Confocal Laser Endomicroscopy

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**Last Review:** 3/2019  
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**Policy**
Blue Cross and Blue Shield of Kansas City (Blue KC) will not provide coverage for confocal laser endomicroscopy. This is considered investigational.

**When Policy Topic is covered**
Not Applicable

**When Policy Topic is not covered**
Use of confocal laser endomicroscopy is considered *investigational*.

**Description of Procedure or Service**

<table>
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<th>Populations</th>
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| Individuals: With suspected or known colorectal lesions                      | Interventions of interest are:  
  - Confocal laser endomicroscopy as an adjunct to colonoscopy                                                                                  | Comparators of interest are:  
  - White-light colonoscopy alone  
  - Colonoscopy used with alternative adjunctive diagnostic aids                                                                                 | Relevant outcomes include:  
  - Overall survival  
  - Disease-specific survival  
  - Test accuracy  
  - Test validity  
  - Resource utilization                                                                                                                        |
| Individuals: With Barrett esophagus who are undergoing surveillance          | Interventions of interest are:  
  - Confocal laser endomicroscopy with targeted biopsy                                                                                          | Comparators of interest are:  
  - Standard endoscopy with random biopsy                                                                                                         | Relevant outcomes include:  
  - Overall survival  
  - Disease-specific survival  
  - Test accuracy  
  - Test validity  
  - Resource utilization                                                                                                                        |
| Individuals: With gastrointestinal lesions and have had endoscopic treatment | Interventions of interest are:  
  - Confocal laser endomicroscopy to assess adequacy of endoscopic treatment                                                                     | Comparators of interest are:  
  - Standard endoscopy (i.e., white-light endoscopy)                                                                                           | Relevant outcomes include:  
  - Overall survival  
  - Disease-specific survival  
  - Test accuracy  
  - Test validity  
  - Resource utilization                                                                                                                        |
| Individuals: With suspicion of a condition diagnosed by identification and biopsy of lesions (eg, lung, bladder, or gastric cancer) | Interventions of interest are:  
  - Confocal laser endomicroscopy                                                                                                                   | Comparators of interest are:  
  - Standard diagnostic procedures                                                                                                                 | Relevant outcomes include:  
  - Overall survival  
  - Disease-specific survival  
  - Test accuracy  
  - Test validity  
  - Resource utilization                                                                                                                        |

Confocal laser endomicroscopy (CLE), also known as confocal fluorescent endomicroscopy and optical endomicroscopy, allows *in vivo* microscopic imaging of cells during endoscopy. CLE is proposed for a variety of purposes, especially as a...
real-time alternative to histology during colonoscopy and for targeting areas to undergo biopsy in patients with inflammatory bowel disease and Barrett’s esophagus.

For individuals who have suspected or known colorectal lesions who receive CLE as an adjunct to colonoscopy, the evidence includes multiple diagnostic accuracy studies. Relevant outcomes are overall survival, disease-specific survival, test accuracy and validity, and resource utilization. While the reported sensitivity and specificity in these studies are high, it is uncertain whether the accuracy is sufficiently high to replace biopsy/polypectomy and histopathologic analysis. Moreover, issues remain about the use of this technology in practice (eg, the learning curve, interpretation of lesions). The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who have Barrett esophagus who are undergoing surveillance who receive CLE with targeted biopsy, the evidence includes several randomized controlled trials (RCTs) and a meta-analysis. Relevant outcomes are overall survival, disease-specific survival, test accuracy and validity, and resource utilization. Evidence from RCTs has suggested CLE is more sensitive than standard endoscopy for identifying areas of dysplasia. However, a 2014 meta-analysis found that the pooled sensitivity, specificity, and negative predictive value of available studies were not sufficiently high to replace the standard surveillance protocol. National guidelines continue to recommend 4-quadrant random biopsies for patients with Barrett esophagus undergoing surveillance. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who have gastrointestinal lesions and have had endoscopic treatment who receive CLE, the evidence includes 1 RCT and a systematic review. Relevant outcomes are overall survival, disease-specific survival, test accuracy and validity, and resource utilization. The single RCT, which compared high definition (HD) white-light endoscopy with HD white-light endoscopy plus CLE, was stopped early because an interim analysis did not find a between-group difference in outcomes. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who have a suspicion of a condition diagnosed by identification and biopsy of lesions (eg, lung, bladder, or gastric cancer) who receive CLE, the evidence includes a small number of diagnostic accuracy studies. Relevant outcomes are overall survival, disease-specific survival, test accuracy and validity, and resource utilization. There is limited evidence on the diagnostic accuracy of these other indications. The evidence is insufficient to determine the effects of the technology on health outcomes.

Background
CLE, also known as confocal fluorescent endomicroscopy and optical endomicroscopy, allows in vivo microscopic imaging of the mucosal epithelium during endoscopy. The process involves using light from a low-power laser to illuminate tissue and, subsequently, the same lens detects light reflected from the
tissue through a pinhole. The term confocal refers to having both illumination and collection systems in the same focal plane. Light reflected and scattered at other geometric angles that is not reflected through the pinhole is excluded from detection, which dramatically increases the special resolution of CLE images.

To date, 2 types of CLE systems have been cleared by the U.S. Food and Drug Administration (FDA). One is an endoscope-based system in which a confocal probe is incorporated onto the tip of a conventional endoscope. The other is a probe-based system; the probe is placed through the biopsy channel of a conventional endoscope. The depth of view is up to 250 um with the endoscopic system and about 120 um with the probe-based system. A limited area can be examined; no more than 700 um in the endoscopic-based system and less with the probe-based system. As pointed out in review articles, the limited viewing area emphasizes the need for careful conventional endoscopy to target the areas for evaluation. Both CLE systems are optimized using a contrast agent. The most widely used agent is intravenous fluorescein, which is FDA-approved for ophthalmologic imaging of blood vessels when used with a laser scanning ophthalmoscope.

Unlike techniques such as chromoendoscopy, which are primarily intended to improve the sensitivity of colonoscopy, CLE is unique in that it is designed to immediately characterize the cellular structure of lesions. CLE can thus potentially be used to make a diagnosis of polyp histology, particularly in association with screening or surveillance colonoscopy, which could allow for small hyperplastic lesions to be left in place rather than removed and sent for histological evaluation. This would reduce risks associated with biopsy and reduce the number of biopsies and histological evaluations.

Another key potential application of CLE technology is targeting areas for biopsy in patients with BE undergoing surveillance endoscopy. This is an alternative to the current standard approach recommended by the American Gastroenterological Association (AGA) which is that patients with BE who do not have dysplasia undergo endoscopic surveillance every 3 to 5 years.(1) AGA further recommends that random 4-quadrant biopsies every 2 cm be taken with white-light endoscopy in patients without known dysplasia.

Other potential uses of CLE under investigation include better diagnosis and differentiation of conditions such as gastric metaplasia, lung cancer, and bladder cancer.

As noted previously, limitations of CLE systems include a limited viewing area and depth of view. Another issue is standardization of systems for classifying lesions viewed with CLE devices. Although there is not currently an internationally accepted classification system for colorectal lesions, 2 systems have been developed that have been used in a number of studies conducted in different countries. These are the Mainz criteria for endoscopy-based CLE devices and the Miami classification system for probe-based CLE devices. (2) Lesion classification systems are less developed for non-gastrointestinal lesions viewed by CLE devices.
e.g., those in the lung or bladder. Another potential issue is the learning curve for obtaining high-quality images and classifying lesions. Several recent studies, however, have found that the ability to acquire high-quality images and interpret them accurately can be learned relatively quickly; these studies were limited to colorectal applications of CLE. (3, 4)

**Regulatory Status**

Two confocal laser endomicroscopy devices have been cleared for marketing by the FDA. These include:

Cellvizio® (Mauna Kea Technologies) is a confocal microscopy with a fiber optic probe (ie, a probe-based CLE system). The device consists of a laser scanning unit, proprietary software, a flat-panel display, and miniaturized fiber optic probes. The F-600 system, cleared by FDA in 2006, can be used with any standard endoscope with a working channel of at least 2.8 mm. According to FDA, the device is intended for imaging the internal microstructure of tissues in the anatomic tract (gastrointestinal or respiratory) that are accessed by an endoscope. The 100 series version of the system was cleared by FDA in 2015 for imaging the internal microstructure of tissues and for visualization of body cavities organs and canals during endoscopic and laparoscopic surgery. In 2018, the CranioFlex™ Confocal Miniprobe (Mauna Kea Technologies) was cleared to “provide visualization within central nervous system during cranial diagnostic and therapeutic procedures such as tumor biopsy and resection.” FDA product codes: GCJ, GWG, OWN.

Confocal Video Colonoscope (Pentax Medical, Montvale, NJ) is an endoscopy-based CLE system. The EC-3S7OCILK system, cleared by FDA in 2004, is used with a Pentax Video Processor and with a Pentax Confocal Laser System. According to FDA, the device is intended to provide optical and microscopic visualization of and therapeutic access to the lower gastrointestinal tract. FDA product code: GCJ/KOG (endoscope and accessories).

**Rationale**

This evidence review was created in January 2013 and has been updated regularly with searches of the MEDLINE database. The most recently literature update was performed through September 6, 2018.

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.

**Confocal Laser Endomicroscopy**

**Clinical Context and Test Purpose**

The purpose of confocal laser endomicroscopy (CLE) scanning in patients with suspected or known colorectal lesions; Barrett esophagus (BE) who are undergoing surveillance; gastrointestinal lesions following endoscopic treatment; or suspected other conditions diagnosed by identification and biopsy of lesions (eg, lung, bladder, head and neck, esophageal, or gastric cancers) is to provide a real-time alternative to histology and assist in targeting areas for biopsy.

The question addressed in this evidence review is: Does the use of CLE improve the net health outcome in individuals with suspected or known colorectal lesions, BE who are undergoing surveillance, gastrointestinal lesions who have had endoscopic treatment, or suspected other conditions (eg, lung, bladder, head and neck, esophageal, or gastric cancers)?

The following PICOTS were used to select literature to inform this review.

**Patients**
The populations of interest are patients with suspected or known colorectal lesions; BE undergoing surveillance; gastrointestinal lesions who have had endoscopic treatment; and suspected other conditions diagnosed by identification and biopsy of lesions.

**Interventions**
The intervention of interest is CLE.

**Comparators**
The following tools and practices are currently being used to diagnose the following conditions:

- For suspected colorectal lesions, white-light colonoscopy alone or alternative adjunctive diagnostic aids
- For BE undergoing surveillance, standard endoscopy with random biopsy
- For gastrointestinal lesions following endoscopic treatment, standard endoscopy (white-light endoscopy)
- For other condition diagnosed by identification and biopsy of lesions, standard diagnostic procedures.

**Outcomes**
The outcomes of interest include overall survival, disease specific survival, test validity, and resource utilization.
Timing
For patients with suspected colorectal lesions, BE, and other conditions, the timing of CLE would be during the disease confirmation process. For patients with gastrointestinal lesions following endoscopic treatment, the timing would be following the endoscopic treatment.

Setting
CLE would be administered in a facility equipped with this endomicroscope.

Technically Reliable
Assessment of technical reliability focuses on specific tests and operators and requires review of unpublished and often proprietary information. Review of specific tests, operators, and unpublished data are outside the scope of this evidence review and alternative sources exist. This evidence review focuses on the clinical validity and clinical utility.

Colorectal Lesions

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).

Systematic Reviews
Several systematic reviews have compared the diagnostic accuracy of CLE with a reference standard. Su et al (2013) reviewed studies on the efficacy of CLE for discriminating colorectal neoplasms from non-neoplasms. To be included in the review, studies had to use histologic biopsy as the reference standard, and the pathologist and endoscopist had to be blinded to each other’s findings. Selected studies also had to use a standardized CLE classification system. Patients had to be at increased risk of colorectal cancer (CRC) due to personal or family history, have previously identified polyps, and/or have inflammatory bowel disease. Two reviewers independently assessed the quality of individual studies using the modified Quality Assessment of Diagnostic Accuracy Studies tool, and studies considered at high risk of bias were excluded from further consideration.

Fifteen studies (total N=719 adults) were selected. All were single-center trials, and two were available only as abstracts. In all studies, suspicious lesions were first identified by conventional white-light endoscopy with or without chromoendoscopy and then further examined by CLE. Meta-analysis of the 15 studies found an overall sensitivity for CLE of 94% (95% confidence interval [CI], 88% to 97%) and a specificity of 95% (95% CI, 89% to 97%) compared with histology. Six studies included patients at increased risk of CRC who were undergoing surveillance endoscopy; 5 studies included patients with colorectal polyps and 4 studies included patients with inflammatory bowel disease. In a predefined subgroup analysis by indication for screening, the pooled sensitivity and specificity for surveillance studies were 94% (95% CI, 90% to 97%) and 98% (95% CI, 97% to 99%), respectively. For patients presenting with colorectal polyps, the pooled sensitivity of CLE was 91% (95% CI, 87% to 94%)
and the specificity was 85% (95% CI, 78% to 90%). For patients with inflammatory bowel disease, the pooled sensitivity was 83% (95% CI, 70% to 92%) and the specificity was 90% (95% CI, 87% to 93%). In other predefined subgroup analyses, the summary sensitivity and specificity were significantly higher (p<0.001) in studies of endoscopy-based CLE (97% and 99%, respectively) than in studies of probe-based CLE (87% and 82%, respectively). In addition, the summary sensitivity and specificity were significantly higher (p<0.01) with real-time CLE in which the macroscopic endoscopy findings were known (96% and 97%, respectively) than in blinded CLE in which recorded confocal images were subsequently analyzed without knowledge of macroscopic endoscopy findings (85% and 82%, respectively).

A systematic review by Dong et al (2013) included studies that compared the diagnostic accuracy of CLE with conventional endoscopy. Reviewers did not explicitly state that the reference standard was histologic biopsy, but this was the implied reference standard. Six studies were included in a meta-analysis. All were prospective, and at least five included blinded interpretation of CLE findings (in 1 study, it was unclear whether interpretation was blinded). In a pooled analysis of data from all 6 studies, the sensitivity was 81% (95% CI, 77% to 85%) and the specificity was 88% (95% CI, 85% to 90%). Reviewers also conducted a subgroup analysis by type of CLE used. When findings from the 2 studies on endoscopy-based CLE were pooled, the sensitivity was 82% (95% CI, 69% to 91%) and the specificity was 94% (95% CI, 91% to 96%). Two studies may not have been sufficient to obtain a reliable estimate of diagnostic accuracy. When findings from the 4 studies on probe-based endoscopy were pooled, the sensitivity was 81% (95% CI, 76% to 85%) and the specificity was 75% (95% CI, 69% to 81%).

A meta-analysis by Wanders et al (2013) searched for studies that reported on the diagnostic accuracy of several new technologies used to differentiate between colorectal neoplasms and non-neoplasms. To be selected, studies had to use the technology to differentiate between non-neoplastic and neoplastic lesions and to use histopathology as the reference standard. Blinding was not an inclusion criterion. Eleven eligible studies identified included an analysis of CLE. Meta-analysis yielded an estimated sensitivity of 93.3% (95% CI, 88.4% to 96.2%) and a specificity of 89.9% (95% CI, 81.8% to 94.6%). Meta-analysis limited to the 5 studies that used endoscopy-based CLE found a sensitivity of 94.8% (95% CI, 90.6% to 98.92%) and a specificity of 94.4% (95% CI, 90.7% to 99.2%). When findings of the 6 probe-based CLE studies were pooled, the sensitivity was 91.5% (95% CI, 86.0% to 97.0%) and specificity was 80.9 (95% CI, 69.4% to 92.4%).

**Cohort Studies**

A study by Xie et al (2011) in China included 116 consecutive patients who had polyps found during CLE (1 patient was excluded from the analysis). All patients had an indication for colonoscopy (19 were undergoing surveillance after polypectomy, 2 had a family history of CRC, 3 had inflammatory bowel disease, 91 were seeking a diagnosis). All patients first underwent white-light colonoscopy.
Endoscopy-based CLE was used on the first polyp identified during withdrawal of the endoscope (ie, 1 polyp per patient was analyzed). Real-time diagnosis of the polyp was performed based on criteria used at the study center (adapted from the Mainz classification system). The polyps were biopsied or removed, and a histopathologic diagnosis was determined. Real-time CLE diagnosis correctly identified 109 (95%) of 115 adenomas or hyperplastic polyps. Four adenomas were misdiagnosed by CLE as hyperplastic polyps (two were tubulous adenomas, two were tubulovillous adenomas) and 2 hyperplastic polyps were misdiagnosed as adenomas. The overall sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of CLE diagnosis were 93.9% (95% CI, 85.4% to 97.6%), 95.9% (95% CI, 86.2% to 98.9%), 96.9% (95% CI, 89% to 99%), and 94.8% (95% CI, 89.1% to 97.6%), respectively. For polyps less than 10 mm in size, CLE diagnosis had a sensitivity of 90.3% and a specificity of 95.7%; for polyps 10 mm or larger, sensitivity was 97.1% and specificity was 100%.

Buchner et al (2010) published findings on 75 patients who had a total of 119 polyps. Patients were eligible for participation if they were undergoing surveillance or screening colonoscopy or undergoing evaluation of known or suspected polyps identified by other imaging modalities or endoscopic resection of larger flat colorectal neoplasia. White-light colonoscopy was used as the primary screening method. When a suspicious lesion was identified, it was evaluated by virtual chromoendoscopy and a probe-based CLE system. After the imaging techniques, the appropriate intervention (ie, polypectomy, biopsy, endoscopic mucosal resection) was performed, and all resected specimens underwent histopathologic analysis by a pathologist blinded to CLE information. Confocal images of the 199 polyps were evaluated after all procedures were completed; the evaluator was blinded to the histology diagnosis and the endoscopic appearance of the lesion. Diagnosis of confocal images used modified Mainz criteria; polyps were classified as benign or neoplastic. According to histopathologic analysis, there were 38 hyperplastic polyps and 81 neoplastic lesions. CLE correctly identified 74 of 81 neoplastic polyps (sensitivity, 91%; 95% CI, 83% to 96%). In addition, CLE correctly identified 29 of 38 hyperplastic polyps (specificity, 76%; 95% CI, 60% to 89%). In contrast, virtual chromoendoscopy correctly identified 62 neoplastic polyps (sensitivity, 77%; 95% CI, 66% to 85%) and 27 hyperplastic polyps (specificity, 71%; 95% CI, 54% to 85%).

Another study from the same academic medical center as Buchner was published by Shadid et al (2012). The study compared 2 methods of analyzing CLE images: real-time diagnosis and blinded review of video images after endoscopy (known as “offline” diagnosis). The study included 74 patients with 154 colorectal lesions. Eligibility criteria were similar to the Buchner study (previously discussed)¼selected patients were undergoing surveillance or screening colonoscopy. Patients had white-light colonoscopy, and identified polyps were also evaluated with virtual chromoendoscopy and probe-based CLE. At examination, an endoscopist made a real-time diagnosis based on CLE images. Based on that diagnosis, the patient underwent polypectomy, biopsy, or endoscopic mucosal resection, and histopathologic analysis was done on the specimens. CLE images were deidentified and reviewed offline by the same endoscopist at
least 1 month later. At the second review, the endoscopist was blinded to the endoscopic and histopathologic diagnosis. Of the 154 polyps, 74 were found by histopathologic analysis to be non-neoplastic, and 80 were neoplastic (63 tubular adenomas, 12 tubulovillous adenomas, 3 mixed hyperplastic-adenoma polyps, 2 adenocarcinomas). Overall, there was no statistically significant difference in the diagnostic accuracy between real-time CLE diagnosis and blinded offline CLE diagnosis (ie, confidence intervals overlapped). The sensitivity, specificity, PPV, and NPV for real-time CLE diagnosis were 81%, 76%, 87%, and 79%, respectively. For offline diagnosis, these values were 88%, 77%, 81%, and 85%, respectively. For larger polyps, there was a nonsignificant trend in favor of better diagnostic accuracy with real-time compared with offline CLE. However, in the subgroup of 107 smaller polyps (<10 mm in size), the accuracy of real-time CLE was significantly less than offline CLE. For smaller polyps, the sensitivity, specificity, PPV and NPV of real-time CLE were 71%, 83%, 78%, and 78%, respectively; for offline CLE, they were 86%, 78%, 76%, and 87%, respectively.

A study by Hlavaty et al (2011) included patients with ulcerative colitis or Crohn disease. Thirty patients were examined with standard white-light colonoscopy, chromoendoscopy, and an endoscopy-based CLE system. Another 15 patients were examined only with standard colonoscopy. All lesions identified by white-light colonoscopy or chromoendoscopy were examined using CLE to identify neoplasia using the Mainz classification system. Suspicious lesions were biopsied, and random biopsies were taken from 4 quadrants every 10 cm per the standard surveillance colonoscopy protocol. All specimens underwent histologic analysis by a gastrointestinal pathologist blinded to CLE diagnosis. Diagnostic accuracy of CLE was calculated for examinable lesions only. Compared with histologic diagnosis, the sensitivity of CLE for diagnosing low-grade and high-grade intraepithelial neoplasia was 100%, specificity was 98.4%, PPV was 66.7%, and NPV was 100%. However, whereas CLE was able to examine 28 (93%) of 30 flat lesions, it could examine only 40 (57%) of 70 protruding polyps. Moreover, 6 (60%) of 10 dysplastic lesions, including 3 of 5 low-grade and high-grade intraepithelial neoplasms, were not evaluable by CLE. It is also worth noting that the diagnostic accuracy of chromoendoscopy (see evidence review 2.01.84) is similar to that of CLE. The sensitivity, specificity, PPV, and NPV of chromoendoscopy were 100%, 97.9%, 75%, and 100%, respectively.

**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.
In patients at average risk of CRC, no RCTs or nonrandomized comparative studies were identified that evaluated the impact of CLE on subsequent development of CRC or on CRC mortality.

**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.

It is not clear that the diagnostic performance of this technology is sufficient to obviate the need for biopsy of identified polyp lesions. Thus, there is insufficient evidence to support a chain of evidence to demonstrate an improvement in net health outcome.

**Section Summary: Colorectal Lesions**
Multiple studies have compared the accuracy of CLE with the histopathology for diagnosing colorectal lesions. In 3 published systematic reviews, pooled estimates of overall sensitivity of CLE ranged from 81% to 94%, and pooled estimates of the specificity ranged from 88% to 95%. Although the reported diagnostic accuracy tended to be relatively high, it is unclear whether the accuracy is high enough to replace biopsy/polypectomy and histologic analysis. Moreover, there are no controlled studies on the impact of using CLE on CRC incidence or mortality, and the available evidence is insufficient to support a chain of evidence.

**Barrett Esophagus**
This section addresses whether CLE can distinguish BE without dysplasia from BE with low- and high-grade dysplasia (HGD) and/or lead to fewer biopsies of benign tissue compared with surveillance with random biopsies. The ideal study to answer this question would include an unselected clinical population of patients with BE presenting for surveillance and would randomized patients to CLE with targeted biopsy or a standard biopsy protocol without CLE.

**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).

**Systematic Reviews**
Xiong et al (2016) published a meta-analysis of prospective studies evaluating the diagnostic accuracy of CLE in patients with BE, using histopathologic analysis as the criterion standard. Studies were not required to compare CLE with standard 4-quadrant biopsy. Fourteen studies were included. In a pooled analysis 7 studies (n=473 patients) reporting a per-patient analysis, the sensitivity of CLE for detecting neoplasia was 89% (95% CI, 82% to 94%) and the specificity was 83% (95% CI, 78% to 86%). The pooled positive and negative likelihood ratios were 6.53 (95% CI, 3.12 to 13.4) and 0.17 (95% CI, 0.11 to 0.29), respectively. Reviewers did not report PPV or NPV. Moreover, they provided estimates of pretest probability to aid in the interpretation of the likelihood ratios (ie, to evaluate a
person’s risk level before and after getting the test). Sensitivity and specificity were similar to those calculated in the Gupta systematic review (discussed below).

Gupta et al (2014) published a systematic review and meta-analysis of prospective studies comparing the accuracy of CLE plus targeted biopsy with standard 4-quadrant biopsy in patients with BE.13 Reviewers noted that, according to the Preservation and Incorporation of Valuable Endoscopic Innovation Initiative of the American Society of Gastrointestinal Endoscopy, in order to replace the standard Seattle protocol, an alternative approach would need to have a per-patient sensitivity of at least 90%, specificity of at least 80%, and NPV of at least 98% for detecting HGD or esophageal adenocarcinoma compared with the current protocol.

Eight studies published through May 2014 met inclusion criteria; one was a parallel-group RCT, and one was a randomized crossover study. The other six were single- or double-blind nonrandomized comparative studies. Seven studies had data suitable for pooling on a per-lesion basis; together they included 345 patients and 3080 lesions. In a meta-analysis of the diagnosis of HGD or esophageal adenocarcinoma, the pooled sensitivity was 68% (95% CI, 64% to 73%) and pooled specificity was 88% (95% CI, 87% to 89%). Four studies were included in the per-patient meta-analysis. The pooled sensitivity and specificity were 86% (95% CI, 74% to 96%) and 83% (95% CI, 77% to 88%), respectively. NPV (calculated using the sensitivity, specificity, and overall prevalence) was 96%. Thus, according to the criteria in the Preservation and Incorporation of Valuable Endoscopic Innovation Initiative, the diagnostic accuracy of CLE in the studies evaluated was not sufficiently high for this technique to replace the standard Seattle protocol. HGD and esophageal adenocarcinoma rates were much higher in the studies included in the meta-analysis than is generally seen in clinical practice and therefore diagnostic accuracy results should be interpreted cautiously.

**Randomized Controlled Trials**

Canto et al (2014) reported on a single-blind, multicenter trial conducted at academic centers with experienced endoscopists.14 It included consecutive patients undergoing endoscopy for routine BE surveillance or for suspected or known neoplasia. Patients were randomized to high-definition white-light endoscopy with random biopsy (n=98) or white-light endoscopy with endoscopy-based CLE and targeted biopsy (n=94). In the white-light endoscopy-only group, 4-quadrant random biopsies were taken every 1 to 2 cm over the entire length of the BE for patients undergoing surveillance and every 1 cm for patients with suspected neoplasia. In the CLE group, biopsy specimens were obtained only when there was CLE evidence of neoplasia. Final pathologic diagnosis was the reference standard. A per-patient analysis of diagnostic accuracy for diagnosing BE-related neoplasia found a sensitivity of 40% with white-light endoscopy only and 95% with white-light endoscopy plus CLE. Specificity was 98% with white-light endoscopy only and 92% with white-light endoscopy plus CLE. When the analysis was done on a per-biopsy specimen basis and when CLE was added, sensitivity was substantially higher, and specificity was slightly lower. The median number of biopsies per patient was significantly higher in the white-light endoscopy group (n=4) compared with the CLE group (n=2; p<0.001).
The investigators analyzed the number of cases in which CLE resulted in a different diagnosis. Thirty-two (34%) of 94 patients in the white-light plus CLE group had a correct change in dysplasia grade after CLE compared with initial endoscopic findings. Six (19%) of the 32 patients had lesions, and the remaining 26 did not. In 21 of the 26 patients without lesions, CLE changed the plan from biopsy to no biopsy. The remaining 62 (65%) of 94 patients in the white-light endoscopy plus CLE group had concordant diagnoses with both techniques. Because the trial was conducted at academic centers and used endoscopy-based CLE, findings may not be generalizable to other clinical settings or to probe-based CLE.

Sharma et al (2011) published an international, multicenter RCT that included 122 consecutive patients presenting for surveillance of BE or endoscopic treatment of HGD or early carcinoma. Patients were randomized to both standard white-light endoscopy and narrow-band imaging. Following these 2 examinations, done in a blinded fashion, the location of lesions was unblinded and, subsequently, all patients underwent probe-based CLE. All examinations involved a presumptive diagnosis of suspicious lesions. Also, in both groups, after all evaluations were performed, all suspicious lesions were biopsied, as well as random locations (4 quadrants every 2 cm). The histopathologic analysis was the reference standard. Twenty-one patients were excluded from the analysis. Of the remaining 101 patients, 66 (65%) were found on histopathologic analysis to have no dysplasia, 4 (4%) had low-grade dysplasia, 6 (6%) had HGD, and 25 (25%) had early carcinoma. Sensitivity of CLE plus white-light endoscopy for detecting HGD or early carcinoma was 68.3% (95% CI, 60.0% to 76.7%), which was significantly higher than white-light endoscopy alone (34.2%; 95% CI, 25.7% to 42.7%; p=0.002). However, specificity of CLE plus white-light endoscopy was significantly lower (87.8%; 95% CI, 85.5% to 90.1%) than white-light endoscopy alone (92.7%; 95% CI, 90.8% to 94.6%; p<0.001). For white-light endoscopy alone, the PPV was 42.7% (95% CI, 32.8% to 52.6%) and NPV was 89.8% (95% CI, 87.7% to 92.0%). For white-light endoscopy with probe-based CLE, the PPV was 47.1% (95% CI, 39.7% to 54.5%) and NPV was 94.6% (95% CI, 92.9% to 96.2%). White-light endoscopy alone missed 79 (66%) of 120 areas with HGD or early carcinoma, and white-light endoscopy plus CLE missed 38 (32%) areas. On a per-patient basis, 31 patients were diagnosed with HGD or early carcinoma. White-light endoscopy alone failed to identify 4 of these patients (sensitivity, 87%), whereas white-light endoscopy plus CLE failed to identify 2 patients (sensitivity, 93.5%).

A single-center crossover RCT was published by Dunbar et al (2009). Forty-six patients with BE were enrolled, and 39 (95%) completed the study protocol. Of these, 23 were undergoing BE surveillance, and 16 had BE with suspected neoplasia. All patients received endoscopy-based CLE and standard endoscopy, in random order. One endoscopist performed all CLE procedures, and another endoscopist performed all standard endoscopy procedures; endoscopists were blinded to the finding of the other procedure. During the standard endoscopy procedure, biopsies were taken of any discrete lesions followed by 4-quadrant
random biopsy (every 1 cm for suspected neoplasia, every 2 cm for BE surveillance). During the CLE procedure, only lesions suspicious of neoplasia were biopsied. Endoscopists interpreted CLE images using the Confocal Barrett’s Classification system, developed in a previous research study. Histopathologic analysis was the reference standard. Among the 16 study completers with suspected high-risk dysplasia, there were significantly fewer biopsies per patient with CLE (mean, 9.8 biopsies per patient) than with standard endoscopy (mean, 23.9 biopsies per patient; p=0.002). Although there were fewer biopsies, the mean number of biopsy specimens showing HGD or cancer was similar in the 2 groups (3.1 during CLE vs 3.7 during standard endoscopy). The diagnostic yield for neoplasia was 33.7% with CLE and 17.2% with standard endoscopy. None of the 23 patients undergoing BE for surveillance had HGD or cancer. The mean number of mucosal specimens obtained for patients in this group was 12.6 with white-light endoscopy and 1.7 with CLE (p<0.001).

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 CLE to distinguish BE without dysplasia from BE with low- grade dysplasia or HGD 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 CLE has not been established for this indication, a chain of evidence cannot be constructed.

Section Summary: Barrett Esophagus
Several RCTs and nonrandomized comparative studies have evaluated CLE for detecting dysplasia and neoplasia in patients with BE. A 2014 meta-analysis found that the pooled sensitivity, specificity, and NPV of available studies were not sufficiently high to replace the standard Seattle protocol, according to criteria adopted by the American Society of Gastrointestinal Endoscopy. There are limited data comparing standard protocols using random biopsies with protocols using CLE and targeted biopsies; therefore, data are inconclusive on the potential for CLE to reduce the number of biopsies in patients with BE undergoing surveillance without compromising diagnostic accuracy. Moreover, studies do not appear to have used a consistent approach to classifying lesions as dysplastic using CLE.
Adequacy of Endoscopic Treatment of Gastrointestinal Lesions
This section addresses whether the use of CLE improves the detection of residual disease compared with conventional techniques (ie, white-light endoscopy).

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).

Systematic Reviews
Ypsilantis et al (2015) published a systematic review that included retrospective and prospective studies reporting the diagnostic accuracy of CLE for the detection of residual disease after endoscopic mucosal resection of gastrointestinal lesions. After examining full-text articles, 3 studies (1 RCT, 2 prospective, nonrandomized comparative studies) met the eligibility criteria. Studies included patients with BE, gastric neoplasia, and colorectal neoplasia. There was significant heterogeneity among studies. In a per-lesion meta-analysis, pooled sensitivity of CLE for detecting neoplasia was 91% (95% CI, 83% to 96%) and pooled specificity was 69% (95% CI, 61% to 76%). Based on the small number of studies and heterogeneity among studies, reviewers concluded that the evidence on the utility of CLE in assessing the adequacy of endoscopic mucosal resection was weak.

Randomized Controlled Trials
The single RCT in the Ypsilantis review was published by Wallace et al (2012). This multicenter trial included patients with BE who were undergoing ablation. After an initial attempt at ablation, patients were randomized to follow-up with high-definition white-light endoscopy or high-definition white-light endoscopy plus CLE. The primary outcome was the proportion of optimally treated patients, defined as those with no evidence of disease at follow-up, and those with residual disease who were identified and treated. Trial enrollment was halted after an interim analysis showed no difference between groups and higher than expected residual BE in both arms. Among the 119 patients enrolled at the interim analysis, 15 (26%) of 57 in the high-definition white-light endoscopy group and 17 (27%) of 62 in the high-definition white-light endoscopy plus CLE group were optimally treated; the difference was not statistically significant. Moreover, other outcomes were similar in the 2 groups.

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 CLE to improve the treatment assessment of gastrointestinal lesions 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 CLE has not been established for this indication, a chain of evidence cannot be constructed.

**Section Summary: Adequacy of Endoscopic Treatment of Gastrointestinal Lesions**
There is insufficient evidence to demonstrate that CLE improves on standard practice for assessing the adequacy of endoscopic treatment of gastrointestinal lesions. The single RCT on this topic was stopped early because an interim analysis found that CLE did not improve on high-definition white-light endoscopy.

**Other Potential Applications of CLE**
Studies have evaluated CLE for diagnosing a variety of conditions, including lung cancer,19,20,21, bladder cancer,22,23, head and neck cancer,24,25, esophageal cancer,26,27, atrophic gastritis,28, gastric cancer,29,30, pancreatic cysts,31,32, breast surgery,33, and biliary strictures.34. These studies, mostly pilot feasibility studies and diagnostic accuracy studies, are insufficient to determine the accuracy of CLE and its potential role in clinical care for patients with these conditions.

**Summary of Evidence**
For individuals who have suspected or known colorectal lesions who receive CLE as an adjunct to colonoscopy, the evidence includes multiple diagnostic accuracy studies. Relevant outcomes are overall survival, disease-specific survival, test validity, and resource utilization. While the reported sensitivity and specificity in these studies are high, it is uncertain whether the accuracy is sufficiently high to replace biopsy/polypectomy and histopathologic analysis. Moreover, issues remain concerning the use of this technology in clinical practice (eg, the learning curve, interpretation of lesions). The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who have Barrett esophagus who are undergoing surveillance who receive CLE with targeted biopsy, the evidence includes several RCTs and a meta-analysis. Relevant outcomes are overall survival, disease-specific survival, test validity, and resource utilization. Evidence from RCTs has suggested CLE is more sensitive than standard endoscopy for identifying areas of dysplasia. However, a 2014 meta-analysis found that the pooled sensitivity, specificity, and negative predictive value of available studies were not sufficiently high to replace the standard surveillance protocol. National guidelines continue to recommend 4-quadrant random biopsies for patients with Barrett esophagus undergoing
surveillance. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who have gastrointestinal lesions and have had endoscopic treatment who receive CLE to assess adequacy of endoscopic treatment, the evidence includes an RCT and a systematic review. Relevant outcomes are overall survival, disease-specific survival, test validity, and resource utilization. The single RCT, which compared high-definition white-light endoscopy with high-definition white-light endoscopy plus CLE, was stopped early because an interim analysis did not find a between-group difference in outcomes. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who have a suspicion of a condition diagnosed by identification and biopsy of lesions (eg, lung, bladder, or gastric cancer) who receive CLE, the evidence includes a small number of diagnostic accuracy studies. Relevant outcomes are overall survival, disease-specific survival, test validity, and resource utilization. There is limited evidence on the diagnostic accuracy of CLE for these other indications. The evidence is insufficient to determine the effects of the technology on health outcomes.

SUPPLEMENTAL INFORMATION

Practice Guidelines and Position Statements

American Society for Gastrointestinal Endoscopy
In 2006 (reaffirmed in 2011), the American Society for Gastrointestinal Endoscopy published guidelines on the role of endoscopy in the surveillance of premalignant conditions of the upper gastrointestinal (GI) tract. 35,36. Regarding the use of confocal endoscopy as an adjunct to white-light endoscopy, the guidelines stated that this technique is "still in development." The guidelines also included the following statements on surveillance of patients with Barrett esophagus:

2. "The cost effectiveness of surveillance in patients without dysplasia is controversial. Surveillance endoscopy is appropriate for patients fit to undergo therapy, should endoscopic/histologic findings dictate. For patients with established Barrett's esophagus of any length and with no dysplasia, after 2 consecutive examinations within 1 year, an acceptable interval for additional surveillance is every 3 years."

3. "Patients with high-grade dysplasia are at significant risk for prevalent or incident cancer. Patients who are surgical candidates may elect to have definitive therapy. Patients who elect surveillance endoscopy should undergo follow-up every 3 months for at least 1 year, with multiple large capacity biopsy specimens obtained at 1 cm intervals. After 1 year of no cancer detection, the interval of surveillance may be lengthened if there are no dysplastic changes on 2 subsequent endoscopies performed at 3-month intervals. High-grade dysplasia should be confirmed by an expert GI pathologist."
4. “Surveillance in patients with low-grade dysplasia is recommended. The significance of low-grade dysplasia as a risk factor for cancer remains poorly defined; therefore, the optimal interval and biopsy protocol has not been established. A follow-up EGD [screening esophagogastrroduodenoscopy] (i.e., at 6 months) should be performed with concentrated biopsies in the area of dysplasia. If low-grade dysplasia is confirmed, then one possible management scheme would be surveillance at 12 months and yearly thereafter as long as dysplasia persists.”

The Society published a technology status evaluation on confocal laser endomicroscopy (CLE) in 2014. It concluded that CLE is an emerging technology with the potential to improve patient care. However, before it can be widely accepted, further studies are needed in the following areas:

1. “[T]he applicability and practicality of CLE, especially in community settings [because the research has been done] primarily in academic centers.”
2. The “learning curve of CLE image interpretation … and additional time needed to perform the procedure....”
3. The clinical efficacy of the technology … compared to other available advanced imaging technologies....”
4. Improvements in CLE imaging and image interpretation....”

American Gastroenterological Association
In 2011, the American Gastroenterological Association published a position statement on the management of Barrett esophagus. The statement included the following recommendations on endoscopic surveillance of Barrett esophagus (see Table 1).

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>LOR</th>
<th>QOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>“The guideline developers suggest that endoscopic surveillance be performed in patients with Barrett’s esophagus.”</td>
<td>Weak</td>
<td>Moderate</td>
</tr>
<tr>
<td>“The guideline developers suggest the following surveillance intervals:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• No dysplasia: 3-5 years&lt;br&gt;   • Low-grade dysplasia: 6-12 months&lt;br&gt;   • High-grade dysplasia in the absence of eradication therapy: 3 months”</td>
<td>Weak</td>
<td>Low</td>
</tr>
<tr>
<td>“For patients with Barrett’s esophagus who are undergoing surveillance, the guideline developers recommend:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Endoscopic evaluation be performed using white-light endoscopy.</td>
<td>Strong</td>
<td>Moderate</td>
</tr>
<tr>
<td>• 4-quadrant biopsy specimens be taken every 2 cm.</td>
<td>Strong</td>
<td>Moderate</td>
</tr>
<tr>
<td>• Specific biopsy specimens of any mucosal irregularities be submitted separately to the pathologist.</td>
<td>Strong</td>
<td>Moderate</td>
</tr>
<tr>
<td>• 4-quadrant biopsy specimens be obtained every 1 cm in patients with known or suspected dysplasia.”</td>
<td>Strong</td>
<td>Moderate</td>
</tr>
<tr>
<td>The guideline developers suggest against requiring chromoendoscopy or advanced imaging techniques for the routine surveillance of patients with Barrett’s esophagus at this time.”</td>
<td>Weak</td>
<td>Low</td>
</tr>
</tbody>
</table>

LOR: level of recommendation; QOE: quality of evidence.
U.S. Preventive Services Task Force Recommendations
The U.S. Preventive Services Task Force recommendations on colorectal cancer screening do not mention CLE.  

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
Currently ongoing and unpublished trials that might influence this review are listed in Table 2.

Table 2. Summary of Key Trials

<table>
<thead>
<tr>
<th>NCT No.</th>
<th>Trial Name</th>
<th>Planned Enrollment</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ongoing</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NCT02552004</td>
<td>Assessment of Intraoperative Probe-based Confocal Laser Endomicroscopy in Digestive and Endocrine Surgery: a Pilot Study (Pilot pCLE)</td>
<td>30</td>
<td>Dec 2018</td>
</tr>
<tr>
<td>NCT02922049</td>
<td>Probe-Based Confocal Laser Microendoscopy in Accurate Histopathologic Diagnosis of Neoplastic Gastrointestinal Lesion</td>
<td>80</td>
<td>Apr 2020</td>
</tr>
<tr>
<td><strong>Unpublished</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NCT03013894</td>
<td>Feasibility of Confocal Laser Microendoscopy in Bladder Cancer Diagnosis</td>
<td>60</td>
<td>Oct 2017 (completed)</td>
</tr>
<tr>
<td>NCT02672774</td>
<td>Study of Minimally Invasive Endoscopic Imaging Methods for the Evaluation of Neoangiogenesis in Gastrointestinal Cancers</td>
<td>50</td>
<td>Sep 2017 (unknown)</td>
</tr>
<tr>
<td>NCT02799420</td>
<td>Role of Probe-based Confocal Laser Endomicroscopy Targeted Biopsy in the Molecular Study of Undifferentiated Gastric Cancer</td>
<td>74</td>
<td>Sep 2017 (completed)</td>
</tr>
<tr>
<td>NCT02930616</td>
<td>A Comparison of pCLE Based Targeted Biopsy and WLE Based Standard Biopsy in Staging the Operative Link on Gastric Intestinal Metaplasia (OLGIM): A Randomized Cross-over Study</td>
<td>40</td>
<td>Jun 2017</td>
</tr>
<tr>
<td>NCT01887509</td>
<td>Evaluation of Rectal Tumor Margin Using Confocal Endomicroscopy and Comparison to Histopathology</td>
<td>21</td>
<td>Oct 2016 (terminated)</td>
</tr>
<tr>
<td>NCT02632682</td>
<td>Real-Time Diagnosis of Barrett’s Esophagus: Comparing Confocal Laser Endomicroscopy with Conventional Histology for the Identification of Specialized Intestinal Metaplasia</td>
<td>172</td>
<td>Sep 2016 (completed)</td>
</tr>
<tr>
<td>NCT No.</td>
<td>Trial Name</td>
<td>Planned Enrollment</td>
<td>Completion Date</td>
</tr>
<tr>
<td>-------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>NCT01931579</td>
<td>Assessment of the Probe-Based Confocal Laser Endomicroscopy for In-vivo Diagnosis of Peripheral Lung Nodules and Masses (NODIVEM Study)</td>
<td>120</td>
<td>Jun 2016 (completed)</td>
</tr>
<tr>
<td>NCT02515721</td>
<td>PCLE for the Diagnosis of Gastric Intestinal Metaplasia, Intraepithelial Neoplasia, and Carcinoma</td>
<td>242</td>
<td>Aug 2015 (unknown)</td>
</tr>
</tbody>
</table>

NCT: national clinical trial.

REFERENCES


Billing Coding/Physician Documentation Information

0397T Endoscopic retrograde cholangiopancreatography (ERCP), with optical endomicroscopy (List separately in addition to code for primary procedure) (new code 1/1/2016)

43206 Esophagoscopy, flexible, transoral; with optical endomicroscopy

43252 Esophagogastroduodenoscopy, flexible, transoral; with optical endomicroscopy

88375 Optical endomicroscopic image(s), interpretation and report, real-time or referred, each endoscopic session

ICD10 Codes

K22.70- Barrett's esophagus code range

K22.719

Z13.810 Encounter for screening for upper gastrointestinal disorder

Z13.811 Encounter for screening for lower gastrointestinal disorder

Z13.83 Encounter for screening for respiratory disorder NEC

The interpretation and report of optical endomicroscopic image(s) would be reported with the following code:

88375: Optical endomicroscopic image(s), interpretation and report, real-time or referred, each endoscopic session.

Code 88375 cannot be reported in conjunction codes 43206 and 43252.

Additional Policy Key Words

N/A

Policy Implementation/Update Information

3/1/13 New policy; considered investigational.

9/1/13 No policy statement changes.

3/1/14 No policy statement changes.


3/1/15 No policy statement changes.

9/1/15 No policy statement changes.

3/1/16 Added Cat III CPT code. No policy statement changes.

9/1/16 No policy statement changes.

3/1/17 No policy statement changes.
9/1/17  No policy statement changes.
3/1/18  No policy statement changes.
9/1/18  No policy statement changes.
3/1/19  No policy statement changes.

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