health outcome of care. The net health outcome can be improved if patients receive correct therapy, more effective therapy, or avoid unnecessary therapy or testing.

### **Direct Evidence**

Direct evidence of clinical utility is provided by studies that have compared health outcomes for patients managed with and without the test. Because these are intervention studies, the preferred evidence would be from RCTs.

No RCTs assessing the clinical utility of wireless CE for this indication were identified.

### **Chain of Evidence**

Indirect evidence on clinical utility rests on clinical validity. If the evidence is insufficient to demonstrate test performance, no inferences can be made about clinical utility.

Based on evidence that CE can provide a diagnosis of CD when other tests cannot, a chain of evidence can be constructed to support the clinical utility of CE for this indication.

### **Section Summary: Suspected Crohn Disease**

For patients with suspected CD who cannot be diagnosed by other modalities, CE can confirm the diagnosis in a substantial number of patients.

### **Suspected Celiac Disease**

#### **Clinical Context and Test Purpose**

The purpose of wireless CE for patients who have suspected celiac disease is to confirm a diagnosis and inform a decision to proceed to appropriate treatment.

The following PICO was used to select literature to inform this review.

#### ***Populations***

The relevant population of interest is individuals with suspected celiac disease. Celiac disease, or gluten-sensitive enteropathy, is an immune-mediated condition of the small intestine. Serologic markers of the disease have good sensitivity and specificity in triaging patients to endoscopy.

#### ***Interventions***

The test being considered is wireless CE. Capsule endoscopy has been evaluated as an alternative method of diagnosing celiac disease, assessing the extent of disease, and in the evaluation of celiac disease unresponsive to treatment.

#### ***Comparators***

The following test is currently being used to diagnose celiac disease: endoscopy with biopsy. The criterion standard for the diagnosis of celiac disease is obtained through small bowel biopsies during endoscopy.

#### ***Outcomes***

The general outcomes of interest are test validity, other test performance measures, symptoms, and change in disease status.

The diagnosis of celiac disease requires confirmatory imaging when the disease is prominent on the differential diagnosis list. The imaging study would be performed and promptly followed by appropriate treatment. Celiac disease is a chronic condition requiring long-term follow-up.

### Study Selection Criteria

Below are selection criteria for studies to assess whether a test is clinically valid.

- The study population represents the population of interest. Eligibility and selection are described.
- The test is compared with a credible reference standard.
- If the test is intended to replace or be an adjunct to an existing test; it should also be compared with that test.
- Studies should report sensitivity, specificity, and predictive values. Studies that completely report true- and false-positive results are ideal. Studies reporting other measures (e.g., receiver operator curve, area under the receiver operator curve, c-statistic, likelihood ratios) may be included but are less informative.
- Studies should also report reclassification of the diagnostic or risk category.

### Clinically Valid

A test must detect the presence or absence of a condition, the risk of developing a condition in the future, or treatment response (beneficial or adverse).

### Review of Evidence

#### Systematic Reviews

A meta-analysis by El-Matary et al (2009) compared the diagnostic performance of CE with a reference standard of duodenal biopsy.<sup>10</sup> The pooled analysis of 3 studies showed a sensitivity of 83% and a specificity of 98%. Another meta-analysis by Rokkas and Niv (2012) also compared the diagnostic performance of CE with biopsy, summarizing 6 studies (N=166 subjects).<sup>11</sup> The overall pooled sensitivity was 89%, and the specificity was 95%.

Capsule endoscopy detected involvement of intestines beyond the duodenum; however, the clinical significance of detecting the extent of celiac disease is uncertain. Given the less than 90% sensitivity of CE for celiac disease, it does not appear to be an adequate alternative method of making an initial diagnosis.

#### Nonrandomized Studies

In a study by Kurien et al (2013), 62 patients with an equivocal diagnosis of celiac disease and 69 patients with confirmed celiac disease who were unresponsive to standard treatment were evaluated with CE.<sup>12</sup> Results were combined with human leukocyte antigen typing and response to gluten challenge, with the final diagnosis made by 3 expert physicians who received the information from all 3 sources. The main outcome was the increase in diagnostic yield after CE combined with the other tests. The diagnostic yield was greatest in cases with antibody-negative villous atrophy where a diagnosis of celiac disease was made in 9 (28%) of 32 patients. In 8 (12%) of the 69 nonresponsive celiac disease patients, CE identified 2 cases of enteropathy-associated lymphoma, 4 type 1 refractory disease cases, 1 fibroepithelial polyp, and 1 case of ulcerative jejunitis. This study was limited by the small sample size and use of other tests in conjunction with CE to ascertain a final diagnosis.

One case series by Culliford et al (2005) evaluated 47 patients with complicated celiac disease and found unexpected additional findings in 60% of patients, most of which were ulcerations.<sup>13</sup> However, the definition of "complicated" celiac disease included other factors such as evidence of blood loss, itself an indication for CE. The impact on patient management and outcomes is unclear.

### Clinically Useful

A test is clinically useful if the use of the results informs management decisions that improve the net health outcome of care. The net health outcome can be improved if patients receive correct therapy, more effective therapy, or avoid unnecessary therapy or testing.

### **Direct Evidence**

Direct evidence of clinical utility is provided by studies that have compared health outcomes for patients managed with and without the test. Because these are intervention studies, the preferred evidence would be from RCTs.

No RCTs assessing the clinical utility of wireless CE for this indication were identified.

### **Chain of Evidence**

Indirect evidence on clinical utility rests on clinical validity. If the evidence is insufficient to demonstrate test performance, no inferences can be made about clinical utility.

Because the clinical validity of wireless CE for diagnosing celiac disease has not been established, a chain of evidence supporting the test's clinical utility for this indication cannot be constructed.

### **Section Summary: Suspected Celiac Disease**

In cases where the diagnosis of celiac disease is equivocal, CE can sometimes reveal morphologic changes in the small bowel consistent with celiac disease. However, it is unlikely that the appearance of small bowel on CE is itself sufficient to make a definitive diagnosis of celiac disease. Small bowel biopsy, celiac serologies, and human leukocyte antigen typing remain the standard tests for confirming celiac disease and have a higher sensitivity and specificity for this purpose. Case series of patients with unresponsive celiac disease undergoing CE have shown some yield of actionable diagnoses that have the potential to improve patient outcomes. Larger studies are needed to better determine the diagnostic yield of CE in these patients.

### **Unexplained Chronic Abdominal Pain**

#### **Clinical Context and Test Purpose**

The purpose of wireless CE for patients who have unexplained chronic abdominal pain is to confirm a diagnosis and inform a decision to proceed to appropriate treatment.

The following PICO was used to select literature to inform this review.

#### ***Populations***

The relevant population of interest is individuals with unexplained chronic abdominal pain.

#### ***Interventions***

The test being considered is wireless CE.

#### ***Comparators***

The following practice is currently being used to diagnose chronic abdominal pain: standard workup for abdominal pain without CE.

#### ***Outcomes***

The general outcomes of interest are test validity, other test performance measures, symptoms, and change in disease status.

The diagnosis of chronic abdominal pain is often one of exclusion after a comprehensive clinical evaluation including empirical treatment. Imaging studies are used during initial and follow-up evaluations. Continued follow-up would be based on a definitive or working diagnosis, which would typically occur over weeks to months.

### **Study Selection Criteria**

Below are selection criteria for studies to assess whether a test is clinically valid.

- The study population represents the population of interest. Eligibility and selection are described.

- The test is compared with a credible reference standard.
- If the test is intended to replace or be an adjunct to an existing test; it should also be compared with that test.
- Studies should report sensitivity, specificity, and predictive values. Studies that completely report true- and false-positive results are ideal. Studies reporting other measures (e.g., receiver operator curve, area under the receiver operator curve, c-statistic, likelihood ratios) may be included but are less informative.
- Studies should also report reclassification of the diagnostic or risk category.

### Clinically Valid

A test must detect the presence or absence of a condition, the risk of developing a condition in the future, or treatment response (beneficial or adverse).

### Review of Evidence

#### Systematic Reviews

Xue et al (2015) reported on a systematic review of 21 studies (N=1520 patients) evaluating CE for unexplained chronic abdominal pain.<sup>14</sup> The pooled diagnostic yield was 20.9% (95% confidence interval [CI], 15.9% to 25.9%). The most commonly identified findings were inflammatory lesions (78.3%) and tumors (9.0%). Studies in the review were highly heterogeneous. Limitations in interpreting the findings included retrospective study designs, different durations of abdominal pain, and the use of different tests before CE.

#### Case Series

In a study not included in the systematic review, Yang et al (2014) reported on a case series evaluating 243 patients with CE for unexplained chronic abdominal pain.<sup>15</sup> The diagnostic yield of CE was 23.0%. Identified findings included 19 (7.8%) patients with CD, 15 (6.2%) with enteritis, 11 (4.5%) with idiopathic intestinal lymphangiectasia, 5 (2.1%) with uncinariasis, and 5 (2.1%) with abnormal transit time and other findings (e.g., small bowel tumor, ascariasis, anaphylactoid purpura).

### Clinically Useful

A test is clinically useful if the use of the results informs management decisions that improve the net health outcome of care. The net health outcome can be improved if patients receive correct therapy, more effective therapy, or avoid unnecessary therapy or testing.

### Direct Evidence

Direct evidence of clinical utility is provided by studies that have compared health outcomes for patients managed with and without the test. Because these are intervention studies, the preferred evidence would be from RCTs.

No RCTs assessing the clinical utility of wireless CE for this indication were identified.

### Chain of Evidence

Indirect evidence on clinical utility rests on clinical validity. If the evidence is insufficient to demonstrate test performance, no inferences can be made about clinical utility.

Because the clinical validity of wireless CE for diagnosing unexplained chronic abdominal pain has not been established, a chain of evidence supporting the test's clinical utility for this indication cannot be constructed.

### Section Summary: Unexplained Chronic Abdominal Pain

While CE diagnosed unexplained chronic abdominal pain in a proportion of patients reported in retrospective studies, the sequence and chronology of testing and treatment recommended before CE needs to be defined to determine whether CE has utility to diagnose the condition.

## Established Crohn Disease

### Clinical Context and Test Purpose

The purpose of wireless CE for patients who have an established diagnosis of CD is to inform management decisions based on disease status.

The following PICO was used to select literature to inform this review.

### *Populations*

The relevant population of interest is patients with CD.

### *Interventions*

The intervention of interest is wireless CE.

### *Comparators*

The following tests are currently being used to monitor CD: ileocolonoscopy, barium small bowel follow-through, CTE, and MRE.

### *Outcomes*

The beneficial outcome of a true test result, if correctly classified as low disease activity, is the avoidance of endoscopy and unnecessary medications.

Wireless CE would be performed to monitor patients with CD.

## Study Selection Criteria

Below are selection criteria for studies to assess whether a test is clinically valid.

- The study population represents the population of interest. Eligibility and selection are described.
- The test is compared with a credible reference standard.
- If the test is intended to replace or be an adjunct to an existing test; it should also be compared with that test.
- Studies should report sensitivity, specificity, and predictive values. Studies that completely report true- and false-positive results are ideal. Studies reporting other measures (e.g., receiver operator curve, area under the receiver operator curve, c-statistic, likelihood ratios) may be included but are less informative.
- Studies should also report reclassification of the diagnostic or risk category.

## Clinically Valid

A test must detect the presence or absence of a condition, the risk of developing a condition in the future, or treatment response (beneficial or adverse).

## Review of Evidence

### Systematic Reviews

Kopylov et al (2017) published a systematic review of studies evaluating the use of CE for CD.<sup>16</sup> Reviewers included prospective studies comparing CE with MRE and/or small bowel contrast ultrasound in patients who had suspected and/or established CD. In pooled analyses of the 11 studies that included patients with established CD, the diagnostic yield of CE was similar to that of MRE (odds ratio [OR], 1.88; 95% CI, 0.53 to 1.48;  $P=48\%$ ) and to ultrasound (OR, 0.57; 95% CI, 0.27 to 1.20;  $P=67\%$ ).

### Diagnostic Accuracy Studies

Bruining et al (2020) reported results from the multicenter, prospective BLINK trial comparing the diagnostic accuracy of CE compared to ileocolonoscopy and/or MRE in patients with established CD.<sup>17</sup> The per-protocol analysis included 99/158 enrolled subjects with 16 patients tested by all 3

modalities. Major reasons for exclusion from analysis included patency failure or MRE stricture and major protocol violations. The reference standard was defined as the presence or absence of inflammation as designated by the modality-specific scoring system at prospective interpretation by expert central readers. In cases of discrepant findings for any bowel segment, all modalities were reviewed and resolved by a consensus panel consisting of 3 gastroenterologists. Overall sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were 94% (95% CI, 86% to 98%), 74% (95% CI, 55% to 87%), 91% (95% CI, 82% to 96%), and 83% (95% CI, 64% to 94%) for CE compared to 100% (95% CI, 95% to 100%), 22% (95% CI, 10% to 41%), 77% (95% CI, 68% to 85%), and 100% (95% CI, 54% to 100%) for ileocolonoscopy and/or MRE. Sensitivity of CE was significantly higher compared to MRE for enteric inflammation in the proximal small bowel (97% vs. 71%,  $p=.021$ ) and similar in the terminal ileum and colon ( $p=.500$  to  $.625$ ). Discrepant reads between the proximal small bowel, terminal ileum, and colon were 57%, 49%, and 81%, respectively. In the proximal small bowel, the majority consensus panel decision was agreement with CE.

### Cohort Studies

A study by Elosua et al (2022) evaluated the therapeutic impact of CE in patients with established CD in this retrospective, single-center study.<sup>18</sup> Therapeutic impact was defined as change in CD-related treatment recommended based on CE results and 305 patients (N=432 procedures) with established CD who underwent a CE procedure between January 2008 and December 2019 were included. Of the included CE procedures, 87.5% were deemed conclusive. Mild inflammation was detected in 41.6% of patients and moderate-to-severe activity was detected in 21.9% of patients. Management changes guided by CE procedures occurred in 51.3% of procedures, with 46.1% of procedures leading to treatment escalation and 5.3% of procedures leading to de-escalation. Disease activity demonstrated by CE results was correlated with therapeutic changes. Mucosal healing assessed via CE was the only independent factor that predicted therapy de-escalation (OR, 6.86; 95% CI, 1.42 to 33). The single-center group of clinicians limited heterogeneity. These results are limited by the retrospective design of the study.

### Clinically Useful

A test is clinically useful if the use of the results informs management decisions that improve the net health outcome of care. The net health outcome can be improved if patients receive correct therapy, more effective therapy, or avoid unnecessary therapy or testing.

### Direct Evidence

Direct evidence of clinical utility is provided by studies that have compared health outcomes for patients managed with and without the test. Because these are intervention studies, the preferred evidence would be from RCTs.

No RCTs assessing the clinical utility of wireless CE for this indication were identified.

### Chain of Evidence

Indirect evidence on clinical utility rests on clinical validity. If the evidence is insufficient to demonstrate test performance, no inferences can be made about clinical utility.

Based on evidence that CE has a similar diagnostic yield as radiography when used to monitor CD and CE can be used when radiography cannot, a chain of evidence can be constructed to support the clinical utility of CE for this indication.

### Section Summary: Established Crohn Disease

A 2017 systematic review of 11 studies in patients with established CD found a similar diagnostic yield with CE compared with radiography. A diagnostic accuracy study of CE compared with ileocolonoscopy and/or MRE for the detection of active inflammatory CD in patients with established CD found a comparable sensitivity, higher specificity and PPV, and lower NPV compared to ileocolonoscopy and/or MRE. Differences may be attributed to high rates of discrepant reads



between modalities, and high consensus panel agreement with CE results in cases of discrepancy. A retrospective cohort study demonstrated therapeutic management changes based on CE results, but RCTs are still needed to further assess the impact of CE results on therapy management.

## **Ulcerative Colitis**

### **Clinical Context and Test Purpose**

The purpose of wireless CE for patients who have ulcerative colitis is to inform management decisions based on disease status.

The following PICO was used to select literature to inform this review.

### ***Populations***

The relevant population of interest is individuals with ulcerative colitis.

### ***Interventions***

The test being considered is wireless CE.

### ***Comparators***

The following test is currently being used to manage ulcerative colitis: optical colonoscopy.

### ***Outcomes***

The general outcomes of interest are test validity, other test performance measures, symptoms, and change in disease status.

Wireless CE would be performed to monitor patients after a confirmed diagnosis of ulcerative colitis.

## **Study Selection Criteria**

Below are selection criteria for studies to assess whether a test is clinically valid.

- The study population represents the population of interest. Eligibility and selection are described.
- The test is compared with a credible reference standard.
- If the test is intended to replace or be an adjunct to an existing test; it should also be compared with that test.
- Studies should report sensitivity, specificity, and predictive values. Studies that completely report true- and false-positive results are ideal. Studies reporting other measures (e.g., receiver operator curve, area under the receiver operator curve, c-statistic, likelihood ratios) may be included but are less informative.
- Studies should also report reclassification of the diagnostic or risk category.

## **Clinically Valid**

A test must detect the presence or absence of a condition, the risk of developing a condition in the future, or treatment response (beneficial or adverse).

## **Review of Evidence**

A number of prospective observational studies have evaluated the diagnostic accuracy of CE in patients with ulcerative colitis. Tables 12 and 13 summarize the characteristics and results of these studies.

**Table 12. Characteristics of Observational Comparative Studies Assessing CE for UC**

Study	Study Type	Country	Dates	Participants	Treatment	Follow-Up
Shi et al (2017) <sup>19</sup>	Single-center prospective observational	China	2014-2016	Patients 18 to 80 y with UC requiring colonoscopy	150 patients underwent CE-2 and colonoscopy	NR
San Juan-Acosta et al (2014) <sup>20</sup>	Single-blind prospective comparative	Spain	2010-2012	Patients 18 to 70 y with UC with flare in disease activity or due for CRC screening	23 underwent CE-1, 19 had CE-2; all followed by colonoscopy	NR
Oliva et al (2014) <sup>21</sup>	Prospective observational	Spain	2011-2012	Patients 6 to 18 y with a diagnosis at least 3 mo prior to enrollment	30 patients underwent CE-2, followed by colonoscopy	NR
Sung et al (2012) <sup>22</sup>	Prospective cohort	China and Singapore	2000-2008	Patients with suspected or known UC	100 patients underwent CE and same-day colonoscopy	NR

CE-1: first-generation capsule endoscopy; CE-2: second-generation capsule endoscopy; CRC: colorectal cancer; NR: not reported; UC: ulcerative colitis.

**Table 13. Results of Observational Comparative Studies Assessing CE for Ulcerative Colitis**

Study	Active Colonic Inflammation, %		PPV, %	NPV, %	Correlation Between Colon CE and Colonoscopy	
	Sensitivity <sup>a</sup>	Specificity			Disease Severity	Extent of Inflammation
<b>Shi et al (2017)<sup>19</sup></b>						
N	150	150	150		150	150
Mucosal inflammation (MES >0)	97			94 to 95		
M-to-S inflammation (MES >1)	94					
Postinflammatory polyps	100	91				
ICC (95% CI)					0.69 (0.46 to 0.81) <sup>a</sup>	0.64 (0.38 to 0.78) <sup>b</sup>
p					<.001	<.001
<b>San Juan-Acosta et al (2014)<sup>20</sup></b>						
N	42	42	42		42	42
<b>CE vs colonoscopy</b>						
Disease activity	77.78	95.83	93.33	85.19		
Disease extent	68.75	96.15	91.67	83.33		
κ (95% CI)					0.79 (0.62 to 0.96)	0.71 (0.52 to 0.90)
<b>Oliva et al (2014)<sup>21</sup></b>						
N	30	30	30			
% (95% CI)	96 (79 to 99)	100 (61 to 100)	100 (85 to 100)	85 (49 to 97)		
<b>Sung et al (2012)<sup>22</sup></b>						
N	100	100	100			
% (95% CI)	89 (80 to 95)	75 (51 to 90)	93 (84 to 97)	65 (43 to 83)		

CE: capsule endoscopy; CI: confidence interval; ICC: intraclass correlation coefficient; MES: Mayo Endoscopic Subscore; M-to-S: moderate to severe; NPV: negative predictive value; PPV: positive predictive value.

<sup>a</sup> MES.

<sup>b</sup> Ulcerative Colitis Endoscopic Index of Severity.

In the study by San Juan-Acosta et al (2014), although the correspondence between the 2 methods was reasonably good, it is uncertain whether management changes based on 1 or the other test would result in similar or different patient outcomes.<sup>20</sup>

Oliva et al (2014) evaluated 30 patients with known ulcerative colitis with both CE and colonoscopy to assess disease activity.<sup>21</sup> The reference standard for disease activity was a Matts score greater than 6 as judged by colonoscopy. Although the 2 methods had a high concordance at this cutoff level of disease in this study, patient outcomes linked to these assessments of disease activity cannot be determined.

### **Clinically Useful**

A test is clinically useful if the use of the results informs management decisions that improve the net health outcome of care. The net health outcome can be improved if patients receive correct therapy, or more effective therapy, or avoid unnecessary therapy, or avoid unnecessary testing.

### **Direct Evidence**

Direct evidence of clinical utility is provided by studies that have compared health outcomes for patients managed with and without the test. Because these are intervention studies, the preferred evidence would be from RCTs.

No RCTs assessing the clinical utility of wireless CE for this indication were identified.

### **Chain of Evidence**

Indirect evidence on clinical utility rests on clinical validity. If the evidence is insufficient to demonstrate test performance, no inferences can be made about clinical utility.

Because the clinical validity of wireless CE for monitoring ulcerative colitis has not been established, a chain of evidence supporting the test's clinical utility for this indication cannot be constructed.

### **Section Summary: Ulcerative Colitis**

Several diagnostic accuracy studies have compared CE with colonoscopy to assess disease activity in patients with ulcerative colitis. Two of 4 studies were small (i.e., <50 patients) and thus data on diagnostic accuracy are limited. Because there are insufficient data on diagnostic accuracy, a chain of evidence on clinical utility cannot be constructed.

## **Esophageal Disorders**

### **Clinical Context and Test Purpose**

The purpose of wireless CE for patients who have esophageal disorders is to inform management decisions based on disease status.

The following PICO was used to select literature to inform this review.

### ***Populations***

The relevant population of interest is individuals with esophageal disorders. Gastroesophageal reflux disease and chronic sequelae such as Barrett esophagus may require diagnostic and surveillance interventions.

### ***Interventions***

The test being considered is wireless CE. In the esophagus, the capsule camera has been proposed as a screening technique for Barrett esophagus associated with gastroesophageal reflux disease. Evaluation of the esophagus requires limited transit time, and it is estimated that the test takes 20 minutes to perform.

Capsule endoscopy can visualize several types of esophageal conditions. It could substitute for traditional upper endoscopy for several indications and may have the advantage of comfort and convenience. However, interventional procedures and biopsies cannot be performed with CE. Capsule endoscopy could triage patients for endoscopy if either the sensitivity or the specificity is high. Traditional endoscopy could then be performed on the appropriate group to determine false-

positives or false-negatives, having spared the group with a high positive predictive value an endoscopy procedure.

### ***Comparators***

The following test is currently being used to manage esophageal disorders: upper GI endoscopy.

### ***Outcomes***

The general outcomes of interest are test validity, other test performance measures, symptoms, and change in disease status.

Wireless CE would be performed to monitor patients after a confirmed diagnosis of an esophageal disorder.

### **Study Selection Criteria**

Below are selection criteria for studies to assess whether a test is clinically valid.

- The study population represents the population of interest. Eligibility and selection are described.
- The test is compared with a credible reference standard.
- If the test is intended to replace or be an adjunct to an existing test; it should also be compared with that test.
- Studies should report sensitivity, specificity, and predictive values. Studies that completely report true- and false-positive results are ideal. Studies reporting other measures (e.g., receiver operator curve, area under the receiver operator curve, c-statistic, likelihood ratios) may be included but are less informative.
- Studies should also report reclassification of the diagnostic or risk category.

### **Clinically Valid**

A test must detect the presence or absence of a condition, the risk of developing a condition in the future, or treatment response (beneficial or adverse).

### **Review of Evidence**

#### **Systematic Reviews**

Most studies have shown that CE has inferior diagnostic characteristics compared with traditional upper endoscopy for a variety of esophageal conditions. A meta-analysis by Guturu et al (2011) evaluated 9 studies comparing CE with traditional endoscopy for detecting esophageal varices and calculated a sensitivity of 83% and specificity of 85%.<sup>23</sup> A meta-analysis by Bhardwaj et al (2009) assessed 9 studies comparing CE with traditional endoscopy for detecting Barrett esophagus and reported a sensitivity of 77% and specificity of 86%.<sup>24</sup> Because of the lower sensitivity and specificity of that test, CE cannot substitute for traditional endoscopy nor can it be used to triage patients to endoscopy.

### **Clinically Useful**

A test is clinically useful if the use of the results informs management decisions that improve the net health outcome of care. The net health outcome can be improved if patients receive correct therapy, more effective therapy, or avoid unnecessary therapy or testing.

### **Direct Evidence**

Direct evidence of clinical utility is provided by studies that have compared health outcomes for patients managed with and without the test. Because these are intervention studies, the preferred evidence would be from RCTs.

No RCTs assessing the clinical utility of wireless CE for this indication were identified.

### **Chain of Evidence**

Indirect evidence on clinical utility rests on clinical validity. If the evidence is insufficient to demonstrate test performance, no inferences can be made about clinical utility. Because the clinical validity of wireless CE for monitoring esophageal disorders has not been established, a chain of evidence supporting the test's clinical utility for this indication cannot be constructed.

### **Section Summary: Esophageal Disorders**

Other available modalities are superior to CE for monitoring esophageal disorders. The diagnostic characteristics of CE are inadequate to substitute for other modalities or to triage patients to other modalities.

### **Hereditary Gastrointestinal Polyposis Syndromes**

#### **Clinical Context and Test Purpose**

The purpose of wireless CE for patients who have hereditary GI polyposis syndromes is to inform management decisions based on disease status.

The following PICO was used to select literature to inform this review.

#### ***Populations***

The relevant population of interest is individuals with hereditary GI polyposis syndromes, including Lynch syndrome and Peutz-Jeghers syndrome (PJS).

#### ***Interventions***

The test being considered is wireless CE.

#### ***Comparators***

The following tests and practices are currently being used to manage hereditary GI polyposis syndromes: ileocolonoscopy, barium small bowel follow-through, CTE, and MRE.

#### ***Outcomes***

The general outcomes of interest are, test validity, other test performance measures, symptoms, and change in disease status.

Wireless CE would be performed to monitor patients after a confirmed diagnosis with hereditary GI polyposis syndromes.

### **Study Selection Criteria**

Below are selection criteria for studies to assess whether a test is clinically valid.

- The study population represents the population of interest. Eligibility and selection are described.
- The test is compared with a credible reference standard.
- If the test is intended to replace or be an adjunct to an existing test; it should also be compared with that test.
- Studies should report sensitivity, specificity, and predictive values. Studies that completely report true- and false-positive results are ideal. Studies reporting other measures (e.g., receiver operator curve, area under the receiver operator curve, c-statistic, likelihood ratios) may be included but are less informative.
- Studies should also report reclassification of the diagnostic or risk category.

### **Clinically Valid**

A test must detect the presence or absence of a condition, the risk of developing a condition in the future, or treatment response (beneficial or adverse).

### Review of Evidence

Persons with familial adenomatous polyposis and PJS are genetically at high-risk of small bowel polyps and tumors. Urquhart et al (2014) compared CE with MRE in 20 patients with PJS.<sup>25</sup> Capsule endoscopy identified more polyps 10 mm or larger (47 polyps) than MRE (14 polyps;  $p=.02$ ). However, subsequent balloon enteroscopy in 12 patients showed a poor correlation of findings between techniques, with a 100% PPV of finding a polyp on balloon enteroscopy with MRE versus 60% for CE. A study by Brown et al (2006) in 19 patients showed a greater number of polyps identified with CE than with barium follow-through examinations.<sup>26</sup> Mata et al (2005) studied the role of CE in 24 patients with hereditary GI polyposis syndromes, including familial adenomatous polyposis ( $n=20$ ) or PJS ( $n=4$ ).<sup>27</sup> Compared with barium studies using small bowel enteroclysis, CE identified 4 additional patients with small bowel polyps, which were subsequently removed with endoscopic polypectomy. Although these studies were small, they demonstrated that CE can identify additional lesions compared with other diagnostic methods in persons with disease syndromes at high-risk for such lesions.

The lifetime risk of small bowel cancer in Lynch syndrome has been estimated at 5%. Although not extremely high, this risk is greatly increased compared with the general population. There are a few case series of the prevalence of neoplastic lesions in asymptomatic patients with Lynch syndrome. Haanstra et al (2015) evaluated 200 patients with Lynch syndrome who underwent CE.<sup>28</sup> Small bowel neoplasia was detected in the duodenum in 2 patients (1 adenocarcinoma, 1 adenoma). These lesions would have been in the reach of a gastroduodenoscope. In a smaller study by Saurin et al (2010), 35 asymptomatic patients with Lynch syndrome underwent colon CE.<sup>29</sup> Small bowel neoplasms were diagnosed in 3 (8.6%) patients (1 adenocarcinoma, 2 adenomas with low-grade dysplasia).

### Clinically Useful

A test is clinically useful if the use of the results informs management decisions that improve the net health outcome of care. The net health outcome can be improved if patients receive correct therapy, more effective therapy, or avoid unnecessary therapy or testing.

### Direct Evidence

Direct evidence of clinical utility is provided by studies that have compared health outcomes for patients managed with and without the test. Because these are intervention studies, the preferred evidence would be from RCTs.

No RCTs assessing the clinical utility of wireless CE for this indication were identified.

### Chain of Evidence

Indirect evidence on clinical utility rests on clinical validity. If the evidence is insufficient to demonstrate test performance, no inferences can be made about clinical utility.

Because the clinical validity of wireless CE for monitoring hereditary GI polyposis syndromes has not been established, a chain of evidence supporting the test's clinical utility for this indication cannot be constructed.

### Section Summary: Hereditary Gastrointestinal Polyposis Syndromes

Although studies have shown at least a low prevalence of small bowel neoplasms, these data are insufficient to determine whether evaluation with CE would improve patient outcomes. Additional data on the prevalence and natural history of small bowel polyps in Lynch syndrome patients are necessary. At this time, surveillance of the small bowel is not generally recommended as a routine intervention for patients with Lynch syndrome.

### Portal Hypertensive Enteropathy

#### Clinical Context and Test Purpose

The purpose of wireless CE for patients who have portal hypertensive enteropathy is to inform management decisions based on disease status.

The following PICO was used to select literature to inform this review.

### **Populations**

The relevant population of interest is individuals with portal hypertensive enteropathy.

### **Interventions**

The test being considered is wireless CE.

### **Comparators**

The following test is currently being used to manage portal hypertensive enteropathy: upper and lower endoscopy.

### **Outcomes.**

The general outcomes of interest are test validity, other test performance measures, symptoms, and change in disease status.

Wireless CE would be performed to monitor patients after a confirmed diagnosis with portal hypertensive enteropathy.

### **Study Selection Criteria**

Below are selection criteria for studies to assess whether a test is clinically valid.

- The study population represents the population of interest. Eligibility and selection are described.
- The test is compared with a credible reference standard.
- If the test is intended to replace or be an adjunct to an existing test; it should also be compared with that test.
- Studies should report sensitivity, specificity, and predictive values. Studies that completely report true- and false-positive results are ideal. Studies reporting other measures (e.g., receiver operator curve, area under the receiver operator curve, c-statistic, likelihood ratios) may be included but are less informative.
- Studies should also report reclassification of the diagnostic or risk category.

### **Clinically Valid**

A test must detect the presence or absence of a condition, the risk of developing a condition in the future, or treatment response (beneficial or adverse).

### **Review of Evidence**

#### **Systematic Reviews**

Several systematic reviews, including a Cochrane review, have been published. Tables 14 and 15 summarize the characteristics and results of select systematic reviews.

**Table 14. Characteristics of Systematic Reviews Assessing Capsule Endoscopy for Portal Hypertensive Enteropathy**

Study	Dates	Trials	Participants	N (Range)	Design
McCarty et al (2017) <sup>30</sup> .	2005-2015	17	Patients with portal hypertension	1328 (8 to 330)	NR
Colli et al (2014) <sup>31</sup> .	2005-2014	16	Adults with cirrhosis	936 (NR)	Cohort

NR: not reported.

**Table 15. Results of Systematic Reviews Assessing Capsule Endoscopy for Portal Hypertensive Enteropathy**

Study	CE, %		Likelihood Ratios		Diagnostic Accuracy	
	Sensitivity	Specificity	Positive	Negative	CE	Medium-to-Large Varices

Study	CE, %		Likelihood Ratios		Diagnostic Accuracy	
<b>McCarty et al (2017)<sup>30</sup></b>						
N	1328	1328	1328			
PE (95% CI), %	83 (76 to 89)	85 (75 to 91)	5.4 (3.3 to 9.0)	0.20 (0.14 to 0.28)	90 (88 to 93)	92 (90 to 94)
<b>Studies with low risk of bias, n</b>						
PE (95% CI), %	80 (81 to 88)	86 (68 to 94)			85 (81 to 88)	92 (89 to 94)
<b>Colli et al (2014)<sup>31</sup></b>						
N	936	936	936			
PE (95% CI), %	84.8 (77.3 to 90.2)	84.3 (73.1 to 91.4)	5.4 (3.1 to 9.5)	0.18 (0.12 to 0.27)		
<b>Studies with low risk of bias, n</b>						
PE (95% CI), %	79.7 (73.1 to 85.0)	86.1 (64.5 to 95.5)	5.8 (2.1 to 16.1)	0.24 (0.18 to 0.31)		

CE: capsule endoscopy; CI: confidence interval; PE: pooled effect.

### Clinically Useful

A test is clinically useful if the use of the results informs management decisions that improve the net health outcome of care. The net health outcome can be improved if patients receive correct therapy, more effective therapy, or avoid unnecessary therapy or testing.

### Direct Evidence

Direct evidence of clinical utility is provided by studies that have compared health outcomes for patients managed with and without the test. Because these are intervention studies, the preferred evidence would be from RCTs.

No RCTs assessing the clinical utility of wireless CE for this indication were identified.

### Chain of Evidence

Indirect evidence on clinical utility rests on clinical validity. If the evidence is insufficient to demonstrate test performance, no inferences can be made about clinical utility.

Because the clinical validity of wireless CE for monitoring portal hypertensive enteropathy has not been established, a chain of evidence supporting the test's clinical utility for this indication cannot be constructed.

### Section Summary: Portal Hypertensive Enteropathy

Capsule endoscopy has been used to diagnose portal hypertensive enteropathy. Systematic reviews of studies of its diagnostic performance have reported limited sensitivity and specificity. Because neither the sensitivity nor the specificity was high for identifying esophageal varices, CE should not be used instead of esophagogastroduodenoscopy nor should it be used to triage patients to esophagogastroduodenoscopy. Based on these diagnostic characteristics, the test does not appear to have clinical utility.

### Acute Upper Gastrointestinal Tract Bleeding

#### Clinical Context and Test Purpose

The purpose of wireless CE for patients who have acute upper GI tract bleeding is to inform management decisions based on disease status.

The following PICO was used to select literature to inform this review.

#### Populations

The relevant population of interest is patients with acute upper GI tract bleeding.



### ***Interventions***

The intervention of interest is wireless CE.

### ***Comparators***

The following practices are currently being used to manage acute upper GI tract bleeding: standard workup of acute bleeding without wireless CE and, with or without direct endoscopic procedures or specialized GI imaging.

### ***Outcomes***

The primary outcomes of interest for clinical utility are symptoms and disease status that would change due to patient management decisions following wireless CE. Other outcomes of interest are the avoidance of hospitalizations and reductions in resource utilization (e.g., need for additional testing or procedures).

Wireless CE would be performed as soon as possible after acute bleeding is identified. Wireless CE would be performed to monitor patients after a confirmed diagnosis with acute GI tract bleeding.

### **Study Selection Criteria**

Below are selection criteria for studies to assess whether a test is clinically valid.

- The study population represents the population of interest. Eligibility and selection are described.
- The test is compared with a credible reference standard.
- If the test is intended to replace or be an adjunct to an existing test; it should also be compared with that test.
- Studies should report sensitivity, specificity, and predictive values. Studies that completely report true- and false-positive results are ideal. Studies reporting other measures (e.g., receiver operator curve, area under the receiver operator curve, c-statistic, likelihood ratios) may be included but are less informative.
- Studies should also report reclassification of the diagnostic or risk category.

### **Clinically Valid**

A test must detect the presence or absence of a condition, the risk of developing a condition in the future, or treatment response (beneficial or adverse).

### **Review of Evidence**

#### **Randomized Controlled Trials**

Sung et al (2016) reported on a prospective RCT to evaluate the use of CE in the emergency department for patients with suspected upper GI bleeding.<sup>32</sup> Capsule endoscopy was used to determine whether patients would be admitted to the hospital or sent home, versus an alternative strategy of admitting all patients. Eligible patients presented with signs and/or symptoms of acute upper GI bleeding but were without hemodynamic shock or conditions likely to preclude the use of the capsule endoscope. Seventy-one patients were randomized to CE in the emergency department (n=37), followed by monitoring for upper GI bleeding, or standard care (n=34), which included mandatory hospital admission. Seven CE patients with active bleeding or endoscopic findings were admitted, with the remainder discharged home. There were no deaths or morbid outcomes in either group, indicating that CE could result in equivalent patient outcomes with many patients safely avoiding emergency hospitalization.

Tables 16 and 17 summarize the characteristics and results of select RCTs.

**Table 16. Characteristics of RCTs Assessing Capsule Endoscopy for Acute Gastrointestinal Tract Bleeding**

Study	Countries	Sites	Dates	Participants	Interventions	
<b>Sung et al (2016)<sup>32</sup></b>	China	NR	2013-2014	Patients presenting to ED with symptoms suggestive of UGIB	Active 37 randomized to CE; admission determined by CE	Comparator 34 randomized to SOC; admission determined by GBS
<b>Gutkin et al (2013)<sup>33</sup></b>	U.S.	3	NR	Patients ≥18 y with history suggestive of acute UGIB ≤48 h prior to ED presentation	12 randomized to VCE prior to endoscopy	12 randomized to endoscopy

CE: capsule endoscopy; ED: emergency department; GBS: Glasgow Blatchford score; NR: not reported; RCT: randomized controlled trial; SOC: standard of care; UGIB: upper gastrointestinal bleeding; VCE: video capsule endoscopy.

**Table 17. Results of RCTs Assessing Capsule Endoscopy for Acute Gastrointestinal Tract Bleeding**

Study	Active Bleeding or Endoscopic Findings, n	Hospitalization, n	Mortality, n	GBS Score	Agreement Between CE and EGD
<b>Sung et al (2016)<sup>32</sup></b>					
<b>N</b>	68	68	68	68	68
<b>CE</b>	<ul style="list-style-type: none"> <li>• “Coffee ground” material: 2</li> <li>• Peptic ulcer with Forrest Ib stigmata: 2</li> <li>• Forrest IIa: 2</li> <li>• Esophageal varix: 1</li> </ul>	7	0	<ul style="list-style-type: none"> <li>• 6 patients: 0</li> <li>• 3 patients: 1</li> <li>• 25 patients: ≥2</li> </ul>	•
<b>SOC</b>	<ul style="list-style-type: none"> <li>• Peptic ulcer: 14</li> <li>• Duodenal ulcer: 12</li> <li>• Gastritis/duodenitis: 10</li> <li>• Gastric or duodenal erosions: 5</li> <li>• Mallory Weiss tear: 1</li> </ul>	34	0	<ul style="list-style-type: none"> <li>• No patients scored 0</li> <li>• 7 patients: 1</li> <li>• 27 patients: ≥2</li> </ul>	•
<b>Gutkin et al (2013)<sup>33</sup></b>					
<b>N</b>	24				24
<b>VCE</b>	8 (67.7%) had positive findings confirmed by endoscopy; for these patients, average Rockall score was 3; average Blatchford score was 13				VCE data identical to EGD results ( $P=1.0$ )

CE: capsule endoscopy; EGD: esophagogastroduodenoscopy; GBS: Glasgow Blatchford score; RCT: randomized controlled trial; SOC: standard of care; VCE: video capsule endoscopy.

The purpose of the limitations tables (see Tables 18 and 19) is to display notable limitations identified in each study. This information is synthesized as a summary of the body of evidence following each table and provides the conclusions on the sufficiency of the evidence supporting the position statement.

**Table 18. Study Relevance Limitations**

Study	Population <sup>a</sup>	Intervention <sup>b</sup>	Comparator <sup>c</sup>	Outcomes <sup>d</sup>	Duration of Follow-Up <sup>e</sup>
Sung et al (2016) <sup>32</sup>					
Gutkin et al (2013) <sup>33</sup>					

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.

<sup>a</sup> Population key: 1. Intended use population unclear; 2. Clinical context is unclear; 3. Study population is unclear; 4. Study population not representative of intended use.

<sup>b</sup> Intervention key: 1. Classification thresholds not defined; 2. Version used unclear; 3. Not intervention of interest.

<sup>c</sup> Comparator key: 1. Classification thresholds not defined; 2. Not compared to credible reference standard; 3. Not compared to other tests in use for same purpose.

<sup>d</sup> Outcomes key: 1. Study does not directly assess a key health outcome; 2. Evidence chain or decision model not explicated; 3. Key clinical validity outcomes not reported (sensitivity, specificity, and predictive values); 4. Reclassification of diagnostic or risk categories not reported; 5. Adverse events of the test not described (excluding minor discomforts and inconvenience of venipuncture or noninvasive tests).

<sup>e</sup> Follow-Up key: 1. Follow-up duration not sufficient with respect to natural history of disease (true-positives, true-negatives, false-positives, false-negatives cannot be determined).

**Table 19. Study Design and Conduct Limitations**

Study	Selection <sup>a</sup>	Blinding <sup>b</sup>	Delivery of Test <sup>c</sup>	Selective Reporting <sup>d</sup>	Data Completeness <sup>e</sup>	Statistical <sup>f</sup>
Sung et al (2016) <sup>32</sup>						3. As a feasibility study, confidence intervals and p values were not reported
Gutkin et al (2013) <sup>33</sup>					2. Small sample size based on pilot/feasibility study	

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.

<sup>a</sup> Selection key: 1. Selection not described; 2. Selection not random or consecutive (i.e., convenience).

<sup>b</sup> Blinding key: 1. Not blinded to results of reference or other comparator tests.

<sup>c</sup> Test Delivery key: 1. Timing of delivery of index or reference test not described; 2. Timing of index and comparator tests not same; 3. Procedure for interpreting tests not described; 4. Expertise of evaluators not described.

<sup>d</sup> Selective Reporting key: 1. Not registered; 2. Evidence of selective reporting; 3. Evidence of selective publication.

<sup>e</sup> Data Completeness key: 1. Inadequate description of indeterminate and missing samples; 2. High number of samples excluded; 3. High loss to follow-up or missing data.

<sup>f</sup> Statistical key: 1. Confidence intervals and/or p values not reported; 2. Comparison with other tests not reported.

### Cohort Studies

Two 2013 studies with small cohorts of patients (range, 49 to 83 patients) have reported on the use of CE before upper endoscopy for acute GI bleeding, to triage and/or risk-stratify patients in the emergency department or hospital.<sup>34,35</sup> These studies reported that CE provides useful information, such as identifying gross bleeding and inflammatory lesions in a substantial proportion of patients and in stratifying patients into high- or low-risk categories. However, the yield of CE in localizing the bleeding source was lower than for esophagogastroduodenoscopy, which is the standard initial evaluation for acute upper GI bleeding.

### **Clinically Useful**

A test is clinically useful if the use of the results informs management decisions that improve the net health outcome of care. The net health outcome can be improved if patients receive correct therapy, more effective therapy, or avoid unnecessary therapy or testing.

### **Direct Evidence**

Direct evidence of clinical utility is provided by studies that have compared health outcomes for patients managed with and without the test. Because these are intervention studies, the preferred evidence would be from RCTs.

### **Chain of Evidence**

Indirect evidence on clinical utility rests on clinical validity. If the evidence is insufficient to demonstrate test performance, no inferences can be made about clinical utility.

Because the clinical validity of wireless CE for diagnosing acute upper GI tract bleeding has not been established, a chain of evidence supporting the test's clinical utility for this indication cannot be constructed.

### **Section Summary: Acute Upper Gastrointestinal Tract Bleeding**

Use of CE in the emergency department setting for suspected upper GI bleeding is based on efficiency (avoiding hospitalization, avoiding immediate endoscopy). Controlled studies are needed to assess further the impact of CE on health outcomes compared with standard management. Patients should be followed to their ultimate diagnosis to determine whether the use of CE versus other triage strategies or immediate endoscopy results in lower health care resource utilization.

### **Colon Cancer Screening**

#### **Clinical Context and Test Purpose**

The purpose of wireless CE for patients who are being screened for colon cancer is to confirm a diagnosis and inform a decision to proceed to appropriate treatment.

The following PICO was used to select literature to inform this review.

#### ***Populations***

The relevant population of interest is patients who are undergoing colon cancer screening.

#### ***Interventions***

The intervention of interest is wireless CE .

#### ***Comparators***

The following test is currently being used to diagnose colon cancer: standard workup using optical colonoscopy.

#### ***Outcomes***

The outcomes of interest for diagnostic accuracy include test validity (ie, sensitivity, specificity). The primary outcomes of interest for clinical utility are overall mortality and disease-specific mortality from colon cancer.

Wireless CE would be performed after an initial clinical examination. Though not completely standardized, follow-up screening for colon cancer would be based on guidelines for asymptomatic screening or for follow-up of significant screening findings.

### **Study Selection Criteria**

Below are selection criteria for studies to assess whether a test is clinically valid.

- The study population represents the population of interest. Eligibility and selection are described.
- The test is compared with a credible reference standard.
- If the test is intended to replace or be an adjunct to an existing test; it should also be compared with that test.
- Studies should report sensitivity, specificity, and predictive values. Studies that completely report true- and false-positive results are ideal. Studies reporting other measures (e.g., receiver operator curve, area under the receiver operator curve, c-statistic, likelihood ratios) may be included but are less informative.
- Studies should also report reclassification of the diagnostic or risk category.

### Clinically Valid

A test must detect the presence or absence of a condition, the risk of developing a condition in the future, or treatment response (beneficial or adverse).

### Review of Evidence

#### Systematic Reviews

Several studies have assessed the accuracy of CE for detecting colonic lesions. Spada et al (2016) reported on a systematic review and meta-analysis of the diagnostic accuracy of CE for detecting colorectal polyps with stratified results for first- and second-generation capsules.<sup>36</sup> Across the 14 eligible studies, the indications for endoscopy included colorectal cancer screening (n=1261 [47%]), postpolypectomy surveillance or family history of colorectal cancer (n=636 [24%]), symptoms suggestive of cancer and/or fecal occult blood test positivity (n=619 [23%]), positive imaging tests (n=136 [5%]), or other indication (n=24 [1%]). There were no missed cancers (n=11) in the series using second-generation CE (per-patient sensitivity, 100%). In series using the first-generation CE, 6 of 26 proven cancers were missed on CE (per-patient sensitivity, 77%).

Kjohede et al (2020) reported on a systematic review and meta-analysis of the diagnostic accuracy of CE compared to colonoscopy with stratified results for polyps of any size, polyps  $\geq$  6 mm, and polyps  $\geq$  10 mm.<sup>37</sup> Across analyzed patients in the 12 eligible studies, the indications for endoscopy included colorectal cancer screening or history of polyps or colorectal cancer (n=1200 [63.2%]), positive fecal immunochemical test (n=493 [26%]), first-degree relatives of patients with colorectal cancer (n=177 [9.3%]), or unspecified (n=28 [1.5%]). The rate of patients with an adequate bowel preparation ranged from 40% to 100%. The rates of complete CE transits ranged from 57% to 100%. The authors note that the relatively high rate of incomplete CE investigations limits the utility of CE in the colorectal cancer setting. All but 1 study was assessed to have a high risk of bias and applicability concerns for the reference standard.

Characteristics of the systematic reviews and their main findings are summarized in Tables 20 and 21, respectively.

**Table 20. Characteristics of Systematic Reviews Assessing Capsule Endoscopy for Colon Cancer Screening**

Study	Dates	Trials	N (Range)	Design	Outcome
Spada et al (2016) <sup>36</sup>	2006-2015	14	2681 (40 to 884)	Diagnostic accuracy studies	Per-patient sensitivity of CCE for different categories of polyp size and for cancer
Kjohede et al (2020) <sup>37</sup>	2009-2020	12	2199 (20 to 884)	Diagnostic accuracy studies	Per-patient sensitivity of CCE for various polyp size thresholds

CCE: colon capsule endoscopy.

**Table 21. Results of Systematic Reviews Assessing Capsule Endoscopy for Colon Cancer Screening**

Random-Effects Model	Trials	N	Outcomes	Effect Size	95% CI	<i>P</i> , %
<b>Spada et al (2016)<sup>36</sup>,</b>						
For ≥10 mm polyps	10	NR	Diagnostic accuracy for ≥10 mm polyps	Sens=80.0% Spec=96.2% PLR=18.6 NLR=0.22 DOR=90.4	66% to 90.3%; 94.0% to 97.6% 12.0 to 28.2 0.13 to 0.34 44 to 163	53.4 31.3
For ≥6 mm polyps	7	NR	Diagnostic accuracy for ≥6 mm polyps using 1st-generation CCE	Sens=58% Spec=85.7% PLR=3.7 NLR=0.51 DOR=7.4	44% to 70% 80.2% to 90.0%	65
For ≥6 mm polyps	6	NR	Diagnostic accuracy for ≥6 mm polyps using 2nd-generation CCE	Sens=86% Spec=88.1% PLR=7.9 NLR=0.16 DOR=50.5	82% to 89% 74.2% to 95.0% 3.7 to 16.1 0.12 to 0.21 20.3 to 107.0	0
For ≥10 mm polyps	3	NR	Diagnostic accuracy for ≥6 mm polyps using 1st-generation CCE	Sens=54% Spec=97.4% PLR=NR NLR=NR DOR=NR	29% to 77% 96.0% to 98.3%	76.2 0
For ≥10 mm polyps	6	NR	Diagnostic accuracy for ≥6 mm polyps using 2nd-generation CCE	Sens=88% Spec=95.3% PLR=NR NLR=NR DOR=NR	81% to 91% 91.5% to 97.5%	0 67
<b>Kjohede et al (2020)<sup>37</sup>,</b>						
For polyps of any size	4	338	Diagnostic accuracy for polyps of any size	Sens=85% Spec=85% PLR=NR NLR=NR DOR=30.5	73% to 92% 70% to 93% 16.2 to 57.2	NR
For polyps ≥6 mm	6	1324	Diagnostic accuracy for polyps ≥6 mm	Sens=87% Spec=88% PLR=NR NLR=NR DOR=51.1	83% to 90% 75% to 95% 19.8 to 131.8	NR
For polyps ≥10 mm	7	1577	Diagnostic accuracy for polyps ≥10 mm	Sens=87% Spec=95% PLR=NR NLR=NR DOR=136.0	82% to 90% 92% to 97% 70.6 to 262.1	NR

CCE: colon capsule endoscopy; CI: confidence interval; DOR: diagnostic odds ratio; NLR: negative likelihood ratio; NR: not reported; PLR: positive likelihood ratio; Sens: sensitivity; Spec: specificity.

### Prospective Studies

Other recent studies by Saito et al (2015), Morgan et al (2016), Parodi (2018), and Cash et al (2021) have evaluated the diagnostic characteristics of CE, using subsequently performed colonoscopy as the reference standard.<sup>38,39,40,41</sup> Of note, the Cash et al (2021) study randomized patients to colon CE or computed tomography (CT) colonography followed by optical colonoscopy.<sup>41</sup> In the Saito et al (2015) study, of 66 evaluable patients, per-patient sensitivity for the detection of polyps was 94% (95% CI, 88.2% to 99.7%). In the Morgan et al (2016) study, for lesions 10 mm or larger, sensitivity of CE was 100% (95% CI, 56.1% to 100%), with a specificity of 93.0% (95% CI, 79.9% to 98.2%). For lesions 6 mm or larger, sensitivity was 93.3% (95% CI, 66.0% to 99.7%) and the specificity was 80.0% (95% CI,

62.5% to 90.9%). The Parodi (2018) study included 177 first-degree relatives of individuals with colorectal cancer and found, for lesions 6 mm or larger, a sensitivity of 91% (95% CI, 81% to 96%) and a specificity of 88% (95% CI, 81% to 93%).<sup>40</sup> In the Cash et al (2021) study, data from 286 patients revealed that the proportion of enrollees with any polyp 6 mm or larger confirmed by subsequent blinded optical colonoscopy was 31.6% for colon CE versus 8.6% for CT colonography.<sup>41</sup> The sensitivity and specificity of colon CE for polyps 6 mm or larger was 79.2% and 96.3%, respectively, while that of CT colonography was 26.8% and 98.9%. For polyps 10 mm or larger, the sensitivity and specificity of colon CE was 85.7% and 98.2% compared with 50% and 99.1% for CT colonography. The authors concluded that colon CE should be considered comparable or superior to CT colonography as a screening test; however, neither test was as effective as optical colonoscopy.

### **Clinically Useful**

A test is clinically useful if the use of the results informs management decisions that improve the net health outcome of care. The net health outcome can be improved if patients receive correct therapy, more effective therapy, or avoid unnecessary therapy or testing.

### **Direct Evidence**

Direct evidence of clinical utility is provided by studies that have compared health outcomes for patients managed with and without the test. Because these are intervention studies, the preferred evidence would be from RCTs.

No RCTs assessing the clinical utility of wireless CE for this indication were identified.

### **Chain of Evidence**

Indirect evidence on clinical utility rests on clinical validity. If the evidence is insufficient to demonstrate test performance, no inferences can be made about clinical utility.

Because the clinical validity of wireless CE for diagnosing colon cancer has not been established, a chain of evidence supporting the test's clinical utility for this indication cannot be constructed.

### **Section Summary: Colon Cancer Screening**

Studies of diagnostic characteristics alone are insufficient evidence to determine the efficacy of CE for colon cancer screening. Because diagnostic performance is worse than standard colonoscopy, CE would need to be performed more frequently than standard colonoscopy to have comparable efficacy. Without direct evidence of efficacy in a clinical trial of colon cancer screening using CE, modeling studies using established mathematical models of colon precursor incidence and progression to cancer could provide estimates of efficacy in preventing colon cancer mortality. Studies of CE in screening populations are necessary to determine the diagnostic characteristics of the test in this setting.

### **Lower Gastrointestinal Tract Bleeding and Major Risks for Colonoscopy or Moderate Sedation Clinical Context and Test Purpose**

The purpose of wireless CE for patients with evidence of GI bleeding of lower GI origin and major risks for colonoscopy or moderate sedation is to visualize the colon for the detection of polyps or other sources of lower GI bleeding and inform a decision to proceed to further treatment and testing. The following PICO was used to select literature to inform this review.

#### ***Populations***

The relevant population of interest is patients with evidence of GI bleeding of lower GI origin and major risks for colonoscopy or moderate sedation, but who could tolerate colonoscopy and moderate sedation in the event a clinically significant colon abnormality was identified with wireless CE.

**Interventions**

The intervention of interest is wireless CE for the visualization of the colon and detection of polyps or other sources of lower GI bleeding.

**Comparators**

The following reference standard is currently being used to detect colon polyps: standard workup using optical colonoscopy.

**Outcomes**

The outcomes of interest for diagnostic accuracy include test validity. The primary outcomes of interest are symptoms, disease status, and resource utilization that would change due to patient management decisions following wireless CE.

Beneficial outcomes resulting from a true-negative test result are avoiding unnecessary subsequent testing. Harmful outcomes resulting from a false-positive test result are unnecessary testing or therapeutic intervention. Harmful outcomes resulting from a false-negative test result are increased risk of further disease progression and missed colorectal disease.

Therefore, in the evaluation of wireless CE as a triage test, the test would need to identify precisely a group of patients that could safely forgo additional testing; therefore, the sensitivity, specificity, NPV, and negative likelihood ratio are key test validity characteristics.

**Study Selection Criteria**

Below are selection criteria for studies to assess whether a test is clinically valid.

- The study population represents the population of interest. Eligibility and selection are described.
- The test is compared with a credible reference standard.
- If the test is intended to replace or be an adjunct to an existing test; it should also be compared with that test.
- Studies should report sensitivity, specificity, and predictive values. Studies that completely report true- and false-positive results are ideal. Studies reporting other measures (e.g., receiver operator curve, area under the receiver operator curve, c-statistic, likelihood ratios) may be included but are less informative.
- Studies should also report reclassification of the diagnostic or risk category.

**Clinically Valid**

A test must detect the presence or absence of a condition, the risk of developing a condition in the future, or treatment response (beneficial or adverse).

**Review of Evidence****Diagnostic Accuracy Studies**

Several studies have evaluated the diagnostic characteristics of CE for the detection of colon polyps in patients with evidence of lower GI bleeding (e.g., hematochezia, positive fecal occult blood test [FOBT]). Study characteristics and results are described in Table 22 and 23.

**Table 22. Study Characteristics of Clinical Validity**

Study	Study Population	Reference Standard	Threshold for Positive Index Test	Timing of Reference and Index Tests	Blinding of Assessors	Comments
Kobaek-Larsen et al (2017) <sup>42</sup>	FOBT-positive individuals participating in a CRC screening program in	OC adjusted by any findings from all follow-up procedures; repeat	Polyps >9 mm within ±50% of CE measure	OC performed 1 day after CE	Investigators were blinded to both CE and OC; in the case of a second	RS adjusted in 75 patients due to follow-up procedures; only 50% (126)



Study	Study Population	Reference Standard	Threshold for Positive Index Test	Timing of Reference and Index Tests	Blinding of Assessors	Comments
	Denmark (N=253; median age, 64 years)	colonoscopy was offered for suspected missed polyps			endoscopy, investigator was unblinded to CE findings	had complete OC and CE
<b>Rondonotti et al (2014)<sup>43</sup></b>	FOBT-positive individuals participating in a CRC screening program in Italy (N=54; age range, 50 to 69 years)	OC followed by colon segment re-inspection if double unblinding to CTC and CE results revealed a disparity	Polyps $\geq 6$ mm	CTC and OC performed 15 days after CE	Initial blinding to CE and CTC results followed by double-unblinding and opportunity for re-inspection and adjustment of RS	4 patients excluded from analysis (consent withdrawal [2], endoscopist not blinded [2])
<b>Eliakim et al (2009)<sup>44</sup></b>	Individuals with known or suspected colonic disease in Israel; 21% of patients had hematochezia or positive FOBT (N=104; mean age, 49.8 years)	OC	Polyps $\geq 6$ mm and $\geq 10$ mm within +50% of CE measure	OC performed within 10 hours of CE	Investigators blinded to both OC and CE	6 patients excluded from analysis (did not complete bowel prep [2], withdrawal [1], could not ingest capsule [1], capsule retention [1], technical failure [1])

CE: capsule endoscopy; CRC: colorectal cancer; CTC: computed tomography colonography; FOBT: fecal occult blood test; OC: optical colonoscopy; RS: reference standard.

**Table 23. Study Results of Clinical Validity**

Study	N	CE Completion Rate, % (95% CI)	Sensitivity, % (95% CI) <sup>1</sup>	Specificity, % (95% CI) <sup>1</sup>	PLR; NLR	Adverse Events
<b>Kobaek-Larsen et al (2017)<sup>42</sup></b>						None related to OC or CE.
<b>All patients; CE &gt;9mm</b>	253	54 (48 to 60)	87 (83 to 91)	92 (89 to 95)	NR	
<b>Complete CE and OC; CE &gt;9 mm</b>	126	---	97 (94 to 100)	90 (85 to 95)	NR	
<b>All patients; OC &gt; 9 mm</b>	253	90 (86 to 94)	88 (84 to 92)	100 (100)	NR	
<b>Complete CE and OC; OC &gt; 9 mm</b>	126	---	89 (84 to 94)	100 (100)	NR	
<b>Rondonotti et al (2014)<sup>43</sup></b>						None related to OC or CE. 10 cases of mild abdominal pain and 2 cases of significant pain during CTC.
<b>CE <math>\geq 6</math> mm</b>	50	100	88.2 (62.2 to 97.9)	87.8 (70.8 to 96.0)	3.75; 0.06	
<b>CTC <math>\geq 6</math> mm</b>	50	100	88.2 (62.2 to 97.9)	84.8 (67.3 to 94.3)	3.0; 0.07	
<b>Eliakim et al (2009)<sup>44</sup></b>						1 capsule retention; 7 cases of mild-

Study	N	CE Completion Rate, % (95% CI)	Sensitivity, % (95% CI) <sup>1</sup>	Specificity, % (95% CI) <sup>1</sup>	PLR; NLR	Adverse Events
						moderate headache, nausea, or vomiting related to CE bowel preparation.
CE $\geq$ 6 mm	98	NR	89 (70 to 97)	76 (72 to 78)	NR	
CE $\geq$ 10 mm	98	NR	88 (56 to 98)	89 (86 to 90)	NR	

CE: capsule endoscopy; CI: confidence interval; CTC: computed tomography colonography; NLR: negative likelihood ratio; NR: not reported; OC: optical colonoscopy; PLR: positive likelihood ratio.

<sup>1</sup> Per-patient analysis.

Kobaek-Larsen et al (2017) reported on FOBT-positive individuals participating in a colorectal cancer screening program in Denmark.<sup>42</sup> The reference standard consisted of optical colonoscopy (OC) adjusted by any findings from all additional follow-up procedures, including repeat endoscopy due to suspected missed polyps unblinded to CE results in 53 patients, repeated OC due to inadequate bowel preparation in 8 patients, and follow-up CT colonography in 14 patients. The CE completion rate was significantly lower than OC ( $p < .001$ ), with only 50% of patients ( $n=126$ ) having complete OC and CE investigations.

Rondonotti et al (2014) reported on FOBT-positive individuals participating in a colorectal cancer screening program in Italy.<sup>43</sup> Unblinded colonoscopy, integrating OC, CT colonography, and CE results, was used as the reference standard. Investigations were completed in all patients with a positive likelihood ratio and negative likelihood ratio of 3.75 and 0.06 for CE, respectively.

Eliakim et al (2009) conducted a prospective, multicenter study evaluating CE compared to colonoscopy in individuals with known or suspected colonic disease.<sup>44</sup> Twenty-one percent of patients had hematochezia or positive FOBT. The majority of patients were referred for OC due to a personal or family history of colorectal cancer or for colorectal cancer screening. Polyps of any size were detected in 44% of patients, with 53% identified as having adenomas. Overall colon cleanliness for CE was considered adequate in 78% of patients (95% CI, 68 to 86%).

Study relevance, design, and conduct limitations are described in Table 24 and 25.

**Table 24. Study Relevance Limitations**

Study	Population <sup>a</sup>	Intervention <sup>b</sup>	Comparator <sup>c</sup>	Outcomes <sup>d</sup>	Duration of Follow-Up <sup>e</sup>
<b>Kobaek-Larsen et al (2017)<sup>42</sup></b>	4. Study did not specifically evaluate individuals with major risks for colonoscopy or moderate sedation.		2. Adjusted and/or unblinded reference standard not uniformly applied to all patients.	1,3. Impact of findings on health outcomes not assessed. Predictive values not reported.	
<b>Rondonotti et al (2014)<sup>43</sup></b>	4. Study did not specifically evaluate individuals with major risks for colonoscopy or moderate sedation.			1. Impact of findings on health outcomes not assessed.	
<b>Eliakim et al (2009)<sup>44</sup></b>	4. Study did not specifically evaluate individuals with major risks for colonoscopy or moderate sedation; only 21% of subjects had evidence of lower			1,3. Impact of findings on health outcomes not assessed. Predictive values not reported.	

Study	Population <sup>a</sup>	Intervention <sup>b</sup>	Comparator <sup>c</sup>	Outcomes <sup>d</sup>	Duration of Follow-Up <sup>e</sup>
	gastrointestinal bleeding.				

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.

<sup>a</sup> Population key: 1. Intended use population unclear; 2. Clinical context is unclear; 3. Study population is unclear; 4. Study population not representative of intended use.

<sup>b</sup> Intervention key: 1. Classification thresholds not defined; 2. Version used unclear; 3. Not intervention of interest.

<sup>c</sup> Comparator key: 1. Classification thresholds not defined; 2. Not compared to credible reference standard; 3. Not compared to other tests in use for same purpose.

<sup>d</sup> Outcomes key: 1. Study does not directly assess a key health outcome; 2. Evidence chain or decision model not explicated; 3. Key clinical validity outcomes not reported (sensitivity, specificity and predictive values); 4. Reclassification of diagnostic or risk categories not reported; 5. Adverse events of the test not described (excluding minor discomforts and inconvenience of venipuncture or noninvasive tests).

<sup>e</sup> Follow-Up key: 1. Follow-up duration not sufficient with respect to natural history of disease (true positives, true negatives, false positives, false negatives cannot be determined).

**Table 25. Study Design and Conduct Limitations**

Study	Selection <sup>a</sup>	Blinding <sup>b</sup>	Delivery of Test <sup>c</sup>	Selective Reporting <sup>d</sup>	Data Completeness <sup>e</sup>	Statistical <sup>f</sup>
<b>Kobaek-Larsen et al (2017)<sup>42</sup></b>	1. Selection not described.	1. In case of second endoscopy for suspected missed polyps, endoscopist not blinded to results of CE.			1,3. Unclear how many complete investigations included patients with comparison to adjusted and/or unblinded reference standard. High loss due to low CE completion rate.	
<b>Rondonotti et al (2014)<sup>43</sup></b>	1. Selection not described.	1. Endoscopist was unblinded to results of CE and CTC in event polyps were missed prior to segment reinspection.	2. CTC and OC performed 15 days later.			
<b>Eliakim et al (2009)<sup>44</sup></b>	1. Selection not described.			1. Not registered.		

CE: capsule endoscopy; CTC: computed tomography colonography; OC: optical colonoscopy.

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.

<sup>a</sup> Selection key: 1. Selection not described; 2. Selection not random or consecutive (ie, convenience).

<sup>b</sup> Blinding key: 1. Not blinded to results of reference or other comparator tests.

<sup>c</sup> Test Delivery key: 1. Timing of delivery of index or reference test not described; 2. Timing of index and comparator tests not same; 3. Procedure for interpreting tests not described; 4. Expertise of evaluators not described.

<sup>d</sup> Selective Reporting key: 1. Not registered; 2. Evidence of selective reporting; 3. Evidence of selective publication.

<sup>e</sup> Data Completeness key: 1. Inadequate description of indeterminate and missing samples; 2. High number of samples excluded; 3. High loss to follow-up or missing data.

<sup>f</sup> Statistical key: 1. Confidence intervals and/or p values not reported; 2. Comparison to other tests not reported.

**Clinically Useful**

A test is clinically useful if the use of the results informs management decisions that improve the net health outcome of care. The net health outcome can be improved if patients receive correct therapy, more effective therapy, or avoid unnecessary therapy or testing.

**Direct Evidence**

Direct evidence of clinical utility is provided by studies that have compared health outcomes for patients managed with and without the test. Because these are intervention studies, the preferred evidence would be from RCTs.

No RCTs assessing the clinical utility of wireless CE for this indication were identified.

**Chain of Evidence**

Indirect evidence on clinical utility rests on clinical validity. If the evidence is insufficient to demonstrate test performance, no inferences can be made about clinical utility.

Because the clinical validity of wireless CE for detecting colon polyps in this population has not been established, a chain of evidence supporting the test's clinical utility for this indication cannot be constructed.

**Section Summary: Lower Gastrointestinal Tract Bleeding and Major Risks for Colonoscopy or Moderate Sedation**

Studies evaluating the diagnostic characteristics of CE as a triage test have primarily involved colorectal cancer screening populations that have not specifically enrolled patients with major risks for optical colonoscopy or moderate sedation. The 3 studies identified have been heterogeneous in the timing of delivery of the reference standard, in the definition and blinding of the reference standard, and in the significant polyp size threshold determining a positive test result. Only 1 small study reported positive and negative likelihood ratios. Per-patient sensitivity and specificity ranged from 88% to 97% and 76% to 92%, respectively, and was generally reported with wide CIs. While 1 study reported a higher sensitivity and specificity compared to optical colonoscopy versus the defined reference standard, a consistent reference standard was not applied to all patients and carried a low combined rate of complete optical colonoscopy and CE investigations (50%). No studies assessed the impact of study findings on specific health outcomes. Adherence to recommended follow-up diagnostic or therapeutic interventions in patients with major risks for colonoscopy or moderate sedation is unknown. Studies of CE in the intended use population are necessary to determine the diagnostic characteristics of the test in the triage setting.

**Incomplete Colonoscopy****Clinical Context and Test Purpose**

The purpose of wireless CE for patients with an incomplete colonoscopy after adequate preparation where a complete evaluation of the colon was not technically possible is to visualize the colon for the detection of polyps and inform a decision to proceed to further treatment and testing.

The following PICO was used to select literature to inform this review.

***Populations***

The relevant population of interest is patients undergoing screening for colon polyps who experience an incomplete colonoscopy after adequate bowel preparation where a complete visualization of the colon was not technically possible. Factors that may contribute to incomplete colonoscopies include patient pain and discomfort, diverticulosis, tortuosity, adhesions due to prior surgeries, angulation or fixation of bowel loops, ineffective sedation, and endoscopist and technician expertise.<sup>45</sup>

***Interventions***

The intervention of interest is wireless CE for the detection of colon polyps..

### ***Comparators***

The comparator of interest is repeat optical colonoscopy. Repeat colonoscopy following a prior incomplete procedure may be modified with adjusted endoscopic techniques, pediatric instruments, abdominal pressure and position changes, water exchange and water immersion techniques, carbon dioxide insufflation, magnetic endoscope imaging, alternate sedation methods, anesthesia assistance, and management with more experienced physicians.<sup>45</sup>

### ***Outcomes***

The outcomes of interest for diagnostic accuracy include test validity. The primary outcomes of interest are symptoms, disease status, and resource utilization that would change due to patient management decisions following wireless CE.

Beneficial outcomes resulting from a true-negative test result are avoiding unnecessary repeat colonoscopy. Harmful outcomes resulting from a false-positive test result are unnecessary testing or therapeutic intervention. Harmful outcomes resulting from a false-negative test result are increased risk of missed colorectal disease.

Therefore, in the evaluation of wireless CE as a triage test, the test would need to identify precisely a group of patients that could safely forego additional testing; therefore, the sensitivity, specificity, NPV, and negative likelihood ratio are key test validity characteristics.

### **Study Selection Criteria**

Below are selection criteria for studies to assess whether a test is clinically valid.

- The study population represents the population of interest. Eligibility and selection are described.
- The test is compared with a credible reference standard.
- If the test is intended to replace or be an adjunct to an existing test; it should also be compared with that test.
- Studies should report sensitivity, specificity, and predictive values. Studies that completely report true- and false-positive results are ideal. Studies reporting other measures (e.g., receiver operator curve, area under the receiver operator curve, c-statistic, likelihood ratios) may be included but are less informative.
- Studies should also report reclassification of the diagnostic or risk category.

### **Clinically Valid**

A test must detect the presence or absence of a condition, the risk of developing a condition in the future, or treatment response (beneficial or adverse).

### **Review of Evidence**

#### **Case Series**

Studies evaluating the diagnostic characteristics of CE compared to a reference standard for the detection of colon polyps in patients with an incomplete colonoscopy following adequate bowel preparation were not identified. Several prospective case series describing the diagnostic yield of CE following incomplete colonoscopy for various indications are summarized in Table 26. Study relevance, design, and conduct limitations are described in Table 27 and 28.

### **Table 26. Study Characteristics and Results**

Study	Study Population	Indications for OC	Threshold for Significant Polyps	Timing of CE	Incremental CE Diagnostic Yield, n/N (%)	Complete Visualization of the Colon, n/N (%)	Comments
<b>Hussey et al (2018)<sup>46</sup></b>	Patients aged $\geq 18$ years who had an incomplete OC for reasons other than poor bowel preparation or suspected obstruction of the colonic lumen (N=50)	NR	> 6 mm or $\geq 3$ polyps	Administered 90 min after IC	CE (any polyps): 19/50 (38)  CE (significant polyps): 7/50 (14)  CE + IC (any diagnosis): 37/50 (74)	CE: 38/50 (76) CE + IC: 42/50 (84)	CCE Findings (n): normal (13), polyps (19; 7/19 significant), inflammation (1), diverticular disease (1), angiodysplasia (1), cancer (1).  7 patients with significant polyps were referred for polypectomy, which detected 14 adenomas and hyperplastic polyps.
<b>Baltes et al (2018)<sup>47</sup></b>	Patients aged $\geq 18$ years who had an incomplete OC due to failure to reach the cecum or ileo-cecal anastomosis due to looping, bowel angulation, adhesions, and intolerance of sedation or inflammation (N=81)	CRC screening (22%), anemia (15%), hematochezia (15%), irregular stool (12%), abdominal pain (12%), colitis (5%), other reasons (12%)	$\geq 6$ mm or $\geq 3$ polyps	Protocol A: next day CE (n=38)  Protocol B: CE within 30 d (n=36)	CE (significant polyps): NR (24)  CE + IC (significant polyps): 21/74 (28)	Protocol A: CE: 24/38 (63.3) CE + IC: 34/38 (89.5)  Protocol B: CE: 24/36 (66.7) CE + IC: 35/36 (97.2)	Per protocol analysis: 74/81 due to 7 exclusions for technical failure  Adverse events: 1 capsule retention; 1 case of nausea and vomiting due to prep
<b>Nogales et al (2017)<sup>47</sup></b>	Patients aged $\geq 18$ years who had an incomplete OC when cecal intubation was not achieved despite adequate bowel preparation (N=96)	NR	>6 mm or > 3 polyps	Within 72 hours in 8 cases of suspected CRC. During the following week for all other patients.	CE (any diagnosis): 58/96 (60.4)  CE (significant polyps): 25/96 (26)	CE: 69/96 (71.9) CE + IC: 89/96 (92.7)	CCE Findings (n): polyps (41; 25/41 significant), diverticula (11), colon cancer (2), angioectasia (2), solitary colonic ulcers (2). In 43/58 patients (44.8%) the new findings modified the therapeutic approach.

Study	Study Population	Indications for OC	Threshold for Significant Polyps	Timing of CE	Incremental CE Diagnostic Yield, n/N (%)	Complete Visualization of the Colon, n/N (%)	Comments
<b>Negreanu et al (2013)<sup>48</sup></b>	Patients who are at risk for CRC who 1) refused (n=37) or failed prior OC (n=30), or 2) were unable to undergo OC because of anesthetic risk and co-morbidities (n=3) (N=70)	Abnormal transit (8), abdominal pain (4), anemia or overt bleeding (22), weight loss (1), average and high risk CRC screening (29), abnormal imaging or tumor markers (6)	>6 mm or $\geq 3$ polyps	NR	CE (relevant lesions): 23/67 (34) [95% CI, 21.6 to 44.1]  CE (significant polyps): 15/67 (22)	CE: 51/67 (76.1)	Exclusions: technical failures (3)  CCE Findings (n): polyps >6 mm (5), $\geq 3$ polyps (10), multiple colonic angiomias (2), newly discovered Crohn disease (1), radiation enteritis (1), diverticulosis (17), ulcerative colitis and inflammatory pseudopolyps (1), <6 mm polyp (1).  17/23 patients with relevant lesions agreed to therapeutic interventions. 1 clinical failure (ulcerated rectal tumor) who refused OC following incomplete CE was reported.  Adverse events: capsule impaction and retention (5)
<b>Pioche et al (2012)<sup>49</sup></b>	Patients with an indication for OC per the recommendations of the French National Authority for Health, including symptoms or screening who had 1) colonoscopy failure due to	Abnormal transit (14), abdominal pain (22), anemia or overt bleeding (30), weight loss (2), CRC screening (39)	>5 mm or $\geq 3$ polyps	NR	CE (significant polyps, screening): 12/39 (30.8) [95% CI, 22.1 to 39.5]  CE (any lesions explaining symptoms)	CE: 89/107 (83.2) [95% CI, 76.1 to 90.3]	CCE Findings (n): significant polyps (20), insignificant polyps (2), diverticulosis (6), telangiectasia (1), lesions explaining symptoms (16)  Adverse

Study	Study Population	Indications for OC	Threshold for Significant Polyps	Timing of CE	Incremental CE Diagnostic Yield, n/N (%)	Complete Visualization of the Colon, n/N (%)	Comments
		difficult sigmoid loop or adhesions not related to stenosis or inadequate bowel cleansing (n=77) or 2) contraindications to OC with anesthesia due to cardiovascular or respiratory disease (n=30) (N=107)			: 16/68 (23.5)  CE (significant polyps not explaining symptoms) : 8/68 (11.8)  CE (any significant diagnosis): 36/107 (33.6) [95% CI, 24.7 to 42.5]		events: capsule retention (6)  Management: Screening group (12) (endoscopic treatments [6], follow-up [5], refusal [1]); Negative findings (9/64) (OC - normal findings or nonsignificant lesions [5], adenomas [1]; CTC - normal findings [3]); Symptomatic group (24) (medical treatments [8], colectomy [1], endoscopic APC [1], follow-up [6], endoscopic treatments [7], refusal [1])

APC: Argon plasma coagulation; CCE: colon capsule endoscopy; CE: capsule endoscopy; CI: confidence interval; CRC: colorectal cancer; CTC: computed tomography colonography; IC: incomplete colonoscopy; NR: not reported; OC: optical colonoscopy.

**Table 27. Study Relevance Limitations**

Study	Population <sup>a</sup>	Intervention <sup>b</sup>	Comparator <sup>c</sup>	Outcomes <sup>d</sup>	Duration of Follow-Up <sup>e</sup>
<b>Hussey et al (2018)<sup>46</sup></b>	2,3. Original indications for OC not reported.		2. Not compared to a reference standard.	1,3. Impact of findings on health outcomes not assessed. Clinical validity outcomes cannot be assessed.	1. No follow-up with reference standard.
<b>Baltes et al (2018)<sup>47</sup></b>	1. It is not clear whether detection of polyps was the primary goal of CE for symptomatic patients.		2. Not compared to a reference standard.	1,3. Impact of findings on health outcomes not assessed. Clinical validity outcomes cannot be assessed.	1. No follow-up with reference standard.
<b>Nogales et al (2017)<sup>50</sup></b>	2,3. Original indications for OC not reported.		2. Not compared to a reference standard.	1,3. Impact of findings on health outcomes	1. No follow-up with reference standard.



Study	Population <sup>a</sup>	Intervention <sup>b</sup>	Comparator <sup>c</sup>	Outcomes <sup>d</sup>	Duration of Follow-Up <sup>e</sup>
				not assessed. Clinical validity outcomes cannot be assessed.	
<b>Negreanu et al (2013)<sup>48</sup>,</b>	1,4. It is not clear whether detection of polyps was the primary goal of CE for symptomatic patients. Only a small subset of study patients reported IC.		2. Not compared to a reference standard.	1,3. Impact of findings on health outcomes not assessed. Clinical validity outcomes cannot be assessed.	1. No follow-up with reference standard.
<b>Pioche et al (2012)<sup>49</sup>,</b>	1,4. It is not clear whether detection of polyps was the primary goal of CE for symptomatic patients. Only a subset of study patients reported IC.		2. Not compared to a reference standard.	1,3. Impact of findings on health outcomes not assessed. Clinical validity outcomes cannot be assessed.	1. No follow-up with reference standard.

CE: capsule endoscopy; IC: incomplete colonoscopy; OC: optical colonoscopy.

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.

<sup>a</sup> Population key: 1. Intended use population unclear; 2. Clinical context is unclear; 3. Study population is unclear; 4. Study population not representative of intended use.

<sup>b</sup> Intervention key: 1. Classification thresholds not defined; 2. Version used unclear; 3. Not intervention of interest.

<sup>c</sup> Comparator key: 1. Classification thresholds not defined; 2. Not compared to credible reference standard; 3. Not compared to other tests in use for same purpose.

<sup>d</sup> Outcomes key: 1. Study does not directly assess a key health outcome; 2. Evidence chain or decision model not explicated; 3. Key clinical validity outcomes not reported (sensitivity, specificity and predictive values); 4. Reclassification of diagnostic or risk categories not reported; 5. Adverse events of the test not described (excluding minor discomforts and inconvenience of venipuncture or noninvasive tests).

<sup>e</sup> Follow-Up key: 1. Follow-up duration not sufficient with respect to natural history of disease (true positives, true negatives, false positives, false negatives cannot be determined).

**Table 28. Study Design and Conduct Limitations**

Study	Selection <sup>a</sup>	Blinding <sup>b</sup>	Delivery of Test <sup>c</sup>	Selective Reporting <sup>d</sup>	Data Completeness <sup>e</sup>	Statistical <sup>f</sup>
<b>Hussey et al (2018)<sup>46</sup>,</b>	1. Selection not described.	1. No comparison to reference standard.		1. Not registered.		2. Comparison to other tests not reported.
<b>Baltes et al (2018)<sup>47</sup>,</b>	1. Selection not described.	1. No comparison to reference standard.		1. Not registered.		2. Comparison to other tests not reported.
<b>Nogales et al (2017)<sup>50</sup>,</b>		1. No comparison to reference standard.		1. Not registered.		2. Comparison to other tests not reported.
<b>Negreanu et al (2013)<sup>48</sup>,</b>	1. Selection not described.	1. No comparison to reference standard.	1. Timing of CE not described.	1. Not registered.		2. Comparison to other tests not reported.

Study	Selection <sup>a</sup>	Blinding <sup>b</sup>	Delivery of Test <sup>c</sup>	Selective Reporting <sup>d</sup>	Data Completeness <sup>e</sup>	Statistical <sup>f</sup>
Pioche et al (2012) <sup>49</sup>	1. Selection not described.	1. No comparison to reference standard.	1. Timing of CE not described.	1. Not registered.		2. Comparison to other tests not reported.

CE: capsule endoscopy.

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.

<sup>a</sup> Selection key: 1. Selection not described; 2. Selection not random or consecutive (ie, convenience).

<sup>b</sup> Blinding key: 1. Not blinded to results of reference or other comparator tests.

<sup>c</sup> Test Delivery key: 1. Timing of delivery of index or reference test not described; 2. Timing of index and comparator tests not same; 3. Procedure for interpreting tests not described; 4. Expertise of evaluators not described.

<sup>d</sup> Selective Reporting key: 1. Not registered; 2. Evidence of selective reporting; 3. Evidence of selective publication.

<sup>e</sup> Data Completeness key: 1. Inadequate description of indeterminate and missing samples; 2. High number of samples excluded; 3. High loss to follow-up or missing data.

<sup>f</sup> Statistical key: 1. Confidence intervals and/or p values not reported; 2. Comparison to other tests not reported.

### Clinically Useful

A test is clinically useful if the use of the results informs management decisions that improve the net health outcome of care. The net health outcome can be improved if patients receive correct therapy, more effective therapy, or avoid unnecessary therapy or testing.

### Direct Evidence

Direct evidence of clinical utility is provided by studies that have compared health outcomes for patients managed with and without the test. Because these are intervention studies, the preferred evidence would be from RCTs.

No RCTs assessing the clinical utility of wireless CE for this indication were identified.

### Chain of Evidence

Indirect evidence on clinical utility rests on clinical validity. If the evidence is insufficient to demonstrate test performance, no inferences can be made about clinical utility.

Because the clinical validity of wireless CE for detecting colon polyps in this population has not been established, a chain of evidence supporting the test's clinical utility for this indication cannot be constructed.

### Section Summary: Incomplete Colonoscopy

No studies evaluating the diagnostic characteristics of CE compared to a reference standard for the detection of colon polyps in patients with an incomplete colonoscopy following adequate bowel preparation were identified. Case series describing the incremental diagnostic yield of CE varied in their reporting of original indications for OC and inclusion of symptomatic and/or screening patients.

It is unclear whether the primary goal of CE was the detection of colon polyps in symptomatic patients, as these lesions were reported as not explaining symptoms in 1 study. Successful CE completion rates were low (range, 63.3% to 83.2%) with 3/5 studies reporting full visualization of the colon for combined CE and incomplete colonoscopy in 84% to 97.2% of patients. Given the variable prevalence of significant and actionable findings for patients with mixed indications for colonoscopy, the diagnostic yield is insufficient to determine the clinical validity of the test. No studies assessed the impact of study findings on specific health outcomes. Information on adherence to recommended follow-up diagnostic or therapeutic interventions in patients with incomplete colonoscopies are limited, with several refusals and clinical failures reported. Studies of CE compared to standard management with repeat colonoscopy in the intended use population are necessary to determine the diagnostic characteristics of the test in the triage setting.

## Known or Suspected Small Bowel Stricture

### Clinical Context and Test Purpose

The purpose of the patency capsule for patients scheduled to undergo CE for known or suspected small bowel stricture is to confirm a diagnosis and inform a decision to proceed to CE.

The following PICO was used to select literature to inform this review.

### *Populations*

The relevant population of interest is individuals scheduled to undergo CE for known or suspected small bowel stricture. Contraindications to the use of CE include known or suspected obstruction or stricture, Zenker diverticulum, intestinal pseudo-obstruction, and motility disorders. Certain patients with known or suspected strictures of the small bowel may be at risk of retaining the capsule. Surgical removal may be necessary.

### *Interventions*

The test being considered is a patency capsule as a technique to evaluate patients with known or suspected strictures before using wireless CE. The capsule could be used to select patients for CE instead of assessing clinical risk factors.

The use of the patency capsule has some risk itself. Published studies are small and do not provide comparative data on the incremental value of this capsule over standard clinical evaluation. In some series, the administration of the patency capsule has produced symptoms requiring hospitalization and even surgery. In a European study, Spada et al (2007) reported findings for 27 patients, 24 with CD.<sup>51</sup> In this study, 25 (92.6%) patients retrieved the patency capsule in their stools. Six patients complained of abdominal pain, 4 of whom excreted a nonintact capsule, and hospitalization was required in 1 patient due to the occlusive syndrome.

### *Comparators*

The following practices are currently being used to diagnose known or suspected small bowel stricture: CE without patency capsule and alternative workup without CE.

### *Outcomes*

The general outcomes of interest are test validity, symptoms, change in disease status, and treatment-related morbidity.

## Study Selection Criteria

Below are selection criteria for studies to assess whether a test is clinically valid.

- The study population represents the population of interest. Eligibility and selection are described.
- The test is compared with a credible reference standard.
- If the test is intended to replace or be an adjunct to an existing test; it should also be compared with that test.
- Studies should report sensitivity, specificity, and predictive values. Studies that completely report true- and false-positive results are ideal. Studies reporting other measures (e.g., receiver operator curve, area under the receiver operator curve, c-statistic, likelihood ratios) may be included but are less informative.
- Studies should also report reclassification of the diagnostic or risk category.

## Clinically Valid

A test must detect the presence or absence of a condition, the risk of developing a condition in the future, or treatment response (beneficial or adverse).

## Review of Evidence

### Case Series

In a series from Europe, Delvaux et al (2005) reported on findings in 22 patients with suspected intestinal stricture, 15 of whom had CD.<sup>52</sup> In this study, at 30 hours after ingestion, the patency capsule was detected in 17 (72.3%) patients. In all patients in whom the capsule was blocked in the small intestine, the stenosis had been suspected on CT scan or small bowel follow-through. In 3 patients, the delay in the progression of the patency capsule led to the cancellation of CE. In 3 patients, the patency capsule induced a symptomatic intestinal occlusion, which resolved spontaneously in 1 and required emergency surgery in 2. The authors commented that the current technical development of the patency capsule limits its use in clinical practice, because it did not detect stenoses undiagnosed by CT or small bowel follow-through, and the start of dissolution at 40 hours after ingestion is too slow to prevent episodes of intestinal occlusion. They also commented that a careful interview eliciting the patient's history and symptoms remains the most useful indicator for suspicion of an intestinal stenosis.

Several studies have shown that patients who had an uncomplicated passage of the patency capsule subsequently underwent uncomplicated CE.<sup>53,54,55</sup> These patients often had significant findings on CE.<sup>53,54</sup> However, it is difficult to determine whether CE findings in these patients improved their outcomes beyond any alternative testing regimen available. In 1 of these studies, 3 of 106 patients had severe adverse events, including 1 patient who required surgery.<sup>53</sup>

### **Clinically Useful**

A test is clinically useful if the use of the results informs management decisions that improve the net health outcome of care. The net health outcome can be improved if patients receive correct therapy, more effective therapy, or avoid unnecessary therapy or testing.

### **Direct Evidence**

Direct evidence of clinical utility is provided by studies that have compared health outcomes for patients managed with and without the test. Because these are intervention studies, the preferred evidence would be from RCTs.

No RCTs assessing the clinical utility of wireless CE for this indication were identified.

### **Chain of Evidence**

Indirect evidence on clinical utility rests on clinical validity. If the evidence is insufficient to demonstrate test performance, no inferences can be made about clinical utility.

Because the clinical validity of the patency capsule for diagnosing known or suspected strictures has not been established, a chain of evidence supporting the test's clinical utility for this indication cannot be constructed.

### **Section Summary: Known or Suspected Small Bowel Stricture**

The overall balance of harm and benefit of using the patency capsule cannot be determined from the existing studies.

### **Unexplained Upper Abdominal Complaints**

#### **Clinical Context and Test Purpose**

The purpose of magnetic CE for patients who have unexplained upper abdominal complaints is to confirm a diagnosis and inform a decision to proceed to appropriate treatment.

The following PICO was used to select literature to inform this review.

#### **Populations**

The relevant population of interest is patients with unexplained upper abdominal complaints such as upper abdominal pain and/or anemia.

#### **Interventions**

The intervention of interest is magnetic CE. Magnetic CE is indicated for visualization of the stomach of adults ( $\geq 22$  years) with a body mass index  $< 38$ . The device is contraindicated for use in patients

with GI obstruction, stenosis, fistula, or those with dysphagia. Other contraindications include patients with cardiac pacemakers or other implantable electronic medical devices as well as pregnant women, those <22 years of age, and those with a body mass index  $\geq 38$ .

### **Comparators**

The following practice is currently being used to evaluate upper abdominal complaints: standard workup for abdominal pain without magnetic CE.

### **Outcomes**

The outcomes of interest for diagnostic accuracy include test validity (i.e., sensitivity, specificity). The primary outcomes of interest are symptoms and disease status that would change due to patient management decisions following magnetic CE.

Follow-up for further diagnostic evaluation and surveillance for recurrence of symptoms would be immediate to weeks if no etiology is identified. Follow-up of weeks to months would be based on the disease condition identified by magnetic CE.

### **Study Selection Criteria**

Below are selection criteria for studies to assess whether a test is clinically valid.

- The study population represents the population of interest. Eligibility and selection are described.
- The test is compared with a credible reference standard.
- If the test is intended to replace or be an adjunct to an existing test; it should also be compared with that test.
- Studies should report sensitivity, specificity, and predictive values. Studies that completely report true- and false-positive results are ideal. Studies reporting other measures (e.g., receiver operator curve, area under the receiver operator curve, c-statistic, likelihood ratios) may be included but are less informative.
- Studies should also report reclassification of the diagnostic or risk category.

### **Clinically Valid**

A test must detect the presence or absence of a condition, the risk of developing a condition in the future, or treatment response (beneficial or adverse).

### **Review of Evidence**

#### **Diagnostic Accuracy Studies**

Denzer et al (2015) prospectively evaluated a magnetically guided gastric capsule as compared to conventional gastroscopy in 189 patients with upper abdominal complaints (e.g., upper abdominal pain and/or anemia) from 2 French centers.<sup>56</sup> In this study, capsule gastroscopy was performed initially followed by conventional gastroscopy, with a maximum delay of 1 day but a minimum delay of 4 hours. For conventional gastroscopy, the examination was performed blinded initially. If results of the magnetic capsule and blinded gastroscopy differed, then a subsequent unblinded gastroscopy was performed. Biopsies were taken whenever appropriate. The combined endoscopic assessment (blinded and unblinded gastroscopy) including biopsy was used as the final gold standard. The primary outcome parameters were the accuracy and the sensitivity, specificity, and predictive values of magnetically guided capsule gastroscopy compared with the final gold standard with regard to major lesions on a per-patient and per-lesion basis. Overall, 23 major lesions were discovered in 21 patients. Capsule accuracy on a per-patient basis was 90.5% (95% CI, 85.4% to 94.3%) with a specificity of 94.1% (95% CI, 89.3% to 97.1%) and a sensitivity of 61.9% (95% CI, 38% to 82%). The PPV and NPV were 56.5% (95% CI, 34.5% to 76.8%) and 95.2% (95% CI, 90.7% to 97.9%), respectively. Similar results for these values were seen on a per-lesion basis. Of the other 168 patients, 94% had minor and mostly multiple lesions; the capsule made a correct diagnosis in 88.1% (95% CI, 82.2% to 92.6%). No complications of capsule or conventional gastroscopy were noted. Patient preference for capsule use for a future gastroscopy, if indicated, was 100%. In this first large study to evaluate

magnetically guided capsule gastroscopy in patients with upper abdominal symptoms, the authors concluded that this technique was feasible in practice and clearly preferred by patients; however, further studies are needed to define its role in the clinical setting (e.g., as a filter test to stratify patients to undergo conventional gastroscopy or some other role). Of note, this non-US study reported a low sensitivity with a wide CI and provided an extremely limited discussion of the types of upper abdominal complaints experienced by enrolled patients. No discussion in terms of the severity and duration of the complaints, as well as prior testing and treatment was undertaken, which makes determination of the appropriate place in therapy for magnetic CE in patients with unexplained upper abdominal complaints difficult.

Liao et al (2016) evaluated the accuracy of magnetically controlled CE as compared with conventional gastroscopy in 350 patients with upper abdominal complaints in a prospective, multicenter, blinded comparison study conducted in China.<sup>57</sup> All patients underwent magnetic CE followed by conventional gastroscopy 2 hours later, without sedation. The primary outcome of the study was an evaluation of gastric focal lesions. Overall, with conventional gastroscopy as the gold standard, magnetic CE detected gastric focal lesions in the entire stomach with 90.4% sensitivity (95% CI, 84.7% to 96.1%), 94.7% specificity (95% CI, 91.9% to 97.5%), and 93.4% accuracy (95% CI, 90.83% to 96.02%). The PPV and NPV were 87.9% (95% CI, 81.7% to 94%) and 95.9% (95% CI, 93.4% to 98.4%), respectively. Similar sensitivity and specificity results were observed with magnetic CE as compared to conventional gastroscopy when detecting focal lesions in the upper or lower stomach specifically. No lesions of significance were missed by magnetic CE. Additionally, 335 (95.7%) patients preferred magnetic CE over conventional gastroscopy and only 5 patients reported an adverse event; the majority of these events were considered to be related to gastric preparation. The authors concluded that magnetic CE detects upper abdominal focal lesions with comparable accuracy to conventional gastroscopy and is a promising alternative for screening for gastric diseases; however, similar to the prior study, this non-US study provided no discussion of the types of upper abdominal complaints experienced by patients or prior tests or treatments undertaken.

The purpose of the limitations tables (Tables 29 and 30) is to display notable limitations identified in each study. This information is synthesized as a summary of the body of evidence following each table and provides the conclusions on the sufficiency of evidence supporting the position statement.

**Table 29. Study Relevance Limitations**

Study	Population <sup>a</sup>	Intervention <sup>b</sup>	Comparator <sup>c</sup>	Outcomes <sup>d</sup>	Duration of Follow-Up <sup>e</sup>
<b>Denzer et al (2015)<sup>56</sup></b>	4. Study population non-U.S. (conducted in France)			1. Sensitivity is low with a wide confidence interval	
<b>Liao et al (2016)<sup>57</sup></b>	4. Study population non-U.S. (conducted in China)		2. Conventional gastroscopy performed without sedation		

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.

<sup>a</sup> Population key: 1. Intended use population unclear; 2. Clinical context is unclear; 3. Study population is unclear; 4. Study population not representative of intended use.

<sup>b</sup> Intervention key: 1. Classification thresholds not defined; 2. Version used unclear; 3. Not intervention of interest.

<sup>c</sup> Comparator key: 1. Classification thresholds not defined; 2. Not compared to credible reference standard; 3. Not compared to other tests in use for same purpose.

<sup>d</sup> Outcomes key: 1. Study does not directly assess a key health outcome; 2. Evidence chain or decision model not explicated; 3. Key clinical validity outcomes not reported (sensitivity, specificity and predictive values); 4. Reclassification of diagnostic or risk categories not reported; 5. Adverse events of the test not described (excluding minor discomforts and inconvenience of venipuncture or noninvasive tests).

<sup>e</sup> Follow-Up key: 1. Follow-up duration not sufficient with respect to natural history of disease (true positives, true negatives, false positives, false negatives cannot be determined).

**Table 30. Study Design and Conduct Limitations**

Study	Selection <sup>a</sup>	Blinding <sup>b</sup>	Delivery of Test <sup>c</sup>	Selective Reporting <sup>d</sup>	Data Completeness <sup>e</sup>	Statistical <sup>f</sup>
<b>Denzer et al (2015)<sup>56</sup></b>	1. Selection of patients not clearly described	1. Final gold standard of conventional gastroscopy with biopsy was unblinded				
<b>Liao et al (2016)<sup>57</sup></b>	1. Selection of patients not clearly described					

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.

<sup>a</sup> Selection key: 1. Selection not described; 2. Selection not random or consecutive (i.e., convenience).

<sup>b</sup> Blinding key: 1. Not blinded to results of reference or other comparator tests.

<sup>c</sup> Test Delivery key: 1. Timing of delivery of index or reference test not described; 2. Timing of index and comparator tests not same; 3. Procedure for interpreting tests not described; 4. Expertise of evaluators not described.

<sup>d</sup> Selective Reporting key: 1. Not registered; 2. Evidence of selective reporting; 3. Evidence of selective publication.

<sup>e</sup> Data Completeness key: 1. Inadequate description of indeterminate and missing samples; 2. High number of samples excluded; 3. High loss to follow-up or missing data.

<sup>f</sup> Statistical key: 1. Confidence intervals and/or p values not reported; 2. Comparison to other tests not reported.

### Clinically Useful

A test is clinically useful if the use of the results informs management decisions that improve the net health outcome of care. The net health outcome can be improved if patients receive correct therapy, more effective therapy, or avoid unnecessary therapy or testing.

### Direct Evidence

Direct evidence of clinical utility is provided by studies that have compared health outcomes for patients managed with and without the test. Because these are intervention studies, the preferred evidence would be from RCTs.

No RCTs assessing the clinical utility of magnetic CE for this indication were identified.

### Chain of Evidence

Indirect evidence on clinical utility rests on clinical validity. If the evidence is insufficient to demonstrate test performance, no inferences can be made about clinical utility.

Although magnetic CE has a similar diagnostic yield as conventional gastroscopy when evaluating patients with unexplained upper abdominal complaints, the sequence and chronology of testing and treatment recommended before magnetic CE needs to be defined to determine whether magnetic CE has utility to diagnose the condition.

### Section Summary: Unexplained Upper Abdominal Complaints

Studies evaluating the diagnostic characteristics of magnetic CE as compared to conventional gastroscopy in the target population have generally demonstrated similar accuracy, sensitivity, and specificity, with increases in patient preference and an acceptable safety profile with the magnetic CE approach. However, the sequence and chronology of testing and treatment recommended before magnetic CE needs to be defined to determine whether magnetic CE has utility to diagnose the condition. No RCTs assessing the clinical utility of magnetic CE for this indication were identified.

### Supplemental Information

The purpose of the following information is to provide reference material. Inclusion does not imply endorsement or alignment with the evidence review conclusions.

### Practice Guidelines and Position Statements

Guidelines or position statements will be considered for inclusion in ‘Supplemental Information’ if they were issued by, or jointly by, a US professional society, an international society with US representation, or National Institute for Health and Care Excellence (NICE). Priority will be given to guidelines that are informed by a systematic review, include strength of evidence ratings, and include a description of management of conflict of interest.

#### American College of Gastroenterology

In 2013, the American College of Gastroenterology (ACG) issued guidelines on the diagnosis and management of celiac disease.<sup>58</sup> The guidelines recommended that capsule endoscopy (CE) not be used for initial diagnosis, except for patients with positive celiac-specific serology who are unwilling or unable to undergo upper endoscopy with biopsy (strong recommendation, moderate level of evidence). These guidelines were updated in 2023, with no mention of CE.<sup>59</sup>

In 2018, the ACG updated its guidelines on the management of Crohn Disease (CD) in adults.<sup>60</sup> It makes 2 recommendations specific to video capsule endoscopy:

- “Video capsule endoscopy (VCE) is a useful adjunct in the diagnosis of patients with small bowel Crohn disease in patients in whom there is a high index of suspicion of disease.”
- “Patients with obstructive symptoms should have small bowel imaging and/or patency capsule evaluation before VCE to decrease risk of capsule retention.”

These recommendations are based on multiple studies. Capsule endoscopy was found to be “superior to small bowel barium studies, computed tomography enterography (CTE) and ileocolonoscopy in patients with suspected CD, with incremental yield of diagnosis of 32%, 47%, and 22%, respectively...Capsule endoscopy has a high negative predictive value of 96%.”

In 2015, the ACG issued guidelines on the diagnosis and management of small bowel bleeding (including using “small bowel bleeding” to replace “obscure GI [gastrointestinal] bleeding,” which should be reserved for patients in whom a source of bleeding cannot be identified anywhere in the GI tract).<sup>61</sup> As of November 2023, a guideline update is in progress.<sup>62</sup> The 2015 guidelines made the following statements related to video CE (Table 31).

**Table 31. Recommendations on Diagnosis and Management of Small Bowel Bleeding**

Recommendation	SOR	LOE
“... VCE should be considered as a first-line procedure for SB evaluation after upper and lower GI sources have been excluded, including second-look endoscopy when indicated”	Strong	Moderate
“VCE should be performed before deep enteroscopy to increase diagnostic yield. Initial deep enteroscopy can be considered in cases of massive hemorrhage or when VCE is contraindicated”	Strong	High

GI: gastrointestinal; LOE: level of evidence; SB: small bowel; SOR: strength of recommendation; VCE: video capsule endoscopy.

In 2021, the ACG issued guidelines on colorectal cancer screening.<sup>63</sup> They “suggest consideration of the following screening tests for individuals unable or unwilling to undergo a colonoscopy or FIT [fecal immunochemical testing]: flexible sigmoidoscopy, multitarget stool DNA test, CT [computed tomography] colongraphy, or colon capsule [capsule endoscopy]” (conditional recommendation, very low quality of evidence).

#### American Gastroenterological Association Institute

In 2017, the American Gastroenterological Association Institute issued guidelines on the use of CE.<sup>64</sup> Table 32 summarizes the most relevant recommendations (not all recommendations are included).



**Table 32. AGA 2017 Capsule Endoscopy Recommendations**

Statement Recommendation number		Grade	QOE
<b>Recommendations supporting the use of CE</b>			
1	For suspected CD, with negative ileocolonoscopy and imaging studies (CE of small bowel)	Strong	Very low
2	For CD and clinical features unexplained by ileocolonoscopy or imaging studies	Strong	Very low
3	For CD, when assessment of small-bowel mucosal healing (beyond reach of ileocolonoscopy) is needed	Conditional	Very low
4	For suspected small-bowel recurrence of CD after colectomy, undiagnosed by ileocolonoscopy or imaging studies	Strong	Very low
7	For celiac disease with unexplained symptoms despite treatment and appropriate investigations	Strong	Very low (efficacy)Low (safety)
8	For documented overt GI bleeding (excluding hematoemesis) and negative findings on high-quality EGD and colonoscopy	Strong	Very low
9	For overt, obscure bleeding episode, as soon as possible	Strong	Very low
10	With prior negative CE with repeated obscure bleeding, repeated studies (endoscopy, colonoscopy and/or CE)	Strong	Very low
11	For suspected obscure bleeding and unexplained mild chronic iron-deficiency anemia, in selected cases	Strong	Very low
12	For polyposis syndromes, which require small bowel studies, for ongoing surveillance	Conditional	Very low (efficacy)Low (safety)
<b>Recommendations against the use of CE</b>			
5	For diagnosing CD when chronic abdominal pain or diarrhea are only symptoms, and with no evidence of biomarkers associated with CD	Conditional	Low
6	For diagnosing celiac disease	Strong	Very low (efficacy)Low (safety)
13	For routine substitution of colonoscopy	Strong	Very low
14	For IBD, as substitute for colonoscopy to assess extent and severity of disease	Strong	Very low (efficacy)Low (safety)

AGA: American Gastroenterological Association; CD: Crohn disease; CE: capsule endoscopy; EGD: esophagogastroduodenoscopy; GI: gastrointestinal; IBD: inflammatory bowel disease; QOE: quality of evidence.

### American Society of Gastrointestinal Endoscopy

In 2017, the American Society of Gastrointestinal Endoscopy released guidelines for the use of endoscopy in the management of suspected small bowel bleeding.<sup>65</sup> These guidelines made the following recommendations on capsule endoscopy (Table 33).

**Table 33. Recommendations on Use of Endoscopy to Manage Suspected Small Bowel Bleeding**

Recommendation	QOE
<b>We suggest VCE as the initial test for patients with overt or occult small-bowel bleeding. Positive VCE results should be followed with push enteroscopy if within reach or DAE."</b>	Moderate
<b>"We suggest DAE or push enteroscopy if VCE is unavailable or nondiagnostic in patients with overt small bowel bleeding."</b>	Moderate

DAE: device-assisted enteroscopy; QOE: quality of evidence; VCE: video capsule endoscopy.

### U.S. Multi-Society Task Force

The U.S. Multi-Society Task Force (2017) issued recommendations for colorectal cancer screening with representation from the ACG, the American Gastroenterological Association, and the American Society for Gastrointestinal Endoscopy.<sup>66</sup> Capsule endoscopy every 5 years received a tier 3 ranking with the following recommendation:

- "We suggest that capsule colonoscopy (if available) is an appropriate screening test when patients decline colonoscopy, FIT, FIT-fecal DNA, CT colonography, and flexible sigmoidoscopy (weak recommendation, low-quality evidence)."

In tandem with the U.S. Preventative Services Task Force (USPSTF) 2021 recommendations, the Multi-Society Task Force released a focused update to these guidelines in 2021, however, no changes were made regarding CE.<sup>67</sup>

### U.S. Preventive Services Task Force Recommendations

The USPSTF published its most recent recommendations for colorectal cancer screening in 2021.<sup>68</sup> Colorectal cancer screening was recommended starting at age 50 years and continuing until age 75 years (A recommendation) and in adults aged 45 to 49 years (B recommendation). The USPSTF recommendation for screening for colorectal cancer does not include serum tests, urine tests, or CE for colorectal cancer screening because of the limited available evidence on these tests and because other effective tests are available.

### Medicare National Coverage

There is no national coverage determination. In the absence of a national coverage determination, coverage decisions are left to the discretion of local Medicare carriers.

### Ongoing and Unpublished Clinical Trials

Some currently ongoing and unpublished trials that might influence this review are listed in Table 34.

**Table 34. Summary of Key Trials**

NCT No.	Trial Name	Planned Enrollment	Completion Date
<i>Ongoing</i>			
NCT04472364	Impact of Blood Detection Capsule "HemoPill Acute" on the Time to Emergency Endoscopy in Case of Suspected Nonvariceal Upper Gastrointestinal Bleeding	72	Dec 2024
NCT02738359	Efficacy of Colonoscopy, Colon Capsule and Fecal Immunological Test for Colorectal Cancer Screening, in First Degree Relatives of Patients With Colorectal Neoplasia: a Prospective Randomized Study	3250	Nov 2023
NCT04307901	Safety of Colorectal Assessment and Tumor Evaluation by Colon Capsule Endoscopy (SOCRATEC)	600	Dec 2030
NCT05108844	A Randomized Controlled Trial Evaluating the Efficacy of Early Videocapsule Endoscopy Following Negative Gastroscopy in Patients Presenting With Suspected Upper Gastrointestinal Bleeding	70	Oct 2023
NCT03616041	Video Capsule Endoscopy for Lesion Localization and Diagnosis in Patients With Severe Hematochezia	50	Jul 2023
<i>Unpublished</i>			
NCT03458000 <sup>a</sup>	Capsule Endoscopy for Hemorrhage in the ER	24	Sep 2020

NCT: national clinical trial.

<sup>a</sup> Denotes industry-sponsored or cosponsored trial.

## References

1. Joseph DA, King JB, Dowling NF, et al. Vital Signs: Colorectal Cancer Screening Test Use - United States, 2018. MMWR Morb Mortal Wkly Rep. Mar 13 2020; 69(10): 253-259. PMID 32163384
2. Siegel RL, Miller KD, Goding Sauer A, et al. Colorectal cancer statistics, 2020. CA Cancer J Clin. May 2020; 70(3): 145-164. PMID 32133645

3. Bourreille A, Ignjatovic A, Aabakken L, et al. Role of small-bowel endoscopy in the management of patients with inflammatory bowel disease: an international OMED-ECCO consensus. *Endoscopy*. Jul 2009; 41(7): 618-37. PMID 19588292
4. Cross A, Szoka N. SAGES NaviCam stomach capsule system. March 10, 2021. <https://www.sages.org/publications/tavac/navicam-stomach-capsule-system/>. Accessed November 6, 2023.
5. Koulaouzidis A, Rondonotti E, Giannakou A, et al. Diagnostic yield of small-bowel capsule endoscopy in patients with iron-deficiency anemia: a systematic review. *Gastrointest Endosc*. Nov 2012; 76(5): 983-92. PMID 23078923
6. Leung WK, Ho SS, Suen BY, et al. Capsule endoscopy or angiography in patients with acute overt obscure gastrointestinal bleeding: a prospective randomized study with long-term follow-up. *Am J Gastroenterol*. Sep 2012; 107(9): 1370-6. PMID 22825363
7. Hartmann D, Schmidt H, Bolz G, et al. A prospective two-center study comparing wireless capsule endoscopy with intraoperative enteroscopy in patients with obscure GI bleeding. *Gastrointest Endosc*. Jun 2005; 61(7): 826-32. PMID 15933683
8. Pennazio M, Santucci R, Rondonotti E, et al. Outcome of patients with obscure gastrointestinal bleeding after capsule endoscopy: report of 100 consecutive cases. *Gastroenterology*. Mar 2004; 126(3): 643-53. PMID 14988816
9. Choi M, Lim S, Choi MG, et al. Effectiveness of Capsule Endoscopy Compared with Other Diagnostic Modalities in Patients with Small Bowel Crohn's Disease: A Meta-Analysis. *Gut Liver*. Jan 15 2017; 11(1): 62-72. PMID 27728963
10. El-Matary W, Huynh H, Vandermeer B. Diagnostic characteristics of given video capsule endoscopy in diagnosis of celiac disease: a meta-analysis. *J Laparoendosc Adv Surg Tech A*. Dec 2009; 19(6): 815-20. PMID 19405806
11. Rokkas T, Niv Y. The role of video capsule endoscopy in the diagnosis of celiac disease: a meta-analysis. *Eur J Gastroenterol Hepatol*. Mar 2012; 24(3): 303-8. PMID 22266837
12. Kurien M, Evans KE, Aziz I, et al. Capsule endoscopy in adult celiac disease: a potential role in equivocal cases of celiac disease?. *Gastrointest Endosc*. Feb 2013; 77(2): 227-32. PMID 23200728
13. Culliford A, Daly J, Diamond B, et al. The value of wireless capsule endoscopy in patients with complicated celiac disease. *Gastrointest Endosc*. Jul 2005; 62(1): 55-61. PMID 15990820
14. Xue M, Chen X, Shi L, et al. Small-bowel capsule endoscopy in patients with unexplained chronic abdominal pain: a systematic review. *Gastrointest Endosc*. Jan 2015; 81(1): 186-93. PMID 25012561
15. Yang L, Chen Y, Zhang B, et al. Increased diagnostic yield of capsule endoscopy in patients with chronic abdominal pain. *PLoS One*. 2014; 9(1): e87396. PMID 24498097
16. Kopylov U, Yung DE, Engel T, et al. Diagnostic yield of capsule endoscopy versus magnetic resonance enterography and small bowel contrast ultrasound in the evaluation of small bowel Crohn's disease: Systematic review and meta-analysis. *Dig Liver Dis*. Aug 2017; 49(8): 854-863. PMID 28512034
17. Bruining DH, Oliva S, Fleisher MR, et al. Panenteric capsule endoscopy versus ileocolonoscopy plus magnetic resonance enterography in Crohn's disease: a multicentre, prospective study. *BMJ Open Gastroenterol*. Jun 2020; 7(1). PMID 32499275
18. Elosua A, Rullan M, Rubio S, et al. Does capsule endoscopy impact clinical management in established Crohn's disease?. *Dig Liver Dis*. Jan 2022; 54(1): 118-124. PMID 34518128
19. Shi HY, Chan FKL, Higashimori A, et al. A prospective study on second-generation colon capsule endoscopy to detect mucosal lesions and disease activity in ulcerative colitis (with video). *Gastrointest Endosc*. Dec 2017; 86(6): 1139-1146.e6. PMID 28713062
20. San Juan-Acosta M, Caunedo-Álvarez A, Argüelles-Arias F, et al. Colon capsule endoscopy is a safe and useful tool to assess disease parameters in patients with ulcerative colitis. *Eur J Gastroenterol Hepatol*. Aug 2014; 26(8): 894-901. PMID 24987825
21. Oliva S, Di Nardo G, Hassan C, et al. Second-generation colon capsule endoscopy vs. colonoscopy in pediatric ulcerative colitis: a pilot study. *Endoscopy*. Jun 2014; 46(6): 485-92. PMID 24777427

22. Sung J, Ho KY, Chiu HM, et al. The use of Pillcam Colon in assessing mucosal inflammation in ulcerative colitis: a multicenter study. *Endoscopy*. Aug 2012; 44(8): 754-8. PMID 22696193
23. Gaturu P, Sagi SV, Ahn D, et al. Capsule endoscopy with PILLCAM ESO for detecting esophageal varices: a meta-analysis. *Minerva Gastroenterol Dietol*. Mar 2011; 57(1): 1-11. PMID 21372764
24. Bhardwaj A, Hollenbeak CS, Pooran N, et al. A meta-analysis of the diagnostic accuracy of esophageal capsule endoscopy for Barrett's esophagus in patients with gastroesophageal reflux disease. *Am J Gastroenterol*. Jun 2009; 104(6): 1533-9. PMID 19491867
25. Urquhart P, Grimpen F, Lim GJ, et al. Capsule endoscopy versus magnetic resonance enterography for the detection of small bowel polyps in Peutz-Jeghers syndrome. *Fam Cancer*. Jun 2014; 13(2): 249-55. PMID 24509884
26. Brown G, Fraser C, Schofield G, et al. Video capsule endoscopy in peutz-jeghers syndrome: a blinded comparison with barium follow-through for detection of small-bowel polyps. *Endoscopy*. Apr 2006; 38(4): 385-90. PMID 16680639
27. Mata A, Llach J, Castells A, et al. A prospective trial comparing wireless capsule endoscopy and barium contrast series for small-bowel surveillance in hereditary GI polyposis syndromes. *Gastrointest Endosc*. May 2005; 61(6): 721-5. PMID 15855978
28. Haanstra JF, Al-Toma A, Dekker E, et al. Prevalence of small-bowel neoplasia in Lynch syndrome assessed by video capsule endoscopy. *Gut*. Oct 2015; 64(10): 1578-83. PMID 25209657
29. Saurin JC, Pilleul F, Soussan EB, et al. Small-bowel capsule endoscopy diagnoses early and advanced neoplasms in asymptomatic patients with Lynch syndrome. *Endoscopy*. Dec 2010; 42(12): 1057-62. PMID 20821360
30. McCarty TR, Afinogenova Y, Njei B. Use of Wireless Capsule Endoscopy for the Diagnosis and Grading of Esophageal Varices in Patients With Portal Hypertension: A Systematic Review and Meta-Analysis. *J Clin Gastroenterol*. Feb 2017; 51(2): 174-182. PMID 27548729
31. Colli A, Gana JC, Turner D, et al. Capsule endoscopy for the diagnosis of oesophageal varices in people with chronic liver disease or portal vein thrombosis. *Cochrane Database Syst Rev*. Oct 01 2014; 2014(10): CD008760. PMID 25271409
32. Sung JJ, Tang RS, Ching JY, et al. Use of capsule endoscopy in the emergency department as a triage of patients with GI bleeding. *Gastrointest Endosc*. Dec 2016; 84(6): 907-913. PMID 27156655
33. Gutkin E, Shalomov A, Hussain SA, et al. Pillcam ESO(®) is more accurate than clinical scoring systems in risk stratifying emergency room patients with acute upper gastrointestinal bleeding. *Therap Adv Gastroenterol*. May 2013; 6(3): 193-8. PMID 23634183
34. Chandran S, Testro A, Urquhart P, et al. Risk stratification of upper GI bleeding with an esophageal capsule. *Gastrointest Endosc*. Jun 2013; 77(6): 891-8. PMID 23453185
35. Gralnek IM, Ching JY, Maza I, et al. Capsule endoscopy in acute upper gastrointestinal hemorrhage: a prospective cohort study. *Endoscopy*. 2013; 45(1): 12-9. PMID 23254402
36. Spada C, Pasha SF, Gross SA, et al. Accuracy of First- and Second-Generation Colon Capsules in Endoscopic Detection of Colorectal Polyps: A Systematic Review and Meta-analysis. *Clin Gastroenterol Hepatol*. Nov 2016; 14(11): 1533-1543.e8. PMID 27165469
37. Kjølhede T, Ølholm AM, Kaalby L, et al. Diagnostic accuracy of capsule endoscopy compared with colonoscopy for polyp detection: systematic review and meta-analyses. *Endoscopy*. Jul 2021; 53(7): 713-721. PMID 32858753
38. Saito Y, Saito S, Oka S, et al. Evaluation of the clinical efficacy of colon capsule endoscopy in the detection of lesions of the colon: prospective, multicenter, open study. *Gastrointest Endosc*. Nov 2015; 82(5): 861-9. PMID 25936450
39. Morgan DR, Malik PR, Romeo DP, et al. Initial US evaluation of second-generation capsule colonoscopy for detecting colon polyps. *BMJ Open Gastroenterol*. 2016; 3(1): e000089. PMID 27195129
40. Parodi A, Vanbiervliet G, Hassan C, et al. Colon capsule endoscopy to screen for colorectal neoplasia in those with family histories of colorectal cancer. *Gastrointest Endosc*. Mar 2018; 87(3): 695-704. PMID 28554656

41. Cash BD, Fleisher MR, Fern S, et al. Multicentre, prospective, randomised study comparing the diagnostic yield of colon capsule endoscopy versus CT colonography in a screening population (the TOPAZ study). *Gut*. Nov 2021; 70(11): 2115-2122. PMID 33443017
42. Kobaek-Larsen M, Kroijer R, Dyrvig AK, et al. Back-to-back colon capsule endoscopy and optical colonoscopy in colorectal cancer screening individuals. *Colorectal Dis*. Jun 2018; 20(6): 479-485. PMID 29166546
43. Rondonotti E, Borghi C, Mandelli G, et al. Accuracy of capsule colonoscopy and computed tomographic colonography in individuals with positive results from the fecal occult blood test. *Clin Gastroenterol Hepatol*. Aug 2014; 12(8): 1303-10. PMID 24398064
44. Eliakim R, Yassin K, Niv Y, et al. Prospective multicenter performance evaluation of the second-generation colon capsule compared with colonoscopy. *Endoscopy*. Dec 2009; 41(12): 1026-31. PMID 19967618
45. Franco DL, Leighton JA, Gurudu SR. Approach to Incomplete Colonoscopy: New Techniques and Technologies. *Gastroenterol Hepatol (N Y)*. Aug 2017; 13(8): 476-483. PMID 28867979
46. Hussey M, Holleran G, Stack R, et al. Same-day colon capsule endoscopy is a viable means to assess unexplored colonic segments after incomplete colonoscopy in selected patients. *United European Gastroenterol J*. Dec 2018; 6(10): 1556-1562. PMID 30574326
47. Baltés P, Bota M, Albert J, et al. PillCamColon2 after incomplete colonoscopy - A prospective multicenter study. *World J Gastroenterol*. Aug 21 2018; 24(31): 3556-3566. PMID 30131662
48. Negreanu L, Babiuc R, Bengus A, et al. PillCam Colon 2 capsule in patients unable or unwilling to undergo colonoscopy. *World J Gastrointest Endosc*. Nov 16 2013; 5(11): 559-67. PMID 24255748
49. Pioche M, de Leusse A, Filoche B, et al. Prospective multicenter evaluation of colon capsule examination indicated by colonoscopy failure or anesthesia contraindication. *Endoscopy*. Oct 2012; 44(10): 911-6. PMID 22893133
50. Nogales Ó, García-Lledó J, Luján M, et al. Therapeutic impact of colon capsule endoscopy with PillCam™ COLON 2 after incomplete standard colonoscopy: a Spanish multicenter study. *Rev Esp Enferm Dig*. May 2017; 109(5): 322-327. PMID 28229607
51. Spada C, Shah SK, Riccioni ME, et al. Video capsule endoscopy in patients with known or suspected small bowel stricture previously tested with the dissolving patency capsule. *J Clin Gastroenterol*. Jul 2007; 41(6): 576-82. PMID 17577114
52. Delvaux M, Ben Soussan E, Laurent V, et al. Clinical evaluation of the use of the M2A patency capsule system before a capsule endoscopy procedure, in patients with known or suspected intestinal stenosis. *Endoscopy*. Sep 2005; 37(9): 801-7. PMID 16116529
53. Herrerias JM, Leighton JA, Costamagna G, et al. Agile patency system eliminates risk of capsule retention in patients with known intestinal strictures who undergo capsule endoscopy. *Gastrointest Endosc*. May 2008; 67(6): 902-9. PMID 18355824
54. Postgate AJ, Burling D, Gupta A, et al. Safety, reliability and limitations of the given patency capsule in patients at risk of capsule retention: a 3-year technical review. *Dig Dis Sci*. Oct 2008; 53(10): 2732-8. PMID 18320313
55. Banerjee R, Bhargav P, Reddy P, et al. Safety and efficacy of the M2A patency capsule for diagnosis of critical intestinal patency: results of a prospective clinical trial. *J Gastroenterol Hepatol*. Dec 2007; 22(12): 2060-3. PMID 17614957
56. Denzer UW, Rösch T, Hoytat B, et al. Magnetically guided capsule versus conventional gastroscopy for upper abdominal complaints: a prospective blinded study. *J Clin Gastroenterol*. Feb 2015; 49(2): 101-7. PMID 24618504
57. Liao Z, Hou X, Lin-Hu EQ, et al. Accuracy of Magnetically Controlled Capsule Endoscopy, Compared With Conventional Gastroscopy, in Detection of Gastric Diseases. *Clin Gastroenterol Hepatol*. Sep 2016; 14(9): 1266-1273.e1. PMID 27211503
58. Rubio-Tapia A, Hill ID, Kelly CP, et al. ACG clinical guidelines: diagnosis and management of celiac disease. *Am J Gastroenterol*. May 2013; 108(5): 656-76; quiz 677. PMID 23609613
59. Rubio-Tapia A, Hill ID, Semrad C, et al. American College of Gastroenterology Guidelines Update: Diagnosis and Management of Celiac Disease. *Am J Gastroenterol*. Jan 01 2023; 118(1): 59-76. PMID 36602836

60. Lichtenstein GR, Loftus EV, Isaacs KL, et al. ACG Clinical Guideline: Management of Crohn's Disease in Adults. *Am J Gastroenterol*. Apr 2018; 113(4): 481-517. PMID 29610508
61. Gerson LB, Fidler JL, Cave DR, et al. ACG Clinical Guideline: Diagnosis and Management of Small Bowel Bleeding. *Am J Gastroenterol*. Sep 2015; 110(9): 1265-87; quiz 1288. PMID 26303132
62. American College of Gastroenterology Guidelines. 2023. <https://gi.org/guidelines/>. Accessed November 6, 2023.
63. Shaukat A, Kahi CJ, Burke CA, et al. ACG Clinical Guidelines: Colorectal Cancer Screening 2021. *Am J Gastroenterol*. Mar 01 2021; 116(3): 458-479. PMID 33657038
64. Enns RA, Hookey L, Armstrong D, et al. Clinical Practice Guidelines for the Use of Video Capsule Endoscopy. *Gastroenterology*. Feb 2017; 152(3): 497-514. PMID 28063287
65. Gurudu SR, Bruining DH, Acosta RD, et al. The role of endoscopy in the management of suspected small-bowel bleeding. *Gastrointest Endosc*. Jan 2017; 85(1): 22-31. PMID 27374798
66. Rex DK, Boland CR, Dominitz JA, et al. Colorectal Cancer Screening: Recommendations for Physicians and Patients From the U.S. Multi-Society Task Force on Colorectal Cancer. *Gastroenterology*. Jul 2017; 153(1): 307-323. PMID 28600072
67. Patel SG, May FP, Anderson JC, et al. Updates on Age to Start and Stop Colorectal Cancer Screening: Recommendations From the U.S. Multi-Society Task Force on Colorectal Cancer. *Gastroenterology*. Jan 2022; 162(1): 285-299. PMID 34794816
68. Davidson KW, Barry MJ, Mangione CM, et al. Screening for Colorectal Cancer: US Preventive Services Task Force Recommendation Statement. *JAMA*. May 18 2021; 325(19): 1965-1977. PMID 34003218

## Documentation for Clinical Review

### Please provide the following documentation:

- History and physical and/or consultation notes including:
  - Reason for procedure including suspected or known diagnoses
  - Prior endoscopy or imaging reports if applicable
  - Evidence of anemia (i.e., CBC) or GI bleeding if applicable

### Post Service (in addition to the above, please include the following):

- Operative/procedure report(s)
- Diagnostic radiology reports

## Coding

*This Policy relates only to the services or supplies described herein. Benefits may vary according to product design; therefore, contract language should be reviewed before applying the terms of the Policy.*

*The following codes are included below for informational purposes. Inclusion or exclusion of a code(s) does not constitute or imply member coverage or provider reimbursement policy. Policy Statements are intended to provide member coverage information and may include the use of some codes for clarity. The Policy Guidelines section may also provide additional information for how to interpret the Policy Statements and to provide coding guidance in some cases.*

Type	Code	Description
	0651T	Magnetically controlled capsule endoscopy, esophagus through stomach, including intraprocedural positioning of capsule, with interpretation and report

Type	Code	Description
	91110	Gastrointestinal tract imaging, intraluminal (e.g., capsule endoscopy), esophagus through ileum, with interpretation and report
	91111	Gastrointestinal tract imaging, intraluminal (e.g., capsule endoscopy), esophagus with interpretation and report
	91113	Gastrointestinal tract imaging, intraluminal (e.g., capsule endoscopy), colon, with interpretation and report
HCPCS	None	

## Policy History

This section provides a chronological history of the activities, updates and changes that have occurred with this Medical Policy.

Effective Date	Action
02/13/2002	BCBSA Medical Policy adoption
10/16/2002	BCBSA Medical Policy adoption
11/01/2002	Administrative Review
06/01/2004	BCBSA Medical Policy adoption
04/01/2005	BCBSA Medical Policy adoption Regarding the esophagus; modified, Title change
12/07/2006	BCBSA Medical Policy adoption Criteria revised.
03/01/2007	Policy Review Policy statement unchanged.
01/23/2008	Administrative Review Disclaimer stated added to Medical Policy.
09/25/2009	Policy Revision
01/11/2013	Policy revision with position change
12/15/2014	Policy title change from Wireless Capsule Endoscopy Policy revision with position change effective 2/15/2015
02/15/2015	Policy revision with position change
01/01/2017	Policy title change from Wireless Capsule Endoscopy as a Diagnostic Technique in Disorders of the Small Bowel, Esophagus, and Colon Policy revision without position change
01/01/2018	Policy revision without position change
01/01/2019	Policy revision without position change
02/01/2020	Annual review. No change to policy statement. Literature review updated.
05/01/2020	Administrative update. Policy statement updated.
11/01/2020	Administrative update. Policy statement updated.
02/01/2021	Annual review. Policy statement and literature updated.
08/01/2021	Coding update
02/01/2022	Annual review. Policy statement and literature updated. Policy title changed from Wireless Capsule Endoscopy to Diagnose Disorders of the Small Bowel, Esophagus, and Colon to current one. Coding update.
02/01/2023	Annual review. Policy statement, guidelines and literature review updated
02/01/2024	Annual review. No change to policy statement. Literature review updated

## Definitions of Decision Determinations

**Medically Necessary:** Services that are Medically Necessary include only those which have been established as safe and effective, are furnished under generally accepted professional standards to treat illness, injury or medical condition, and which, as determined by Blue Shield, are: (a) consistent

with Blue Shield medical policy; (b) consistent with the symptoms or diagnosis; (c) not furnished primarily for the convenience of the patient, the attending Physician or other provider; (d) furnished at the most appropriate level which can be provided safely and effectively to the patient; and (e) not more costly than an alternative service or sequence of services at least as likely to produce equivalent therapeutic or diagnostic results as to the diagnosis or treatment of the Member's illness, injury, or disease.

**Investigational/Experimental:** A treatment, procedure, or drug is investigational when it has not been recognized as safe and effective for use in treating the particular condition in accordance with generally accepted professional medical standards. This includes services where approval by the federal or state governmental is required prior to use, but has not yet been granted.

**Split Evaluation:** Blue Shield of California/Blue Shield of California Life & Health Insurance Company (Blue Shield) policy review can result in a split evaluation, where a treatment, procedure, or drug will be considered to be investigational for certain indications or conditions, but will be deemed safe and effective for other indications or conditions, and therefore potentially medically necessary in those instances.

### Prior Authorization Requirements and Feedback (as applicable to your plan)

Within five days before the actual date of service, the provider must confirm with Blue Shield that the member's health plan coverage is still in effect. Blue Shield reserves the right to revoke an authorization prior to services being rendered based on cancellation of the member's eligibility. Final determination of benefits will be made after review of the claim for limitations or exclusions.

Questions regarding the applicability of this policy should be directed to the Prior Authorization Department at (800) 541-6652, or the Transplant Case Management Department at (800) 637-2066 ext. 3507708 or visit the provider portal at [www.blueshieldca.com/provider](http://www.blueshieldca.com/provider).

We are interested in receiving feedback relative to developing, adopting, and reviewing criteria for medical policy. Any licensed practitioner who is contracted with Blue Shield of California or Blue Shield of California Promise Health Plan is welcome to provide comments, suggestions, or concerns. Our internal policy committees will receive and take your comments into consideration.

For utilization and medical policy feedback, please send comments to: [MedPolicy@blueshieldca.com](mailto:MedPolicy@blueshieldca.com)

*Disclaimer: This medical policy is a guide in evaluating the medical necessity of a particular service or treatment. Blue Shield of California may consider published peer-reviewed scientific literature, national guidelines, and local standards of practice in developing its medical policy. Federal and state law, as well as contract language, including definitions and specific contract provisions/exclusions, take precedence over medical policy and must be considered first in determining covered services. Member contracts may differ in their benefits. Blue Shield reserves the right to review and update policies as appropriate.*



**Appendix A**

POLICY STATEMENT (No changes)	
BEFORE	AFTER
<p><b>Wireless Capsule Endoscopy for Gastrointestinal (GI) Disorders 6.01.33</b></p> <p><b>Policy Statement:</b></p> <ol style="list-style-type: none"> <li>I. Wireless capsule endoscopy of the small bowel may be considered <b>medically necessary</b> when <b>both</b> of the following conditions are met:                             <ol style="list-style-type: none"> <li>A. When the procedure is NOT intended for <b>all</b> of the below:                                     <ol style="list-style-type: none"> <li>1. To evaluate of the extent of involvement of known Crohn disease or ulcerative colitis</li> <li>2. To evaluate the esophagus, in individuals with gastroesophageal reflux or other esophageal pathologies</li> <li>3. To evaluate other gastrointestinal (GI)diseases and conditions not presenting with GI bleeding, including but not limited to, celiac sprue, irritable bowel syndrome, lynch syndrome (risk for hereditary nonpolyposis colorectal cancer), portal hypertensive enteropathy, small bowel neoplasm, screening for colonic polyps or cancer and unexplained chronic abdominal pain</li> <li>4. For Initial evaluation of individuals with acute upper GI bleeding</li> <li>5. To evaluate individuals with evidence of lower GI bleeding and major risks for colonoscopy or moderate sedation</li> <li>6. To evaluate individuals following incomplete colonoscopy</li> </ol> </li> <li>B. If the procedure is intended for <b>any</b> of the below:                                     <ol style="list-style-type: none"> <li>1. Suspected small bowel bleeding, and <b>both</b> of the following:   <ol style="list-style-type: none"> <li>a. Inconclusive upper gastrointestinal (GI) endoscopy during the current episode of illness</li> <li>b. Inconclusive lower GI endoscopy (colonoscopy) during the current episode of illness</li> </ol> </li> <li>2. Initial diagnosis in individuals with suspected Crohn disease without evidence of disease on conventional diagnostic tests (such as small bowel follow-through [SBFT] and upper and lower endoscopy)</li> </ol> </li> </ol> </li> </ol>	<p><b>Wireless Capsule Endoscopy for Gastrointestinal (GI) Disorders 6.01.33</b></p> <p><b>Policy Statement:</b></p> <ol style="list-style-type: none"> <li>I. Wireless capsule endoscopy of the small bowel may be considered <b>medically necessary</b> when <b>both</b> of the following conditions are met:                             <ol style="list-style-type: none"> <li>A. When the procedure is NOT intended for <b>all</b> of the below:                                     <ol style="list-style-type: none"> <li>1. To evaluate of the extent of involvement of known Crohn disease or ulcerative colitis</li> <li>2. To evaluate the esophagus, in individuals with gastroesophageal reflux or other esophageal pathologies</li> <li>3. To evaluate other gastrointestinal (GI)diseases and conditions not presenting with GI bleeding, including but not limited to, celiac sprue, irritable bowel syndrome, lynch syndrome (risk for hereditary nonpolyposis colorectal cancer), portal hypertensive enteropathy, small bowel neoplasm, screening for colonic polyps or cancer and unexplained chronic abdominal pain</li> <li>4. For Initial evaluation of individuals with acute upper GI bleeding</li> <li>5. To evaluate individuals with evidence of lower GI bleeding and major risks for colonoscopy or moderate sedation</li> <li>6. To evaluate individuals following incomplete colonoscopy</li> </ol> </li> <li>B. If the procedure is intended for <b>any</b> of the below:                                     <ol style="list-style-type: none"> <li>1. Suspected small bowel bleeding, and <b>both</b> of the following:   <ol style="list-style-type: none"> <li>a. Inconclusive upper gastrointestinal (GI) endoscopy during the current episode of illness</li> <li>b. Inconclusive lower GI endoscopy (colonoscopy) during the current episode of illness</li> </ol> </li> <li>2. Initial diagnosis in individuals with suspected Crohn disease without evidence of disease on conventional diagnostic tests (such as small bowel follow-through [SBFT] and upper and lower endoscopy)</li> </ol> </li> </ol> </li> </ol>

POLICY STATEMENT (No changes)	
BEFORE	AFTER
<p>3. Established diagnosis of Crohn disease, with unexpected change(s) in the course of disease or response to treatment, suggesting the initial diagnosis may be incorrect and reexamination may be indicated</p> <p>4. For surveillance of the small bowel in individuals with hereditary GI polyposis syndromes, including familial adenomatous polyposis and Peutz-Jeghers syndrome</p> <p>II. Wireless Capsule Endoscopy is considered <b>investigational</b> if the patient's situation does not meet the criteria above.</p> <p>III. The patency capsule is considered <b>investigational</b>, including use to evaluate patency of the GI tract before wireless capsule endoscopy.</p> <p>IV. Magnetic capsule endoscopy is considered <b>investigational</b> for the evaluation of individuals with unexplained upper abdominal complaints and all other indications.</p>	<p>3. Established diagnosis of Crohn disease, with unexpected change(s) in the course of disease or response to treatment, suggesting the initial diagnosis may be incorrect and reexamination may be indicated</p> <p>4. For surveillance of the small bowel in individuals with hereditary GI polyposis syndromes, including familial adenomatous polyposis and Peutz-Jeghers syndrome</p> <p>II. Wireless Capsule Endoscopy is considered <b>investigational</b> if the patient's situation does not meet the criteria above.</p> <p>III. The patency capsule is considered <b>investigational</b>, including use to evaluate patency of the GI tract before wireless capsule endoscopy.</p> <p>IV. Magnetic capsule endoscopy is considered <b>investigational</b> for the evaluation of individuals with unexplained upper abdominal complaints and all other indications.</p>