Chemosensitivity and Chemoresistance Assays in Cancer (for Tennessee Only)

Policy Number: CS133TN.M
Effective Date: January 1, 2021

Instructions for Use

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Related Community Plan Policy

- Molecular Oncology Testing for Cancer Diagnosis, Prognosis, and Treatment Decisions (for Tennessee Only)

Commercial Policy

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Application

This Medical Policy applies to Medicaid only plans in the state of Tennessee.

Coverage Rationale

Due to insufficient evidence of efficacy, chemosensitivity and chemoresistance assays are unproven and not medically necessary for predicting response to chemotherapy in individuals with cancer.

Applicable Codes

The following list(s) of procedure and/or diagnosis codes is provided for reference purposes only and may not be all inclusive. Listing of a code in this policy does not imply that the service described by the code is a covered or non-covered health service. Benefit coverage for health services is determined by federal, state, or contractual requirements and applicable laws that may require coverage for a specific service. The inclusion of a code does not imply any right to reimbursement or guarantee claim payment. Other Policies and Guidelines may apply.

CPT Code	Description
0083U	Oncology, response to chemotherapy drugs using motility contrast tomography, fresh or frozen tissue, reported as likelihood of sensitivity or resistance to drugs or drug combinations
0564T	Oncology, chemotherapeutic drug cytotoxicity assay of cancer stem cells (CSCs), from cultured CSCs and primary tumor cells, categorical drug response reported based on percent of cytotoxicity observed, a minimum of 14 drugs or drug combinations
81535	Oncology (gynecologic), live tumor cell culture and chemotherapeutic response by DAPI stain and morphology, predictive algorithm reported as a drug response score; first single drug or drug combination

CPT Code	Description
81536	Oncology (gynecologic), live tumor cell culture and chemotherapeutic response by DAPI stain and morphology, predictive algorithm reported as a drug response score; each additional single drug or drug combination (List separately in addition to code for primary procedure)
86849	Unlisted immunology procedure
89240	Unlisted miscellaneous pathology test

Description of Services

Chemotherapy sensitivity (or “chemosensitivity”) and chemotherapy resistance (or “chemoresistance”) assays are intended to assist the clinician in selecting optimal chemotherapies based on tumor response in individuals with cancer. Specifically, a chemosensitivity assay refers to an in vitro laboratory analysis that assesses whether a standard chemotherapy drug (or more commonly, a panel of drugs), inhibits tumor growth (assay result: “drug sensitive”). In contrast, a chemoresistance assay refers to an in vitro laboratory analysis that assesses whether standard chemotherapy drug(s) do not inhibit tumor growth (assay result: “drug resistant”) (Schrag et al., 2004).

Chemosensitivity and chemoresistance assays may also be referred to as chemotherapy sensitivity and resistance assays (CSRAs) or individualized tumor response testing (ITRT) (Bounaix Morand du Puch, et al., 2016).

Clinical Evidence

Chemosensitivity Assays

There is insufficient evidence in the clinical literature demonstrating that the use of chemosensitivity testing improves clinical decision making and outcomes compared with standard methods of treatment selection.

Chen et al. (2018) evaluated the in vitro CSRAs among 8 single-drug chemotherapies in 120 lung cancer patients and among 7 chemotherapy regimens in 291 lung cancer patients using ATP-TCA. Furthermore, the correlation between the in vitro chemosensitivity and clinical outcome was analyzed based on disease-free survival (DFS) and overall survival (OS). Approximately 31.7% of patients developed resistance to all 8 single-drug chemotherapies, and 25.8% of patients displayed resistance to all 7 chemotherapy regimens. Further analysis showed that patients with higher drug sensitivity tended to have longer DFS (18 months vs. 8.5 months) than patients displaying drug resistance. The authors suggest that the implementation of in vitro drug susceptibility testing before chemotherapy can effectively prevent the occurrence of primary drug resistance and inappropriate drug treatment for individuals with lung cancer. However, some problems remain in the in vitro clinical application which require further studies.

Jamal et al. (2017) conducted a retrospective analysis of 22 tumor specimens from head and neck cancer (HNC) patients that had been tested with the ChemoFx assay (Precision Therapeutics, Inc.) to determine the effectiveness of a phenotypic chemoresponse assay in predicting response to chemotherapy. All specimens were confirmed as being squamous cell carcinoma. Selection of treatment was at the discretion of the treating physician and the results of the assay were not used to determine the therapy. A portion of the patients' solid tumor was established in primary culture, then exposed to increasing doses of different chemotherapeutic agents. The resultant cell counts in the treated wells were used to indicate the tumors' response. Based on the dose response score curve, the test was scored as "responsive," "intermediate response," or "non-responsive." Of the 22 samples submitted, 16 (72.7%) showed adequate cell yield in cultures and subsequently underwent in vitro chemoresponse assays and are reported in this study, but 5 were excluded due to inadequate follow up. Of the 11 remaining patients, 9 showed a predictable chemoresponse assay (81.8% predictability of effective treatment). Three patients had a predictable good response, and 6 failed their chemotherapy regimen within 6 months of treatment and their chemoresponse assay showed an inadequate response to the agents used for treatment. At 3 years follow up, all patients who had a predictable poor response succumbed to their disease except 1, whose test showed intermediate response. The authors concluded that while the study had limitations, their findings demonstrated that chemoresponse assays may be useful adjuncts in the guiding the selection of chemotherapeutic agents in patients with HNC. Further research is required.

Ahn and colleagues (2017) performed an analysis to compare chemosensitivity by using the 21-gene recurrence score (RS) to predict the clinical benefit of chemotherapy for individuals with ER-positive/HER2-negative breast cancer. Among the patients with Oncotype Dx assay, 63 patients were identified who had chemotherapy response assays to doxorubicin based on adenosine triphosphate. The degree of chemosensitivity to doxorubicin was translated into the cell death rate (CDR). The RS was also dichotomized with a cutoff of 26. Of the 63 patients, 34 (54%), 17 (27%), and 12 patients (19%) had a low, intermediate, and high RS, respectively. The mean CDR differed significantly according to categorized RS, with 17.3±10.8 in the low RS group vs. 23.6±16.3 in the intermediate RS group vs. 28.8±12.6 in the high RS group. The mean CDR was significantly higher in the higher RS (26≥) group compared with the lower RS (<26) group, as well as in the high RS (>30) group compared with the low RS (<18) group. Also, continuous RS and CDR correlated positively. The authors concluded that the chemosensitivity measured by in vitro CRSA was different according to the RS, with their findings also supporting that tumors with high RS has the chemosensitivity even though they are luminal/HER2-negative tumors.

Tanigawa et al (2016) conducted a multicenter exploratory phase II trial to see whether a chemosensitivity test, the collagen gel droplet embedded culture drug sensitivity test (CD-DST), can adequately select patients with gastric cancer for postoperative adjuvant chemotherapy. The CD-DST using 4 different concentrations of 5-fluorouracil (5FU) was conducted with resected specimens from preregistered patients who underwent gastrectomy with D2 or more extensive lymphadenectomy. Patients who were histopathologically confirmed to have stage II or greater disease without distant metastasis were eligible for final enrollment. All patients underwent protocol-specified adjuvant chemotherapy with S-1. Three-year relapse-free survival was compared between patients determined as sensitive by the CD-DST (responders) and those deemed insensitive (nonresponders). Of the 311 patients enrolled, 14 were ineligible and 27 failed to start the protocol treatment. The CD-DST failed in 64 other patients, and survival analyses were conducted with the remaining 206 patients (39 stage II disease, 155 stage III disease, and 12 stage IV disease). The outcome of patients who were determined to be responders was significantly superior to that of nonresponders regardless of the 5FU concentrations, although no differences in clinicopathologic characteristics were observed between the 2 groups, except for age. The authors concluded that the CD-DST identified those who benefit from adjuvant chemotherapy, although it deserves further evaluation in the setting of a prospective randomized trial.

Davidson et al. conducted an analysis of primary tumor samples from 159 women with endometrioid endometrial cancer (EEC) to evaluate associations between tumor grade and in vitro chemoresponse. The study group consisted of 28 individuals with grade 1 (18%), 52 with grade 2 (32%), and 79 (50%) with grade 3 tumors. The age range of participants was 31-92 years. Results were classified as sensitive (S), intermediate (I), or resistant (R) to each drug tested. Correlations between tumor grade and response were examined. Most patients (64%) had advanced disease (stage III and IV). Overall chemoresponse was similar across all grades. “S” results to at least 1 agent were seen in 50%, 56% and 51% for grade 1, 2, and 3 tumors, respectively. There was no association between grade and in vitro response to chemotherapy agents except a marginal association between grade and doxorubicin response. Grade 1 and 2 disease was more likely to demonstrate “R” results for doxorubicin compared to grade 3 (G1: 19% vs G2: 25% vs G3: 8%). The authors concluded that grades 1-3 EEC have similar in vitro chemoresponse. These findings suggest that chemotherapy may be useful in advanced low-grade EECs, but further studies are needed (2016).

Monk et al. (2016) conducted an overview of the evolution of CSRAs used to predict outcomes in patients treated with chemotherapy that have been evaluated for use in epithelial ovarian cancer. The researchers stated that over time, changes in these assays have improved their prognostic and predictive value, but there is still a lack of widespread adoption due to methodological difficulties or limited clinical validation.

Bounaix Morand du Puch et al. led a prospective pilot clinical trial to assess the Oncogramme (Oncomedics, Limoges, France), a standardized process using tumor ex vivo models. The study evaluated Oncogramme’s technical feasibility and predictive effectiveness for 19 individuals with stage-IV colorectal cancer receiving currently approved chemotherapies as part of their treatment protocol. Researchers reported a very good sensitivity but a below-average specificity, weakening concordance but still allowing a global agreement of 63.6% (percentage of patients whose response to drugs was correctly predicted by the Oncogramme). Supplementary analysis, focusing on a subset of patients having received only one chemotherapeutic treatment for a longer time course, displayed improved specificity, agreement and concordance. The authors concluded that despite the small study size, these results overall demonstrate practicability and usefulness of the Oncogramme, and indicate future directions for global enhancement of the method (2016).

D’Arcangelo et al (2015) studied drug resistance and sensitivity of cancer stem cells to determine whether cancer stem cells isolation and in vitro sensitivity assay are feasible in a clinical setting. Referred to as the STELLA trial, cancer stem cells were

isolated from effusions or fresh cancer tissue of 23 patients who progressed after standard therapy failure, extracted from liver metastases in 6 cases (25%), lung nodules in 2 (8%), lymph node metastases in 3 (12.5%) and pleural/peritoneal/pericardial effusion in 13 (54%). The cells were exposed in vitro to chemotherapeutic and targeted agents with successful isolation in 15 patients (63%), including 14 with lung cancer (93.3%). A sensitivity assay was successfully performed in 7 patients (30.4%), with a median of 15 drugs/combinations tested (range 5-28) and a median time required for results of 51 days (range 37-95). The authors concluded that the approach used allowed isolation of cancer stem cells in a consistent proportion of patients. The low percentage of cases completing the full procedure and the long median time for obtaining results highlights the need for a more efficient procedure.

Rogalińska et al (2015) examined an in vitro system to determine the response of mononuclear blood cells from individuals with chronic lymphocytic leukemia (CLL) with the goal of improving the efficacy of therapeutic options in these patients. The study combined 4 approaches (i.e., cell viability, apoptosis rate, differential scanning calorimetry (DSC), and immunoblotting) to develop personalized therapy protocols based on the cell sensitivity to drug exposure. The complementary analyses were performed on 28 peripheral blood samples from previously untreated CLL patients before therapy. The induction and progress of apoptosis in CLL cells exposed in vitro to purine analogs combined with mafosfamide, i.e., cladribine + mafosfamide (CM) and fludarabine + mafosfamide (FM) were assessed using the above approaches. The changes in thermal profiles (decrease/loss of transition at 95±5˚C) coincided with an accumulation of apoptotic cells, a decrease in the number of viable cells, and differences in the expression of the apoptosis-related protein PARP-1. No significant changes were observed in the thermal profiles of nuclei isolated from CLL cells resistant to the treatment. The complementary assays revealed a strong relationship between both the in vitro sensitivity of leukemia cells to drugs and the clinical response of the patients, determined usually after the sixth course of treatment (after ~6 months of therapy). The authors conclusion suggests that in vitro incubations of leukemia cells with anticancer drugs is of predictive value and would help to select the optimal therapeutic strategy for individual patient in order to avoid ineffective treatment.

Two studies conducted correlational analyses of the MiCK assay for cancer patients. First, Strickland et al. (2013) evaluated the use of the MiCK assay in 109 patients with untreated acute myeloid leukemia (AML) to determine if use of the assay significantly predicted outcomes after standard AML induction therapy. Chemotherapy-induced apoptosis measured by the MiCK assay showed significant correlation with health outcomes and may be predictive of complete remission and OS for patients receiving standard induction chemotherapy. However, the study did not assess how disease management changes following use of the test and if important health outcomes, such as OS or PFS, improved.

Second, in a prospective blinded trial, Salom and colleagues (2012) examined if use of the MiCK assay could predict the best therapy for patients with ovarian cancer (n=104). The MiCK assay was performed prior to therapy, but treating physicians were blinded to assay results, and they selected treatment based on clinical criteria alone. Health outcomes, such as treatment response, time-to-relapse, and survival, were compared with drug-induced apoptosis as observed by the MiCK assay. Study results showed that overall survival (OS) in chemotherapy-naïve patients with stage III or IV disease was significantly longer if patients received a course of chemotherapy based on results of the MiCK assay, compared with shorter survival in patients who received a chemotherapy based on clinical criteria ($P < 0.01$; HR, 0.23). Multivariate model risk ratio showed that the use of the best chemotherapy in the MiCK assay was the strongest predictor of OS ($P<0.01$) in stage III or IV patients. Response rates were significantly higher if physicians used an active chemotherapy based on the MiCK assay. Study authors concluded that although these preliminary findings show that the MiCK assay may predict the chemotherapy associated with better outcomes in patients with ovarian cancer, future prospective randomized, controlled trials are needed to ascertain these results.

Chemoresistance Assays

There is insufficient evidence in the clinical literature demonstrating that the use of chemoresistance testing improves clinical decision making and outcomes compared with standard methods of treatment selection.

Howard et al. (2017) conducted a prospective study evaluating the use of the ChemoID drug response assay in glioblastoma (GBM) patients treated with standard of care. Forty-one patients (mean age 54 years, 59% male), all eligible for a surgical biopsy, were enrolled in an Institutional Review Board–approved protocol, and fresh tissue samples were collected for drug sensitivity testing. Patients were all treated with standard-of-care temozolomide (TMZ) plus radiation with or without maximal surgery, depending on the status of the disease. Patients were prospectively monitored for tumor response, time to recurrence, progression free survival (PFS), and OS. Odds ratio (OR) associations of 12-month recurrence, PFS, and OS outcomes were estimated for cancer stem cells (CSC), bulk tumor, and combined assay responses for the standard-of-care TMZ treatment; sensitivities/specificities, areas under the curve (AUCs), and risk reclassification components were examined. Median follow-up

was 8 months (range 3-49 months). For every 5% increase in *in vitro* CSC cell kill by TMZ, 12-month patient response (nonrecurrence of cancer) increased two-fold, OR=2.2 (*P*=.016). Similar but somewhat less supported associations with the bulk tumor test were seen, OR=2.75 (*P*=.07) for each 5% bulk tumor cell kill by TMZ. Combining CSC and bulk tumor assay results in a single model yielded a statistically supported CSC association, OR=2.36 (*P*=.036), but a much-attenuated remaining bulk tumor association, OR=1.46 (*P*=.472). AUCs and [sensitivity/specificity] at optimal outpoints (>40% CSC cell kill and >55% bulk tumor cell kill) were AUC=0.989 [sensitivity=100/specificity=97], 0.972 [100/89], and 0.989 [100/97] for the CSC only, bulk tumor only, and combined models, respectively. Median recurrence time was 20 months for patients with a positive (>40% cell kill) CSC test versus only 3 months for those with a negative CSC test, whereas median recurrence time was 13 months versus 4 months for patients with a positive (>55% cell kill) bulk test versus negative. Similar favorable results for the CSC test were observed for PFS and OS outcomes. Panel results across 14 potential other treatments indicated that 34/41 (83%) potentially more optimal alternative therapies may have been chosen using CSC results, whereas 27/41 (66%) alternative therapies may have been chosen using bulk tumor results. The authors concluded that this prospective study showed statistically significant improved response rate (2.2-fold increase) in patients who were given assay-indicated chemotherapy. Larger trials will potentially provide additional statistical proof of assay-directed therapy versus empirical physician choice to determine the validity of ChemoID drug response assay directed toward CSCs, which contribute to tumor propagation, maintenance, and treatment resistance.

Peterse et al (2016) studied expression of mediators of IGF1R signaling and phosphorylation status of IRS1 in chondrosarcoma cell lines by qRT-PCR and Western blot. A total of 10 chondrosarcoma cell lines were treated with OSI-906 (IGF1R and IR dual inhibitor) after which cell proliferation and migration were determined by a viability assay and the xCELLigence system, respectively. In addition, 4 chondrosarcoma cell lines were treated with a combination of doxorubicin and OSI-906. By immunohistochemistry treatment with IGF1R/IR inhibitors did not impact proliferation or migration in any of the chondrosarcoma cell lines, even upon stimulation with IGF1. Although synergistic effects of IGF1R/IR inhibition with doxorubicin have been described for other cancers, the findings demonstrated that this was not the case for chondrosarcoma. In addition, the study detected minimal IGF1R expression in primary tumors in contrast to the high expression detected in chondrosarcoma cell lines, even if both were derived from the same tumor which suggests in-vitro culturing up-regulated IGF1R expression. The authors concluded that the IGF pathway is not expected to be an effective therapeutic marker for chondrosarcoma of bone as IGF1R is only minimally expressed in primary tumors.

Sumiyoshi et al. (2016) examined the expression and role of STAT5b in human pancreatic ductal adenocarcinoma (PDAC) cell lines. Expressions of STAT5b mRNA and protein were detected in 8 kinds of pancreatic cancer cells. STAT5b shRNA clones in PANC-1 cells, which express relatively high levels of STAT5b, exhibited reduced chemoresistance against gemcitabine, adhesion and invasion compared to sham. Conversely, AsPC-1 and BxPC3 cells, which express relatively low levels of STAT5b, exhibited reduced chemoresistance compared to PANC-1 cells. Moreover, STAT5b overexpression clones in AsPC-1 cells exhibited increased chemoresistance compared to sham. STAT5b shRNA clones in PANC-1 cells were more sensitive to the proapoptotic actions of gemcitabine, as evidenced by PARP and cleaved caspase-3 activation. Gemcitabine also significantly reduced Bcl-xL levels in the STAT5b shRNA-expressing cells. While a significant correlation between STAT5b expression and OS rates was not observed, a significant correlation with main pancreatic duct invasion was observed. The authors' findings suggest that targeting STAT5b in PDAC may enhance the effectiveness of other therapeutic modalities by enhancing gemcitabine chemosensitivity, increasing apoptosis and suppressing cellular adhesion and invasion.

National Comprehensive Cancer Network (NCCN) Clinical Practice Guidelines in Oncology for ovarian cancer state that chemosensitivity/resistance and/or other biomarker assays are being used in some NCCN Member Institutions for decisions related to future chemotherapy in situations where there are multiple equivalent chemotherapy options available. The current level of evidence is not sufficient to supplant standard of care chemotherapy. The NCCN panel also stated that in vitro chemosensitivity testing to choose a chemotherapy regimen for recurrent disease should not be recommended due to lack of demonstrated efficacy (NCCN, 2020).

There are multiple open clinical trials studying drug response assays and cancer. For more information, go to www.clinicaltrials.gov. (Accessed September 17, 2020)

Professional Societies

American Society of Clinical Oncology (ASCO)

A 2011 clinical practice guideline update states that the use of chemotherapy sensitivity and resistance assays to select chemotherapeutic agents for individual patients is not recommended outside of a clinical trial setting (Burstein et al., 2011).

U.S. Food and Drug Administration (FDA)

This section is to be used for informational purposes only. FDA approval alone is not a basis for coverage.

Laboratories that perform in vitro chemosensitivity and chemoresistance testing are regulated by the FDA under the Clinical Laboratory Improvement Amendments (CLIA). See the following website for more information: https://www.fda.gov/medical-devices/ivd-regulatory-assistance/clinical-laboratory-improvement-amendments-clia. (Accessed September 17, 2020)

Centers for Medicare and Medicaid Services (CMS)

Medicare does not cover human tumor drug sensitivity assays as they are considered experimental. Refer to the National Coverage Determination (NCD) for Human Tumor Stem Cell Drug Sensitivity Assays (190.7). Local Coverage Determinations (LCDs) exist; see to the LCDs for In Vitro Chemosensitivity & Chemoresistance Assays, MolDX: Molecular Diagnostic Tests (MDT) and Molecular Diagnostic Tests (MDT). (Accessed September 18, 2020)

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Policy History/Revision Information

Date	Summary of Changes
05/01/2021	Template Update • Replaced reference to "MCG™ Care Guidelines" with "InterQual® criteria" in *Instructions for Use*
01/01/2021	Template Update • Reformatted policy; transferred content to new template Related Policies • Added reference link to the Medical Policy titled *Molecular Oncology Testing for Cancer Diagnosis, Prognosis, and Treatment Decisions (for Tennessee Only)* • Removed reference link to the Medical Policy titled *Genetic Testing for Cardiac Disease (for Tennessee Only)* Coverage Rationale • Replaced reference to "patients" with "individuals" Supporting Information • Updated *Clinical Evidence*, *FDA*, and *References* sections to reflect the most current information • Archived previous policy version CS133TN.L

Instructions for Use

This Medical Policy provides assistance in interpreting UnitedHealthcare standard benefit plans. When deciding coverage, the federal, state or contractual requirements for benefit plan coverage must be referenced as the terms of the federal, state or contractual requirements for benefit plan coverage may differ from the standard benefit plan. In the event of a conflict, the federal, state or contractual requirements for benefit plan coverage govern. Before using this policy, please check the federal, state or contractual requirements for benefit plan coverage. UnitedHealthcare reserves the right to modify its Policies and Guidelines as necessary. This Medical Policy is provided for informational purposes. It does not constitute medical advice.

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