Multigene Expression Assay for Predicting Recurrence in Colon Cancer

Description

Over a dozen different gene expression profile (GEP) tests have been developed and reported for use as prognostic markers in stage II colon cancer. These assays are intended to help identify patients with stage II colon cancer who are at high risk for recurrent disease and would be good candidates for adjuvant chemotherapy. Five assays are currently being marketed for clinical use in the United States: ColonPRS®, Signal Genetix, New York, NY; Coloprint® Agendia NV, Amsterdam, Netherlands; Genefx Colon®, Precision Therapeutics, Pittsburgh, PA; OncoDefender™-CRC (colon and rectal cancer), Everist Genomics, Ann Arbor, MI; and Oncotype DX® colon cancer test; Genomic Health, Inc., Redwood City, CA. The gene signatures range from as small as 5 to as many as 634 genes. Independent validation studies ranging in size from 33 to 1,436 patients have been reported on these assays.

Background

Of patients with stage II colon cancer, 75–80% are cured by surgery alone, and the absolute benefit of chemotherapy for the patient population is small. Those patients who are most likely to benefit from chemotherapy are difficult to identify by standard clinical and pathologic risk factors. Genomic tests are intended to be used as an aid in indentifying those stage II patients most likely to experience recurrence after surgery. They are also intended to identify those patients most likely to benefit from additional treatment.

Colorectal cancer is classified stage II when it has spread outside the colon and/or rectum to nearby tissue but is not detectable in the lymph nodes and has not metastasized to distant sites (also called Dukes B). The primary treatment is surgical resection of the primary cancer and colonic anastomosis. After surgery the prognosis is very good, with survival rates of 75% to 80% at 5 years. (1) Meta-analysis of several trials of adjuvant therapy versus surgery alone in all stage II patients found statistically significant, although small, absolute benefit of chemotherapy for disease-free survival but not for overall survival. (1) Therefore, adjuvant chemotherapy with 5-fluorouracil (5-FU) or capecitabine is recommended only as an option for resected patients with high-risk stage II disease (i.e., those with
poor prognostic features). (2) However, the clinical and pathologic features used to identify high-risk disease are not well-established, and the patients for whom the benefits of adjuvant chemotherapy would most likely outweigh the harms cannot be identified with certainty. The current system relies on the use of a variety of factors including tumor sub-stage IIB (T4A tumors that invade the muscularis propria and extend into pericoleorectal tissues) or IIC (T4B tumors that invade or are adherent to other organs or structures), obstruction or bowel perforation at initial diagnosis, inadequately low number of samples lymph nodes at surgery (12 or less); histological features of aggressiveness, a high preoperative carcinoembryonic antigen level, and the presence of indeterminate or positive resection margins. (2).

Of interest, a recent review has noted that microsatellite instability and mismatch repair (MMR) deficiency in colon cancer may represent confounding factors to be considered in treatment. (3) The finding of these factors may identify a small population (15% to 20%) of the population with improved disease-free survival who may derive no benefit or may exhibit deleterious effects from adjuvant fluorouracil/leucovorin based treatments. The status of patients with regard to these findings may be critically important in how to study, interpret, and use a particular GEP test.

**Regulatory Status**

To date, no gene expression test for evaluation of prognosis in stage II colon cancer has been cleared by the U.S. Food and Drug Administration (FDA). These tests are offered as laboratory-developed assays in clinical laboratory improvement amendment (CLIA)-licensed laboratories operated by each company and currently do not require FDA premarket review as a result of enforcement discretion.

**Related Policies**

None

**Policy**

*This policy statement applies to clinical review performed for pre-service (Prior Approval, Precertification, Advanced Benefit Determination, etc.) and/or post-service claims.*

Gene expression assays for determining the prognosis of stage II colon cancer following surgery are considered **investigational**.

**Rationale**

**Introduction**

Validation of genotyping to improve treatment outcomes is a multistep process. In general, important steps in the validation process address the following:

- **Analytic validity**: measures technical performance, i.e., whether the test accurately and reproducibly detects the gene markers of interest.
• **Clinical validity**: measures the strength of the associations between the selected genetic markers and clinical status.

• **Clinical utility**: determines whether the use of genotyping for specific genetic markers to guide treatment decisions improves patient outcomes such as survival or adverse event rate compared to standard treatment without genotyping.

**Literature Review**

**Analytical Validity**

Thirteen gene expression profile (GEP) assays have been developed and reported for use as a prognostic marker in stage II colon cancer since 2004. (4-17) Four are currently offered commercially in the U.S. Information on basic elements of test performance including specimen type, sample handling, and technique used for GEP has been reported for many of these assays.

**Clinical Validity**

**ColonPRS®**: Van Laar in 2010 (10) reported on a 163-gene expression test using data from 232 colon cancer patients across all stages (I to IV) of disease. Patients were stratified into high risk and low risk, and a second validation performed in 33 stage II and 27 stage III patients. Gene expression classification was reported to show a statistically significant decrease in 5-year disease-free survival in low-risk stage II patients and a trend toward a statistically significant decrease in low-risk stage III patients. This assay ColonPRS® is being marketed as a research use only test and has specific warnings against clinical use. Although the test was marketed by Signal Genetics, L.L.C it no longer appears on the company’s website. A telephone call to the company confirmed that ColonPRS® was for internal research use only.

**ColoPrint®**: Salazar et al. (16) in 2011 described the development of an 18-gene expression test (the ColoPrint® test). A total of 188 samples were prospectively collected from patients with colorectal cancers. RNA was isolated from fresh tissue frozen in liquid nitrogen, labeled and hybridized to customized whole-genome oligonucleotide high-density microarrays. A cross-validation procedure was performed on 33,834 gene probes that showed variation across the training samples. These were scored for their association with 5-year distant metastasis-free survival. From this pool of genes, an optimal set of 18 nonredundant probes were identified. These were used to construct the classification scores used in the test. Results were dichotomized into a 2-category system identified as high-risk and low-risk scores.

In a small independent validation study using a patient cohort of 206 patients, 60% of patients were identified as low risk and 40% as high risk. The population studied, however, had a mixture of patients of different disease stages with only 56% representing stage II tumors. In the evaluation of patients with stage II disease, 63.2% were classified as low risk (with a 5-year recurrence-free survival of 90.9%) and 36.8% were classified as high risk (with 5-year recurrence-free survival of 73.9%).
A subsequent validation study was conducted in fresh frozen tumor samples from 135 patients who had undergone curative resection for stage II colon cancer. (18) MMR status, clinical parameters, and follow-up data (median 8.4 years) were collected. Five-year distant metastasis-free survival was 95% for patients classified as low risk by ColoPrint and 80% for patients classified as high risk. Information about net reclassification and clinical utility was not provided. To date, larger validation studies have been published only in abstract form. (19)

**Genefx Colon®**: Kennedy et al. in 2011 (15) reported on the development of a 634-probe set signature. A training set of 215 patients (143 low risk and 73 high risk) was identified based on disease-free survival at 5 years. The assay was performed using DNA-microarray analysis of formalin-fixed paraffin-embedded samples. Cross-validation studies were used to select an optimal transcript signature for prognostic classification.

Independent validation was performed on 144 patients enriched for recurrence (85 low-risk and 59 high-risk patients) using the threshold score identified in the training set. The signature in this convenience sample of patients predicted disease recurrence with a hazard ratio (HR) of 2.53 (P<0.001) in the high-risk group. The signature also predicted cancer-related death with an HR of 2.21 (P=0.00084) in the high-risk group. The authors noted a further retrospective validation of the test in a large cohort of stage II colon cancer samples collected as part of a clinical trial is planned. As of July 2013, no additional information about this study was found.

**OncoDefender®**: Lenehan et al. in 2012 (20) reported on their development of a 5-gene test, the OncoDefender®. A total of 417 cancer-associated genes were preselected for study in archived formalin-fixed, paraffin-embedded primary adenocarcinoma tissues of 74 patients with colorectal cancer (15 with stage I disease and 59 with stage II disease; 60 with colon and 14 with rectal cancer). Patients were divided into a training set and a testing set. Cross validation was performed to estimate the ability of the classifier to generalize to unseen samples. The most important feature of gene fitness was the area under the receiver operating characteristics curve observed for each gene.

External validation was performed on 251 patients with stage I and II colon cancer obtained from an international study set. Patient drop-out from the archived sample banks used was substantial; only 264 (55%) of 484 patients with lymph-node negative colorectal carcinoma (CRC) satisfied the initial clinicopathologic screening. This included a mix of patients with some with both rectal and colon cancer (stage I and II). The test appeared to distinguish patients at high- versus low-risk of recurrence with a hazard ratio of 1.63, p=0.031. Sensitivity and specificity of the OncoDefender® was compared to National Cancer Consortium Network (NCCN) guidelines and showed similar sensitivity (69% vs. 73% with improved specificity 48% vs. 26%). However, isolated performance of the test in patients with stage II colon cancer was not reported, and several NCCN high-risk findings (bowel obstruction/perforation, and lymphovascular invasion) demonstrated higher hazard ratios than observed using the molecular signature. The study alluded to but did not directly address clinical utility.

**Oncotype DX®**: O’Connell et al. (9) in 2010 described the development of a 12-gene expression test (the Oncotype DX® colon cancer test). A total of 761 candidate genes of possible prognostic value for
recurrence or of possible predictive value for treatment were examined by correlating the genes in
tumor samples with the clinical outcomes seen in 1,851 patients who had surgery with or without
adjuvant 5-fluorouracil (5-FU)-based chemotherapy. Gene expression was quantitated from
microdissected fixed paraffin-embedded primary colon cancer tissue. Of the 761 candidate genes
surveyed, a multivariate analysis including disease severity, stage, and nodal involvement, reduced
the genes to a 7-gene prognostic signature and a separate 6-gene predictive signature. Five reference
genes are also included in the assay.

External validation of the algorithm in an independent study, the Quick and Simple and Reliable
(QUASAR) study was reported in 2011. (21) The relationship between the 7-gene test’s recurrence
score and risk of recurrence was found to be statistically significant with the 3-year risk of recurrence
for predefined low-, intermediate-, and high-risk groups to be 12%, 18%, and 22%, respectively. No
relationship was identified comparing the 6-gene treatment score results with benefit from
chemotherapy.

Clinical Utility

No studies of a GEP for determining prognosis of patients with stage II colon cancer have been
published demonstrating the effect of testing on overall reclassification of patients when compared to
existing methods of risk analysis. There is no published information on the impact from use of GEP
results on patient outcomes. In the absence of information showing a direct effect on outcomes or
establishing a strong chain of evidence that testing would be expected to have a positive net effect on
outcomes, the clinical utility of testing remains unclear.

A Technical Brief published by the Agency for Healthcare Research and Quality (AHRQ) in December
2012 reviewed the clinical evidence for the use of gene expression profiling for predicting outcomes,
including benefit from adjuvant chemotherapy, in patients with stage II colon cancer. (22) The four
commercially available assays reviewed above were included in the brief. No prospective studies were
identified that assessed change in net health outcome with use of a GEP assay, and no studies were
identified that used a net reclassification analysis and subsequently evaluated the impact of the
reclassification on net health outcome. Additionally, evidence was limited regarding the reproducibility
of test findings, indications for GEP testing in stage II patients, and whether or not results of GEP
assays can stratify patients into clinically meaningful groups.

Ongoing Clinical Trials

The following relevant ongoing trials were identified from ClinicalTrials.gov:

NCT00903565. The ColoPrint® Assay is being prospectively validated in patients with stage II colon
cancer in the Prospective Analysis of Risk Stratification by Colo-Print (PARSC) study. Estimations of
3-year relapse rates by ColoPrint, ASCO criteria, and independent investigator risk assessment will
be compared. The study was begun in September 2008 with estimated enrollment of 1200 patients.
However, the ClinicalTrials.gov record has not been updated since March 2012.
Practice Guidelines and Position Statements

Current clinical practice guidelines from NCCN state that data are insufficient “to recommend the use of multigene assays to determine adjuvant therapy” in patients with stage II colon cancer. (2)

Summary

The available evidence indicates that gene expression profile tests for colon cancer can improve risk prediction, particularly regarding the risk of recurrence in patients with stage II colon cancer. However, the evidence to date is insufficient to permit conclusions on how GEP classification compares with other approaches for identifying recurrence risk in stage II patients or on how GEP classification impacts patient outcomes (clinical utility). There is even less evidence to permit conclusions on how GEP classification compares with other approaches for management of other stages of colon cancer. Therefore, use of this test, including use to predict the likelihood of disease recurrence for patients with colon cancer, is considered investigational.

References


Policy History

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<th>Date</th>
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<tbody>
<tr>
<td>December 2011</td>
<td>New Policy</td>
<td>Policy and references updated, rationale rewritten, no change to policy statement</td>
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<tr>
<td>December 2012</td>
<td>Update Policy</td>
<td>Policy updated with literature review; references 3, 17-19, and 22 added, reference 2 corrected. No change to policy statement.</td>
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Keywords

Microchip Array, Tumor Gene Expression, Colon Cancer
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Genomic Health
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This policy was approved by the FEP Pharmacy and Medical Policy Committee on December 6, 2013 and is effective January 15, 2014.

Signature on File

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