Genetic Testing for Lynch Syndrome and Inherited Intestinal Polyposis Syndromes

Policy Number: 2.04.08  Last Review: 1/2014

Policy
Blue Cross and Blue Shield of Kansas City (Blue KC) will provide coverage for genetic testing for Lynch Syndrome and inherited intestinal polyposis syndromes when it is determined to be medically necessary because the criteria shown below are met.

Note: Genetic testing may be excluded in some contracts. Verify benefits prior to review of Medical Necessity.

When Policy Topic is covered
Genetic testing for APC gene mutations may be considered medically necessary in the following patients:
- At-risk relatives (see Considerations) of patients with FAP and/or a known APC mutation.
- Patients with a differential diagnosis of attenuated FAP vs. MYH-associated polyposis vs. Lynch syndrome. Whether testing begins with APC mutations or screening for MMR mutations depends upon clinical presentation.

Genetic testing for MUTYH gene mutations may be considered medically necessary in the following patients:
- Patients with a differential diagnosis of attenuated FAP vs. MUTYH-associated polyposis vs. Lynch syndrome and a negative result for APC gene mutations. Family history of no parents or children with FAP is consistent with MUTYH-associated polyposis (autosomal recessive).

Genetic testing for MMR gene mutations is considered medically necessary in the following patients:
- Patients with colorectal cancer, for the diagnosis of Lynch syndrome (See Considerations).
- Patients with endometrial cancer and one first-degree relative diagnosed with a Lynch-associated cancer (see Considerations), for the diagnosis of Lynch syndrome.
- At-risk relatives (see Considerations) of patients with Lynch syndrome with a known MMR mutation.
- Patients with a differential diagnosis of attenuated FAP vs. MUTYH-associated polyposis vs. Lynch syndrome. Whether testing begins with APC mutations or screening for MMR mutations depends upon clinical presentation.
- Patients without colorectal cancer but with a family history meeting the Amsterdam or Revised Bethesda criteria, when no affected family members have been tested for MMR mutations.

Genetic testing for EPCAM mutations is considered medically necessary when any one of the following 3 major criteria (solid bullets) are met:
- Patients with colorectal cancer, for the diagnosis of Lynch syndrome (see Considerations Section) when:
  - Tumor tissue shows a high level of microsatellite instability
  - Tumor tissue shows lack of MSH2 expression by immunohistochemistry
  - Patient is negative for a germline mutation in MSH2
▪ At-risk relatives (see Considerations) of patients with Lynch syndrome with a known EPCAM mutation.
▪ Patients without colorectal cancer but with a family history meeting the Amsterdam or Revised Bethesda criteria, when no affected family members have been tested for MMR mutations, and when sequencing for MMR mutations is negative.

Genetic testing for *BRAF* V600E or *MLH1* promoter methylation may be considered medically necessary to exclude a diagnosis of Lynch syndrome when MLH1 protein is not expressed in a colorectal cancer on immunohistochemical (IHC) analysis.

Pre- and post-test genetic counseling may be considered medically necessary as an adjunct to the genetic testing itself.

**When Policy Topic is not covered**
Genetic testing for *APC* gene mutations is not medically necessary for colorectal cancer patients with classical FAP for confirmation of the FAP diagnosis.

Genetic testing for all other gene mutations for Lynch syndrome or colorectal cancer is considered investigational.

**Considerations**
Due to the high lifetime risk of cancer of the majority of the genetic syndromes discussed in this policy, “at-risk relatives” primarily refers to first-degree relatives. However, some judgment must be allowed, for example, in the case of a small family pedigree, when extended family members may need to be included in the testing strategy.

It is recommended that, when possible, initial genetic testing for FAP or Lynch syndrome be performed in an affected family member so that testing in unaffected family members can focus on the mutation found in the affected family member. (See Benefit Application section.)

In many cases, genetic testing for *MUTYH* gene mutations should first target the specific mutations Y165C and G382D, which account for more than 80% of mutations in Caucasian populations, and subsequently proceed to sequencing only as necessary. In other ethnic populations, however, proceeding directly to sequencing is appropriate.

For patients with colorectal cancer being evaluated for Lynch syndrome, either the microsatellite instability (MSI) test, or the immunohistochemistry (IHC) test with or without *BRAF* gene mutation testing, should be used as an initial evaluation of tumor tissue prior to MMR gene analysis. Both tests are not necessary. Consideration of proceeding to MMR gene sequencing would depend on results of MSI or IHC testing. IHC testing in particular may help direct which MMR gene likely contains a mutation, if any, and may also provide some additional information if MMR genetic testing is inconclusive.

When indicated, genetic sequencing for MMR gene mutations should begin with *MLH1* and *MSH2* genes unless otherwise directed by the results of IHC testing. Standard sequencing methods will not detect large deletions or duplications; when MMR gene mutations are expected based on IHC or MSI studies but none are found by standard sequencing, additional testing for large deletions or duplications is appropriate.

Several Clinical Laboratory Improvement Amendments (CLIA)-licensed clinical laboratories offer MMR gene mutation testing for Lynch syndrome. For example, the GeneTests website, available online at: (http://www.ncbi.nlm.nih.gov/sites/GeneTests/lab/clinical_disease_id/2622?db=genetests ) lists 17 U.S.-located laboratories that offer this service. In at least one laboratory, Lynch syndrome mutation testing is packaged under one copyrighted name. The COLARIS® test from Myriad Genetic Laboratories includes sequence analysis of *MLH1, MSH2, MSH6* and *PMS2*; large rearrangement
analysis for MLH1 MSH2, PMS2, and MSH6 large deletions/duplications; and analysis for large deletions in the EPCAM gene near MSH2. Note that there may be 2 versions of this test, the COLARIS (excludes PMS2 testing) and COLARIS Update (includes PMS2 testing). Testing is likely done in stages, beginning with the most common types of mutations. Individualized testing (e.g., targeted testing for a family mutation) can also be requested.

Similarly, GeneTests lists 15 U.S.-based CLIA-licensed clinical laboratories that provide APC mutation testing and 14 that provide MUTYH mutation testing. The COLARIS® AP test from Myriad Genetic Laboratories includes DNA sequencing analysis of the APC and MUTYH genes, as well as analysis of large rearrangements in the APC gene that are not detected by DNA sequencing.

Amsterdam II Clinical Criteria (all criteria must be fulfilled). (14) The Amsterdam criteria are the most stringent criteria for defining families at high risk for Lynch Syndrome:

- 3 or more relatives with an associated cancer (colorectal cancer, or cancer of the endometrium, small intestine, ureter or renal pelvis);
- 1 should be a first-degree relative of the other 2;
- 2 or more successive generations affected;
- 1 or more relatives diagnosed before the age of 50 years;
- Familial adenomatous polyposis (FAP) should be excluded in cases of colorectal carcinoma;
- Tumors should be verified by pathologic examination.
- Modifications:
  - EITHER: very small families, which cannot be further expanded, can be considered to have HNPCC with only 2 colorectal cancers in first-degree relatives if at least 2 generations have the cancer and at least one case of colorectal cancer was diagnosed by the age of 55 years;
  - OR: in families with 2 first-degree relatives affected by colorectal cancer, the presence of a third relative with an unusual early-onset neoplasm or endometrial cancer is sufficient.

Revised Bethesda Guidelines (fulfillment of any criterion meets guidelines). (6) The Bethesda guidelines are less strict than the Amsterdam criteria and are intended to increase the sensitivity of identifying at-risk families. The Bethesda guidelines are also felt to be more useful in identifying which patients with colorectal cancer should have their tumors tested for microsatellite instability and/or immunohistochemistry:

- Colorectal carcinoma (CRC) diagnosed in a patient who is less than 50 years-old;
- Presence of synchronous (at the same time) or metachronous (at another time i.e.- a recurrence of) CRC or other Lynch syndrome-associated tumors, regardless of age;
- CRC with high microsatellite instability histology diagnosed in a patient less than 60-years old;
- CRC diagnosed in one or more first-degree relatives with a Lynch syndrome-associated tumor, with one of the cancers being diagnosed at younger than 50 years of age;
- CRC diagnosed with one or more first-degree relatives with an HNPCC-related tumor (colorectal, endometrial, stomach, ovarian, pancreas, bladder, ureter and renal pelvis, biliary tract, brain [usually glioblastoma as seen in Turcot syndrome], sebaceous bland adenomas and keratoacanthomas in Muir-Torre syndrome, and carcinoma of the small bowel), with one of the cancers being diagnosed at younger than age 50 years, OR CRC diagnosed in 2 or more first- or second-degree relatives with HNPCC-related tumor, regardless of age. (15)

**Description of Procedure or Service**

Genetic testing is available for both affected individuals, as well as those at risk, for various types of hereditary colon cancer. This policy describes genetic testing for familial adenomatous polyposis (FAP), Lynch syndrome (formerly known as HNPCC), as well as MYH-associated polyposis.

There are currently 2 well-defined types of hereditary colorectal cancer, familial adenomatous polyposis (FAP) and Lynch syndrome (formerly, hereditary nonpolyposis colorectal cancer or HNPCC). Lynch syndrome has been implicated in some endometrial cancers as well.

*Familial adenomatous polyposis and associated variants*
FAP typically develops by age 16 years and can be identified by the appearance of hundreds to thousands of characteristic, precancerous colon polyps. If left untreated, all affected individuals will go on to develop colorectal cancer. The mean age of colon cancer diagnosis in untreated individuals is 39 years. FAP accounts for about 1% of colorectal cancer and may also be associated with osteomas of the jaw, skull, and limbs; sebaceous cysts; and pigmented spots on the retina referred to as congenital hypertrophy of the retinal pigment epithelium (CHRPE). FAP associated with these collective extraintestinal manifestations is sometimes referred to as Gardner syndrome. FAP may also be associated with CNS tumors, referred to as Turcot syndrome.

Germline mutations in the adenomatous polyposis coli (APC) gene, located on chromosome 5, are responsible for FAP and are inherited in an autosomal dominant manner. Mutations in the APC gene result in altered protein length in about 80% to 85% of cases of FAP. A specific APC gene mutation (I1307K) has been found in subjects of Ashkenazi Jewish descent that may explain a portion of the familial colorectal cancer occurring in this population.

A subset of FAP patients may have attenuated FAP (AFAP), typically characterized by fewer than 100 cumulative colorectal adenomas occurring later in life than in classical FAP, colorectal cancer occurring at an average age of 50-55 years, but a high lifetime risk of colorectal cancer of about 70% by age 80. The risk of extra-intestinal cancer is lower compared to classical FAP, but still high at an estimated cumulative lifetime risk of 38% compared to the general population. (1) Only 30% or fewer of AFAP patients have APC mutations; some of these patients instead have mutations in the MUTYH (formerly MYH) gene and are then diagnosed with MUTYH-associated polyposis (MAP). MAP occurs with a frequency approximately equal to FAP, with some variability among prevalence estimates for both. While clinical features of MAP are similar to FAP or AFAP, a strong multigenerational family history of polyposis is absent. Biallelic MUTYH mutations are associated with a cumulative colorectal cancer risk of about 80% by age 70, whereas monoallelic MUTYH mutation-associated risk of colorectal cancer appears to be relatively minimal, although still under debate. (2) Thus, inheritance for high-risk colorectal cancer predisposition is autosomal recessive in contrast to FAP. When relatively few (i.e., between 10 and 99) adenomas are present and family history is unavailable, the differential diagnosis may include both MAP and Lynch syndrome; genetic testing in this situation could include APC, MUTYH if APC is negative for mutations, and screening for mutations associated with Lynch syndrome.

It is important to distinguish among classical FAP, attenuated FAP, and MAP (mono- or biallelic) by genetic analysis because recommendations for patient surveillance and cancer prevention vary according to the syndrome. (3)

Genetic testing for APC mutations may be considered for the following types of patients:

- Family members of patients with FAP and a known APC mutation. Those without the specific mutation have not inherited the susceptibility gene and can forego intense surveillance (although they retain the same risk as the general population and should continue an appropriate level of surveillance).
- Patients with a differential diagnosis of attenuated FAP vs. MUTYH-associated polyposis vs. Lynch syndrome. These patients do not meet the clinical diagnostic criteria for classical FAP, and have few adenomatous colonic polyps.
- Patients with colon cancer with a clinical picture or family history consistent with classical FAP.

**Lynch syndrome**

Patients with Lynch syndrome have a predisposition to colorectal cancer and other malignancies as a result of an inherited mutation in a DNA mismatch repair (MMR) gene. Lynch syndrome includes those with an existing cancer and those who have not yet developed cancer. The term “HNPCC” originated prior to the discovery of explanatory MMR mutations for many of these patients, and now includes some who are negative for MMR mutations and likely have mutations in as-yet unidentified genes. For purposes of clarity and analysis, the use of Lynch syndrome in place of HNPCC has been recommended in several recent editorials and publications.
Lynch syndrome is estimated to account for 3% to 5% of all colorectal cancer and is also associated with an increased risk of other cancers such as endometrial, ovarian, urinary tract, and biliary tract cancer. Lynch syndrome is associated with a risk of developing colorectal cancer by age 70 of approximately 27% to 45% for men, and 22% to 38% for women, after correction for ascertainment bias. (4) Lynch syndrome patients who have colorectal cancer also have an estimated 16% risk of a second primary within 10 years.

Lynch syndrome is associated with any of a large number of possible mutations in 1 of several MMR genes, known as MLH1, MSH2, MSH6, PMS2 and rarely MLH3. Risk of all Lynch syndrome-related cancers is markedly lower for carriers of a mutation in the MSH6 and PMS2 genes, although for most cancers still significantly higher than that of the general population. (3, 4) Estimated cumulative risks of any associated cancer for a carrier of a mutation in any MMR gene do not begin to increase until after age 30.

Lynch syndrome mutations are heterozygous; that is, only one of the 2 gene alleles contains a mutation. In rare cases both alleles contain the mutation, i.e., biallelic MMR gene mutations. This unusual syndrome has been described in multiple families and is to a large extent the result of consanguinity. (5) Children with biallelic MMR mutations may develop extracolonial cancers in childhood, such as brain tumors, leukemias, or lymphomas. Those unaffected or surviving early malignancies are at high risk of later colorectal cancer (average age of colorectal cancer diagnosis 16.4 years (5)). Family history may not suggest Lynch syndrome. Prior to cancer diagnosis, patients may have multiple adenomatous polyps, and thus may have an initial differential diagnosis of attenuated FAP versus MUTYH-associated polyposis versus Lynch syndrome.

About 70% of Lynch syndrome patients have mutations in either MLH1 or MSH2. Testing for MMR gene mutations is often limited to MLH1 and MSH2 and, if negative, then MSH6 and PMS2 testing. Large gene sizes and the difficulty of detecting mutations in these genes make direct sequencing a time- and cost-consuming process. Thus, additional indirect screening methods are needed to determine which patients should proceed to direct sequencing for MMR gene mutations. Available screening methods are microsatellite instability (MSI) testing or immunohistochemical (IHC) testing. BRAF testing is an optional screening method that may be used in conjunction with IHC testing for MLH1 to improve efficiency. A methylation analysis of the MLH1 gene can largely substitute for BRAF testing, or be used in combination to slightly improve efficiency.

Mutations in MMR genes result in a failure of the mismatch repair system to repair errors that occur during the replication of DNA in tumor tissue. Such errors are characterized by the accumulation of alterations in the length of simple, repetitive microsatellite (2 to 5 base repeats) sequences that are distributed throughout the genome, termed microsatellite instability (MSI) and resulting in a MSI-high tumor phenotype. MSI testing was standardized subsequent to a 2004 National Cancer Institute (NCI) workshop. (6) Methodologic studies have also shown the importance of laser microdissection of the tumor tissue, comparison of tumor and normal cells, and a minimum proportion of tumor in relation to the quality of the test results. While the sensitivity of MSI testing is high, the specificity is low because approximately 10% of sporadic CRC are MSI-positive due to somatic hypermethylation of the MLH1 promoter. Additionally, some tumors positive for MSH6 mutations are associated with the MSI-low phenotype, rather than MSI-high; thus MSI-low should not be a criterion against proceeding to MMR mutation testing. (7, 8)

Absent or reduced protein expression may be a consequence of an MMR gene mutation. IHC assays for the expression of MLH1, MSH2, MSH6, and PMS2 can be used to detect loss of expression of these genes and to focus sequencing efforts on a single gene. It is also possible for IHC assays to show loss of expression, and thus indicate the presence of a mutation, when sequencing is negative for a mutation. In such cases, mutations may be in unknown regulatory elements and cannot be detected by sequencing of the protein coding regions. Thus IHC may add additional information.
The \textit{BRAF} gene is often mutated in colorectal cancer; when a particular BRAF mutation (V600E, a change from valine to glutamic acid at amino acid position 600 in the BRAF protein) is present, to date no \textit{MLH1} gene mutations have been reported. (9) Therefore, patients negative for \textit{MLH1} protein expression by IHC, and therefore potentially positive for an \textit{MLH1} mutation, could first be screened for a \textit{BRAF} mutation. \textit{BRAF}-positive samples need not be further tested by \textit{MLH1} sequencing. \textit{MLH1} gene methylation largely correlates with the presence of BRAF-V600E and in combination with \textit{BRAF} testing can accurately separate Lynch from sporadic colorectal cancer in IHC \textit{MLH1}-negative cases. (10)

Various attempts have been made to identify which patients with colon cancer should undergo testing for MMR mutations, based primarily on family history and related characteristics using criteria such as the Amsterdam II criteria (low sensitivity but high specificity) and the Bethesda guidelines (better sensitivity but poorer specificity). While family history is an important risk factor and should not be discounted in counseling families, it has poor sensitivity and specificity for identifying Lynch syndrome. Based on this and other evidence, the Evaluation of Genomic Applications in Practice and Prevention (EGAPP) Working Group recommended testing all newly diagnosed patients with colorectal cancer for Lynch syndrome, using a screening strategy based on MSI or IHC (+ \textit{BRAF}) followed by sequencing in screen-positive patients. This recommendation includes genetic testing for the following types of patients:

- Family members of Lynch syndrome patients with a known MMR mutation; family members would be tested only for the family mutation; those testing positive would benefit from early and increased surveillance to prevent future colorectal cancer.
- Patients with a differential diagnosis of Lynch syndrome vs. attenuated FAP vs. MYH-associated polyposis.
- Lynch syndrome patients. Genetic testing of the proband with colorectal cancer likely benefits the proband where Lynch syndrome is identified and appropriate surveillance for associated malignancies can be initiated and maintained and benefits family members by identifying the family mutation.

Recently, novel deletions have been reported to affect the expression of the \textit{MSH2} MMR gene in the absence of a \textit{MSH2} gene mutation, and thereby cause Lynch syndrome. In these cases, deletions in \textit{EPCAM}, the gene for the epithelial cell adhesion molecule are responsible. \textit{EPCAM} testing has been added to many Lynch syndrome profiles and is conducted only when tumor tissue screening results are MSI-high, and IHC shows a lack of MSH2 expression, but no MSH2 mutation is found by sequencing.

Separately from patients with \textit{EPCAM} deletions, rare Lynch syndrome patients have been reported without detectable germline MMR mutations although IHC testing demonstrates a loss of expression of one of the MMR proteins. In at least some of these cases, research has identified germline "epimutations," i.e., methylation of promoter regions that control the expression of the MMR genes. (11-13) Such methylation may be isolated or in conjunction with a linked genetic alteration near the affected MMR gene. The germline epimutations may arise de novo or may be heritable in either Mendelian or non-Mendelian fashion. This is distinct from some cases of MSI-high sporadic colorectal cancer wherein the tumor tissue may show MLH1 promoter methylation and IHC non-expression, but the same is not true of germline cells. Clinical testing for Lynch syndrome-related germline epimutations is not routine but may be helpful in exceptional cases. Epimutations as a cause of Lynch syndrome are described only for informational purposes; no policy statement is made regarding this testing.

Female patients with Lynch syndrome have a predisposition to endometrial cancer. Lynch syndrome is estimated to account for 2% of all endometrial cancers in women and 10% of endometrial cancers in women younger than 50 years of age. Female carriers of the germline mutations \textit{MLH1}, \textit{MSH2}, \textit{MSH6}, and \textit{PMS2} have an estimated 40-62% lifetime risk of developing endometrial cancer, as well as a 4-12% lifetime risk of ovarian cancer.

\textbf{Rationale}
This policy was originally created in 1998 and was regularly updated with searches of the MEDLINE database. The most recent literature search was performed through September 2013. The following is a summary of the key findings to date.

**Familial Adenomatous Polyposis (FAP) Genetic Testing**
The policy for FAP genetic testing was based on a 1998 TEC Assessment, (16) which offered the following conclusions:

- Genetic testing for FAP may improve health outcomes by identifying which currently unaffected at-risk family members require intense surveillance or prophylactic colectomy.
- At-risk subjects are considered to be those with greater than 10 adenomatous polyps; or close relatives of patients with clinically diagnosed FAP or of patients with an identified adenomatous polyposis coli (APC) mutation.
- The optimal testing strategy is to define the specific genetic mutation in an affected family member and then test the unaffected family members to see if they have inherited the same mutation.

The additional policy information on attenuated FAP and on MYH-associated polyposis (MAP) diagnostic criteria and genetic testing is based on information from GeneReviews (17) and from several publications (18-21) that build on prior, cited research. In addition, GeneReviews (17) summarizes clinical FAP genotype-phenotype correlations that could be used to determine different patient management strategies. The authors of the review conclude, however, that there is not yet agreement about using such correlations to direct management choices.

Testing for the APC gene mutation, i.e., testing for FAP, is considered not medically necessary in those with classical FAP. This is not medically necessary because the genetic testing is not needed to make the diagnosis of FAP in these patients. Testing for the APC mutation has no role (no purpose) in the evaluation, diagnosis, or treatment of these patients where the diagnosis and treatment are based on the clinical presentation.

**Lynch Syndrome and Colorectal Cancer Genetic Testing**
The policy for Lynch syndrome genetic testing in colorectal cancer patients is based on an evidence report published by the Agency for Healthcare Research and Quality (AHRQ), (22) a supplemental assessment to that report contracted by the Evaluation of Genomic Applications in Practice and Prevention (EGAPP) Working Group, (9) and an EGAPP recommendation for genetic testing in colorectal cancer. (23) Based on the AHRQ report and supplemental assessment, the EGAPP recommendation came to the following conclusions regarding genetic testing for MMR mutations in patients already diagnosed with colorectal cancer:

- Family history, while important information to elicit and consider in each case, has poor sensitivity and specificity as a screening test to determine who should be considered for MMR mutation testing and should not be used as a sole determinant or screening test.
- MSI [microsatellite instability] and IHC [immunohistochemical] screening tests for MMR mutations have similar sensitivity and specificity. MSI screening has a sensitivity of about 89% for MLH1 and MSH2 and 77% for MSH6 and a specificity of about 90% for all. It is likely that, using high-quality MSI testing methods, these parameters can be improved. IHC screening has a sensitivity for MLH1, MSH2, and MSH6 of about 83% and a specificity of about 90% for all.
- Optional BRAF testing can be used to reduce the number of patients, who are negative for MLH1 expression by IHC, needing MLH1 gene sequencing, thus improving efficiency without reducing sensitivity for MMR mutations.
- A chain of indirect evidence can be constructed for the clinical utility of testing all patients with colorectal cancer for MMR mutations.
  1. The chain of indirect evidence from well-designed experimental nonrandomized studies (as noted below) is adequate to demonstrate the clinical utility of testing unaffected (without cancer)
first- and second-degree relatives of patients with Lynch syndrome who have a known \textit{MMR} mutation.

2. Seven studies examined how counseling affected testing and surveillance choices among unaffected family members of Lynch syndrome patients. About half of relatives received counseling, and 95% of these chose \textit{MMR} gene mutation testing. Among those positive for \textit{MMR} gene mutations, uptake of colonoscopic surveillance beginning at age 20–25 years was high at 53–100%.

   - One long-term, nonrandomized controlled study and one cohort study of Lynch syndrome family members found significant reductions in colorectal cancer among those who followed recommended colonic surveillance vs. those who did not.
   - Surveillance, prevention for other Lynch syndrome cancers (for detail, refer to last outline bullet)

3. The chain of evidence from descriptive studies and expert opinion (as noted below) is inadequate (inconclusive) to demonstrate the clinical utility of testing the probands with Lynch syndrome (i.e., cancer index patient).

   - Subtotal colectomy is recommended as an alternative to segmental resection, but has not been shown superior in follow-up studies
   - Although a small body of evidence suggests that MSI-positive tumors are resistant to 5-fluorouracil and more sensitive to irinotecan than MSI-negative tumors, no alteration in therapy according to MSI status has yet been recommended.

   Surveillance, prevention for other Lynch syndrome cancers:

   - While invasive and not actively recommended, women may choose hysterectomy with salpingo-oophorectomy to prevent gynecologic cancer. In one retrospective study, women who chose this option had no gynecologic cancer over 10 years, whereas about one-third of women who did not have surgery developed endometrial cancer, and 5.5% developed ovarian cancer
   - In one study, surveillance endometrial biopsy detected endometrial cancer and potentially precancerous conditions at earlier stages in those with Lynch syndrome, but results were not statistically significant, and a survival benefit has yet to be shown. (10) Transvaginal ultrasound (TVUS) is not a highly effective surveillance mechanism for endometrial cancer in patients with Lynch syndrome; however, TVUS in conjunction with endometrial biopsy has been recommended for surveillance.
   - Gastroduodenoscopy for gastric cancer surveillance and urine cytology for urinary tract cancer surveillance are recommended based on expert opinion only, in the absence of adequate supportive evidence.

Based on an indirect chain of evidence with adequate evidence of benefit to unaffected family members found to have Lynch syndrome, the EGAPP working group recommended testing all patients with colorectal cancer for \textit{MMR} gene mutations.

Further support for universal testing of colorectal cancer patients for \textit{MMR} gene mutations was reported by Moreira and colleagues in 2013 in a comparison of universal testing of colorectal cancer patients to alternate screening approaches. (24) The alternate screening approaches included using the Bethesda guidelines, the Jerusalem recommendations and a selective strategy including only those diagnosed with colorectal cancer before age 70, or after age 70 if meeting the Bethesda guidelines. In the analysis of 10,206 newly diagnosed colorectal cancer patients from 4 large cohort studies, MSI testing was used in 2,150 patients and immunostaining was used in 2,278 patients while both MSI and immunostaining were used in 5,591 patients. \textit{MMR} gene mutations were found in 312 (3.1%) patients overall. The universal screening approach was found to be superior to the other screening approaches in the population-based cohorts (n=3671 probands) with a sensitivity of 100% (95% confidence interval [CI]: 99.3-100%), specificity of 93% (95% CI: 92.0-93.7%) and diagnostic yield of 2.2% (95% CI: 1.7-2.7%). The Bethesda guidelines screening sensitivity was 87.8% (95% CI: 78.9-93.2%) with a specificity of 97.5% (95% CI: 96.9-98.0%) and a diagnostic yield of 2.0% (95% CI: 1.5-2.4%; p<0.001). The screening sensitivity with the Jerusalem recommendations was 85.4% (95% CI: 77.1-93.6%) with a
specificity of 96.7% (95% CI: 96.0-97.2%) and a diagnostic yield of 1.9% (95% CI: 1.4-2.3%; p<0.001). The selective strategy had a sensitivity of 95.1% (95% CI: 89.8-99.0%) with a specificity of 95.5% (95% CI: 94.7-96.1%) and a diagnostic yield of 2.1% (95% CI: 1.6-2.6%; p<0.001). However, the diagnostic yield differences between the screening approaches were small, and the false-positive yield was 2.5% with universal screening. Whereas, in the selective strategy, 34.8% fewer patients required tumor MMR testing and 28.6% fewer analyses of MMR mutations resulting in 4.9% missed Lynch syndrome cases.

In addition to DNA mismatch repair (MMR) gene mutation testing, evidence now supports testing for EPCAM deletions in particular cases where all MMR gene mutation testing is negative, but tumor MSH2 IHC indicates lack of expression, and tumor MSI testing shows a high level of instability. EPCAM is found just upstream, in a transcriptional sense, of MSH2. Deletions of EPCAM that encompass the last 2 exons of the EPCAM gene including the polyadenylation signal that normally ends transcription of DNA into messenger RNA result in transcriptional ‘read-through’ and subsequent hypermethylation of the nearby and downstream MSH2 promoter. This hypermethylation prevents normal MSH2 protein expression and leads to Lynch syndrome in a fashion similar to Lynch cases in which an MSH2 mutation prevents MSH2 gene expression. Several studies have characterized such EPCAM deletions, established their correlation with the presence of EPCAM-MSH2 fusion messenger RNAs (apparently non-functional) and with the presence of MSH2 promoter hypermethylation, and, most importantly, have shown the co-segregation of these EPCAM mutations with Lynch-like disease in families. (13, 25-29) Because studies differ slightly in how patients were selected, prevalence of these EPCAM mutations is difficult to estimate but may be in the range of 20-40% of patients/families who meet Lynch syndrome criteria, do not have an MMR mutation, but have MSI-high tumor tissue. Kempers et al. reported that carriers of an EPCAM deletion had a 75% (95% CI: 65–85) cumulative risk of colorectal cancer by age 70 years, not significantly different from that of carriers of an MSH2 deletion (77% 64–90); mean age at diagnosis was 43 years. However, the cumulative risk of endometrial cancer was low at 12% (95% CI: 0–27) by age 70, compared to carriers of a mutation in MSH2 (51% [95% CI: 33–69], p=0.0006). (30)

Grandval et al. selected 25 patients with tumors exhibiting complete loss of MSH2 protein but without a point mutation or genomic rearrangement of the MSH2 gene and found 7 cases of a deletion of the 3’ exon of EPCAM. Genetic testing was subsequently performed on 25 adult first-degree relatives of the 7 cases, and 12 relatives were found to be deletion carriers. Six additional relatives had deceased from Lynch-associated tumors, and 5 were obligate carriers. In summary, the risk to develop colorectal cancer was high, 93.1% (N=27/29) in deletion carriers older than 30 years of age. (31)

Although MMR gene sequencing of all patients is the most sensitive strategy, it is highly inefficient and cost-ineffective and not recommended. Rather, a screening strategy of MSI or IHC testing (with or without optional BRAF testing) is recommended and retains a relatively high sensitivity. Some evidence suggests that IHC requires particular training and experience. (32) Although a particular strategy was not recommended by the EGAPP Working Group, several are potentially effective; efficiency and cost-effectiveness may depend upon local factors.

In 2010, Bouzourene and colleagues analyzed MLH1 protein abnormalities in 11 patients with sporadic colorectal carcinoma (CRC) and 16 patients with Lynch syndrome. (10) BRAF mutation was not found in any of the Lynch syndrome patients. MLH1 promoter methylation was only present in 1 Lynch syndrome patient. However, 8 of the 11 sporadic CRC patients had the BRAF mutation, and all 11 patients were MLH1 methylated, suggesting patients with BRAF mutations could be excluded from germline testing for Lynch syndrome. In 2013, Jin et al. evaluated MMR proteins in 412 newly diagnosed CRC patients. (33) MLH1 and PMS2 protein stains were absent in 65 (72%) patients who were subsequently tested for BRAF mutation. Thirty-six (55%) patients were found to have the BRAF V600E mutation, thus eliminating the need for further genetic testing or counseling for Lynch syndrome.

In 2013, Capper et al. reported on a technique of VE1 IHC testing for BRAF mutations on a series of 91 MSI-H CRC patients. (34) The authors detected BRAF-mutated CRC with 100% sensitivity and 98.8%
specificity. VE1 positive lesions were detected in 21% of MLH1-negative CRC patients who could be excluded from MMR germline testing for Lynch syndrome. Therefore, VE1 IHC testing for BRAF could be an alternative to MLH1 promoter methylation analysis.

To summarize, BRAF mutation V600E or MLH1 promoter methylation testing are optional screening methods that may be used when IHC testing shows a loss of MLH1 protein expression by IHC testing for MLH1. The presence of BRAF V600E or absence of MLH1 protein expression due to MLH1 promoter methylation rarely occurs in Lynch syndrome and would eliminate the need for further germline mutation analysis for a Lynch syndrome diagnosis. (35)

Previous recommendations have used family history as an initial screen to determine who should proceed further to MMR laboratory testing. Family history is important for counseling families, but based on this and similar evidence, it is not recommended as an initial screening tool to make decisions about testing patients who already have colorectal cancer. Recent studies have shown that limiting laboratory testing to patients who met even the more sensitive Revised Bethesda criteria (i.e., compared to the Amsterdam II criteria) would miss much as 28% of Lynch syndrome cases. (36, 37) However, as noted in the policy statement, the Amsterdam II or Revised Bethesda criteria may be used in identifying those without colorectal cancer who might be tested.

Limiting testing for Lynch Syndrome on the basis of age (e.g., test only patients younger than age 50 years) is also not recommended. For example, Hampel et al. found that among 18 Lynch syndrome patients discovered among 500 unselected colorectal cancer patients, only 8 (44%) patients were diagnosed at age younger than 50 years. (36) Similarly, Canard et al. reported that restricting screening to patients younger than 50 years would have missed about half of patients eventually found to have Lynch syndrome. (37) Another group screened colorectal cancer patients who were younger than age 60 and identified 98 likely (MSI-positive, BRAF-negative) Lynch syndrome cases; of these, 47% were between ages 50 and 60 years. (38) A large study of Lynch syndrome family studies found that the cumulative risk of colorectal cancer in MMR mutation carriers was only 13% (95% CI: 9-19) by age 50, but 35% (95% CI: 25-49%) by age 70. (4) For MSH6 mutation carriers, however, colorectal cancer risks do not appear to increase until after age 60.

The estimated risk of stomach cancer in a large study of Lynch syndrome families was 6% (95% CI: 0.2-17%) for carriers of MLH1 mutations and warrants further study to address the utility of gastric surveillance. (4)

As the EGAPP recommendations noted, the evidence to date is limited to clearly support benefit from genetic testing to the index patient with colorectal cancer if found to have Lynch syndrome. However, professional societies have reviewed the evidence and concluded that genetic testing likely has direct benefits for at least some patients with colorectal cancer and Lynch syndrome on the basis of differing recommendations for post-surgical surveillance, and for those who choose prophylactic surgical treatment instead of surveillance. This policy is based on the evidence and professional society recommendations reviewed below.

In the absence of preventive surgery, heightened surveillance is recommended. The National Comprehensive Cancer Network (NCCN) guidelines for colon cancer (39) and for colorectal cancer screening (40) recommend colorectal cancer patients treated with curative-intent surgery undergo surveillance colonoscopy at 1 year post-surgery and, if normal, again in years, then every years based on findings. However, for Lynch syndrome patients, colonoscopy is recommended every 1 to 2 years throughout life based on the high likelihood of cancer for patients diagnosed with Lynch syndrome prior to a cancer diagnosis, and on the high likelihood of a second primary cancer in those diagnosed with Lynch syndrome based on a first cancer diagnosis. (41) For MLH1 and MSH2 mutation carriers, the NCCN guidelines indicate surveillance with colonoscopy should begin “at age 20-25 years or 2-5 years prior to the earliest colon cancer if it is diagnosed before age 25 years and repeat every 1-2 years.” MSH6 mutation carriers should begin surveillance with colonoscopy “at age 30-35 years (may need to be earlier in some families, depending on ages of cancers observed) every 2-3 years and then after
age 40 years every 1-2 years. PMS2 mutation carriers should begin surveillance with colonoscopy at age 35-40 years (may need to be earlier in some families, depending on ages of cancers observed) every 2-3 years and then after age 50 years every 1-2 years. If the patient is not a candidate for routine surveillance, subtotal colectomy may be considered. (40)

Early documentation of the natural history of colorectal cancer in highly selected families with a strong history of hereditary colorectal cancer indicated risks of synchronous and metachronous cancers as high as 18% and 24%, respectively, (42) in patients who already had colorectal cancer. As a result, in 1996, the Cancer Genetic Studies Consortium, a temporary National Institutes of Health (NIH)-appointed body, recommended that if colorectal cancer is diagnosed in patients with an identified mutation or a strong family history, a subtotal colectomy with ileorectal anastomosis (IRA) should be considered in preference to segmental resection. (43) Although the average risk of a second primary is now estimated to be somewhat lower overall (see Description) in patients with Lynch syndrome and colorectal cancer, effective prevention measures remain imperative. One study suggested that subtotal colectomy with IRA markedly reduced the incidence of second surgery for metachronous cancer from 28% to 6% but could not rule out the impact of surveillance. (44) A mathematical model comparing total colectomy and IRA to hemicolectomy resulted in increased life expectancies of 2.3, 1, and 0.3 years for ages 27, 47, and 67, respectively; for Duke’s A, life expectancies for the same ages are 3.4, 1.5, and 0.4, respectively. (45) Based on this work, the joint American Society of Clinical Oncology (ASCO) and Society of Surgical Oncology (SSO) review of risk-reducing surgery in hereditary cancers recommends offering both options to the patient with Lynch syndrome and colorectal cancer, especially those who are younger. (46) This ASCO/SSO review also recommends offering Lynch syndrome patients with an index rectal cancer the options of total proctocolectomy with ileal pouch anal anastomosis or anterior proctosigmoidectomy with primary reconstruction. The rationale for total proctocolectomy is the 17% to 45% rate of metachronous colon cancer in the remaining colon after an index rectal cancer in Lynch syndrome patients.

Lynch Syndrome and Endometrial Cancer Genetic Testing
Several groups have recommended screening endometrial cancer patients for Lynch syndrome. At the 2010 Jerusalem Workshop on Lynch Syndrome, (47) it was proposed that all incident cases of endometrial cancer be screened for Lynch syndrome using mismatch repair-immunohistochemical (MMR-IHC) testing. Clarke and Cooper (48) note that Sloan-Kettering Cancer Center screens all patients younger than 50 years of age with endometrial cancer using MMR-IHC; as well as patients older than 50 years with suggestive tumor morphology, lower uterine segment (LUS) location, personal/family history, or synchronous cell carcinoma of the ovary. Kwon et al. (49) recommended MMR-IHC screening of women with endometrial cancer at any age with at least one first-degree relative with a Lynch syndrome-associated cancer.

The risk of endometrial cancer in MMR mutation carriers has been estimated at 34% (95% CI: 17-60%) by age 70, and of ovarian cancer 8% (95% CI: 2-39%) by age 70. (4) Risks do not appear to appreciably increase until after age 40.

In a recent prospective study, 179 consecutive endometrial cancer patients <=70 years of age were analyzed for microsatellite instability (MSI), by IHC for expression of 4 MMR proteins, MMR gene methylation status and BRAF mutations. Results are presented in Table 1 below; 92% of patients were older than 50 years of age. (50)

<table>
<thead>
<tr>
<th>Result</th>
<th>N</th>
<th>% (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stable MMS and normal protein staining</td>
<td>137</td>
<td>76%</td>
</tr>
<tr>
<td>MSI-H and MLH1 absent</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>- Sporadic MSI-H</td>
<td>31</td>
<td>17% (13-24%)</td>
</tr>
<tr>
<td>Likely to have Lynch syndrome</td>
<td>11</td>
<td>6% (3-11%)</td>
</tr>
<tr>
<td>- mutation-positive</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>
Another study examined 625 endometrial cancer patients who underwent hysterectomy; endometrial cancer was classified as LUS in 9 patients. (51) Twenty-seven randomly chosen patients from the non-LUS group were compared to the LUS group, and no statistically significant differences were found between groups with regard to MSI status or IHC findings. The incidence of Lynch syndrome in the LUS group was 1 in 9. (52, 53)

Kwon et al. (49) developed a Markov Monte Carlo simulation model to compare 6 strategies for Lynch syndrome testing in women with endometrial cancer. Overall, the results suggested that IHC triage at any age, in women with at least one first-degree relative (FDR) with a Lynch-associated cancer, was the most cost-effective strategy (incremental cost-effectiveness ratio [ICER]=$9,126) for identifying Lynch syndrome and subsequent colorectal carcinoma (CRC) cases. The model used published prevalence estimates of Lynch syndrome in all endometrial cancer patients of 2% (range 1-3%), and of 17% (range 15-20%) in endometrial cancer patients with at least one FDR with a Lynch-associated cancer. Results are presented in Table 2:

<table>
<thead>
<tr>
<th>Testing Strategy</th>
<th>No. cases subject to IHC triage</th>
<th>No. identified with Lynch syndrome</th>
<th>No. subsequent CRC cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amsterdam II criteria</td>
<td>NA</td>
<td>539</td>
<td>2582</td>
</tr>
<tr>
<td>Age &lt;50, and at least 1 FDR (Lynch-associated cancer)</td>
<td>NA</td>
<td>530</td>
<td>2470</td>
</tr>
<tr>
<td>IHC triage &lt;age 50</td>
<td>6285</td>
<td>520</td>
<td>2442</td>
</tr>
<tr>
<td>IHC triage &lt;age 60</td>
<td>16226</td>
<td>548</td>
<td>2450</td>
</tr>
<tr>
<td>IHC triage at any age; at least 1 FDR with Lynch-associated cancer</td>
<td>5786</td>
<td>755</td>
<td>2442</td>
</tr>
<tr>
<td>IHC triage all endometrial cancers</td>
<td>45000</td>
<td>827</td>
<td>2413</td>
</tr>
</tbody>
</table>

Female patients with Lynch syndrome who choose risk-reducing surgery are also encouraged to consider oophorectomy because of the risk of ovarian cancer in Lynch syndrome. As already noted, in one retrospective study, women who chose this option had no gynecologic cancer over 10 years, whereas about one-third of women who did not have surgery developed endometrial cancer, and 5.5% developed ovarian cancer. (54) In another retrospective cohort study, hysterectomy improved survival among female colon cancer survivors with Lynch syndrome. (55) This study also estimated that for every 100 women diagnosed with Lynch syndrome-associated colorectal cancer, about 23 will be diagnosed with endometrial cancer within 10 years absent a hysterectomy. Recent data on mutation-specific risks suggest that prophylactic gynecological surgery benefits for carriers of MSH6 mutations may offer less obvious benefits compared to harms, as lifetime risk of endometrial cancer is lower than for carriers of MLH1 or MSH2 mutations, and lifetime risk of ovarian cancer is similar to the risk for the general population. (4)

However, in the case of EPCAM deletion carriers, 3 recent studies found 3 cases of endometrial cancer in 103 female carriers who did not undergo preventative hysterectomy. (30, 31, 56) Women with EPCAM deletions consequently have a lifetime risk of developing endometrial cancer decreased by 10-fold when compared to MMR gene-mutation carriers. This might support a clinical management scenario rather than prophylactic surgery. (31) An alternative to prophylactic surgery is surveillance for endometrial cancer using transvaginal ultrasound (TVUS) and endometrial biopsy. Evidence indicates that such surveillance significantly reduces the risk of interval cancers, but no evidence as yet indicates surveillance reduces mortality due to endometrial cancer. (57)
populations for ovarian cancer has not yet been demonstrated to be successful at improving survival. (57)

Ongoing Clinical Trials
A search of ClinicalTrials.gov on October 27, 2013 identified 3 ongoing studies on genetic testing for Lynch syndrome. The Ohio Colorectal Cancer Prevention Initiative (OCCPI) will evaluate colorectal cancer outcomes in a screening program of 4,000 patients and is scheduled to be completed in September 2017 (NCT01850654). The effects of living with the results of genetic testing for Lynch syndrome that revealed variants of unknown significance (VUS) will be examined in a study of 40 subjects (NCT01646112). This study does not indicate a completion date. In NCT01447199, the role of mismatch repair genes in the development of colon cancer in Lynch syndrome families will be examined in 2,000 subjects. This study is estimated to be completed in September 2015.

Clinical Input Received through Physician Specialty Societies and Academic Medical Centers
In response to requests, input was received through 3 Physician Specialty Societies and 3 Academic Medical Centers while this policy was under review for October 2009. While the various Physician Specialty Societies and Academic Medical Centers may collaborate with and make recommendations during this process, through the provision of appropriate reviewers, input received does not represent an endorsement or position statement by the Physician Specialty Societies or Academic Medical Centers, unless otherwise noted. In general, those providing input were in agreement with the overall approach described in this policy.

Summary
Results of testing for the adenomatous polyposis coli (APC) mutation in individuals with a family history of familial adenomatous polyposis (FAP), or a known APC mutation in the family, lead to changes in surveillance and prophylactic treatment. For patients with a positive result, enhanced surveillance and/or prophylactic treatment will reduce the future incidence of colon cancer and improve health outcomes. Therefore, APC testing is medically necessary for patients with a family history of FAP or a known APC mutation in the family. A related familial polyposis syndrome, MUTYH-associated polyposis (MAP) syndrome, is associated with mutations in the MUTYH gene. Testing for this genetic mutation is medically necessary when the differential diagnosis includes both FAP and MAP, since distinguishing between the two leads to different management strategies. In some cases, Lynch syndrome may be part of the same differential diagnosis, depending on presentation.

A substantial portion of patients with colorectal cancer will be found to have Lynch syndrome, which is associated with mutations in the mismatch repair (MMR) gene. A positive genetic test for the MMR mutation can lead to enhanced surveillance, changes in recommendations about treatment options, and possible prophylactic treatment for other Lynch syndrome malignancies. Therefore, testing for Lynch syndrome in patients with newly diagnosed colorectal cancer and in patients at high risk for Lynch syndrome, defined by meeting the clinical criteria such as Amsterdam II or Revised Bethesda, is considered medically necessary. Additionally, immunohistochemical (IHC) testing for BRAF V600E or MLH1 promoter methylation may be considered medically necessary to exclude a diagnosis of Lynch syndrome when MLH1 is not expressed in the colorectal tumor.

Women with endometrial cancer are also at risk for Lynch syndrome, at a low prevalence; the prevalence is increased substantially when the population is limited to those (at any age) with a first-degree relative diagnosed with a Lynch-associated cancer. Those found to have a MMR mutation will also benefit from enhanced colorectal cancer surveillance and prophylactic treatments. Therefore, testing for Lynch syndrome in patients with newly diagnosed endometrial cancer who also have a first-degree relative diagnosed with a Lynch-associated cancer may be considered medically necessary. The EPCAM mutation is less common than MMR mutations as a cause of Lynch syndrome and should be part of the diagnostic testing for Lynch syndrome in patients who are negative for all MMR mutations but who screen positive for microsatellite instability (MSI) and lack MSH2 immunohistochemistry evidence of protein expression.
Practice Guidelines and Position Statements
The National Comprehensive Cancer Network (NCCN) guidelines for colorectal cancer screening recommend 2 approaches to Lynch syndrome mutation screening of either: 1) all colorectal cancers or 2) colorectal cancer patients diagnosed before age 70 and those ages 70 and older when meeting Bethesda guidelines. (40) Additionally, the colorectal cancer screening guidelines also recommend screening for Lynch syndrome for all endometrial cancer patients younger than 50 years-old. These guidelines note immunohistochemistry and sometimes microsatellite instability testing may be performed at some centers on all newly diagnosed colorectal and endometrial cancer patients to determine need for genetic testing for Lynch syndrome mutations regardless of family history. (40) The guideline does not specifically mention EPCAM deletion testing but does indicate that individuals with loss of MSH2 and/or MSH6 protein expression by immunohistochemistry, regardless of germline MMR mutation status, should be followed as though they have Lynch syndrome. Genetic testing is recommended for at-risk family members of patients with positive mutations in MLH1, MSH2, MSH6 or PMS2. The NCCN colon cancer screening guidelines also indicate BRAF V600E testing or MLH1 promoter methylation testing may be used when MLH1 is not expressed in the tumor on immunohistochemical (IHC) analysis to exclude a diagnosis of Lynch syndrome. As noted in the NCCN guidelines, “the presence of a BRAF mutation indicates MLH1 expression is downregulated by somatic methylation of the promoter region of the gene and not by germline mutation.” These guidelines also address familial adenomatous polyposis (classical and attenuated), and MUTYH-associated polyposis, consistent with the information in this policy.

The NCCN guidelines for colon cancer recommend colon cancer patients younger than 50 years of age be tested for the MMR protein for possible Lynch syndrome. (39) The colon cancer guidelines also indicate all colon cancer patients should be questioned about family history and considered for risk assessment as per the NCCN colorectal screening guidelines. The NCCN guidelines on uterine neoplasms indicate all endometrial cancer patients, especially those younger than 55 years, should be considered for testing for genetic mutations such as Lynch syndrome. (58)

The European Society for Medical Oncology (ESMO) published clinical practice guidelines for familial colorectal cancer risk in 2010. (2) These guidelines addressed Lynch Syndrome, familial adenomatous polyposis, and MUTYH-associated polyposis. No specific recommendations were made regarding how to initially identify Lynch syndrome cases; several methods, including clinical criteria and universal screening of all CRC cases, were mentioned. Other ESMO recommendations are consistent with the information in this policy.

The American Society of Clinical Oncology (ASCO) and the Society of Surgical Oncology (SSO) recommends offering prophylactic total abdominal hysterectomy to female patients with colorectal cancer who have completed childbearing or to women undergoing abdominal surgery for other conditions, especially when there is a family history of endometrial cancer. This recommendation is based on the high rate of endometrial cancer in mutation-positive individuals and the lack of efficacy of screening. (46)

Medicare National Coverage
Under Medicare, genetic tests for cancer are a covered benefit only for a beneficiary with a personal history of an illness, injury, or signs/symptoms thereof (i.e. clinically affected). A person with a personal history of a relevant cancer is a clinically affected person, even if the cancer is considered cured. Predictive or pre-symptomatic genetic tests and services, in the absence of past or present illness in the beneficiary, are not covered under national Medicare rules. CMS recognizes Lynch syndrome as "an autosomal dominant syndrome that accounts for about 3-5% of colorectal cancer cases. [Lynch] syndrome mutations occur in the following genes: hMLH1, hMSH2, hMSH6, PMS2 and EPCAM." CMS also recognizes FAP and MAP syndromes and their associated mutations.

References


**Billing Coding/Physician Documentation Information**

81201 APC (adenomatous polyposis coli) (eg, familial adenomatosis polyposis [FAP], attenuated FAP) gene analysis; full gene sequence
81202 APC (adenomatous polyposis coli) (eg, familial adenomatosis polyposis [FAP], attenuated FAP) gene analysis; known familial variants
81203 APC (adenomatous polyposis coli) (eg, familial adenomatosis polyposis [FAP], attenuated FAP) gene analysis; duplication/deletion variants
81210 BRAF (v-raf murine sarcoma viral oncogene homolog B1) (eg, colon cancer), gene analysis, V600E variant
81292 MLH1 (mutl.homolog 1, colon cancer, nonpolyposis type 2) (eg, hereditary non-polyposis colorectal cancer, Lynch syndrome) gene analysis; full sequence analysis
81293 MLH1 (mutl.homolog 1, colon cancer, nonpolyposis type 2) (eg, hereditary non-polyposis colorectal cancer, Lynch syndrome) gene analysis; known familial variants
81294 MLH1 (mutl.homolog 1, colon cancer, nonpolyposis type 2) (eg, hereditary non-polyposis colorectal cancer, Lynch syndrome) gene analysis; duplication/deletion variants
81295 MSH2 (mutS.homolog 2, colon cancer, nonpolyposis type 1) (eg, hereditary non-polyposis colorectal cancer, Lynch syndrome) gene analysis; full sequence analysis
81296 MSH2 (mutS.homolog 2, colon cancer, nonpolyposis type 1) (eg, hereditary non-polyposis colorectal cancer, Lynch syndrome) gene analysis; known familial variants
81297 MSH2 (mutS.homolog 2, colon cancer, nonpolyposis type 1) (eg, hereditary non-polyposis colorectal cancer, Lynch syndrome) gene analysis; duplication/deletion variants
81298 MSH6 (mutS homolog 6 [E. coli]) (eg, hereditary non-polyposis colorectal cancer, Lynch syndrome) gene analysis; full sequence analysis
Effective in 2012, there are specific CPT codes for genetic testing of MLH1, MSH2, MSH6, PMS2 and microsatellite instability.

Prior to 2012, there were no specific CPT codes for genetic testing; testing was typically coded for using a series of CPT codes describing the individual steps in the testing process. CPT codes 83890-83898 described the preparation of DNA for analysis, single strand conformation polymorphisms, heteroduplex, denaturing gradient gel electrophoresis (all CPT code 83903); mutation identification by sequencing (83904); mutation identification by allele specific transcription (83905) or translation (83906). The exact methodology used will depend on the clinical situation. For example, genetic testing for a single known mutation involves fewer steps than the testing required to identify one of many possible mutations.

Genetic Testing in Patients at Risk for Lynch Syndrome:
83890: Molecular diagnostics: molecular isolation or extraction; each nucleic acid type (i.e., DNA or RNA)
83894: Molecular diagnostics: separation by gel electrophoresis (e.g., agarose, polyacrylamide), each nucleic acid preparation
83898: Molecular diagnostics: amplification, target, each nucleic acid sequence
83902: Molecular diagnostics: reverse transcription
83912: Molecular diagnostics: interpretation and report

Genetic Testing in Patients at Risk for FAP
83890: Molecular diagnostics: molecular isolation or extraction; each nucleic acid type (i.e., DNA or RNA)
83892: Molecular diagnostics: enzymatic digestion; each enzyme treatment
83894: Molecular diagnostics: separation by gel electrophoresis (e.g., agarose, polyacrylamide), each nucleic acid preparation
83898: Molecular diagnostics: amplification, target, each nucleic acid sequence
83902: Molecular diagnostics: reverse transcription
83912: Molecular diagnostics: interpretation and report

There are CPT genetic testing modifiers specific to MLH1 (-0J), and MSH2, MSH6 or PMS2 (-0K). There was a series of 4 HCPCS codes (see coding section below) that specifically describe genetic sequencing for MLH1 and MSH2, individually or together, or genetic testing for a single mutation in a known affected family. Therefore, these codes could have been used in lieu of using CPT coding for the individual components of genetic testing.

Genetic testing for colon cancer is not widely available and is most commonly performed by commercial reference labs or research labs dedicated to genetic testing in general.

Associated genetic counseling performed by a trained genetic counselor would be coded using CPT code 96040 (Medical genetics and genetic counseling services, each 30 minutes face-to-face with
Genetic counseling performed by a physician is coded using the appropriate CPT evaluation and management codes.

**Additional Policy Key Words**

Colaris

**Policy Implementation/Update Information**

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>1/1/04</td>
<td>New policy added to the Medical and Laboratory sections.</td>
</tr>
<tr>
<td>1/1/05</td>
<td>No policy statement changes.</td>
</tr>
<tr>
<td>1/1/06</td>
<td>No policy statement changes.</td>
</tr>
<tr>
<td>1/1/07</td>
<td>The second policy statement in the section titled When Policy Topic Is Covered, was modified slightly to include the words “…with a history of…”</td>
</tr>
<tr>
<td>1/1/08</td>
<td>No policy statement changes.</td>
</tr>
<tr>
<td>1/1/09</td>
<td>No policy statement changes.</td>
</tr>
<tr>
<td>1/1/10</td>
<td>Policy statements changed to indicate that testing the index patient with APC is considered not medically necessary. Intent of other policy statements generally unchanged, although requirement for positive family history no longer required for testing.</td>
</tr>
<tr>
<td>1/1/11</td>
<td>No policy statement changes.</td>
</tr>
<tr>
<td>1/1/12</td>
<td>Policy revised to add medically necessary indication for testing for EPCAM mutations in patients with colorectal cancer and negative MMR mutations. Coding updated.</td>
</tr>
<tr>
<td>1/1/13</td>
<td>Additional medically necessary indication added for patients with endometrial cancer and one first-degree relative diagnosed with a Lynch associated cancer. CPT coding updated. Title changed from Genetic Testing for Inherited Susceptibility to Colon Cancer Including Microsatellite Instability</td>
</tr>
<tr>
<td>1/1/14</td>
<td>Policy statement added that BRAF V600E or MLH1 promoter methylation may be considered medically necessary when MLH1 is not expressed in the tumor on IHC analysis. Added policy statement indicating testing for all other gene mutations for Lynch syndrome or colorectal cancer is considered investigational.</td>
</tr>
<tr>
<td>4/1/14</td>
<td>Removed deleted codes S3833, S3834.</td>
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State and Federal mandates and health plan contract language, including specific provisions/exclusions, take precedence over Medical Policy and must be considered first in determining eligibility for coverage. The medical policies contained herein are for informational purposes. The medical policies do not constitute medical advice or medical care. Treating health care providers are independent contractors and are neither employees nor agents Blue KC and are solely responsible for diagnosis, treatment and medical advice. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, photocopying, or otherwise, without permission from Blue KC.