Corporate Medical Policy

In Vitro Chemoresistance and Chemosensitivity Assays AHS- G2100

File Name: in_vitro_chemoresistance_and_chemosensitivity_assays
Origination: 1/1/2019
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Description of Procedure or Service

In vitro chemotherapy sensitivity and resistance assays refer to any in vitro laboratory analysis that is performed specifically to evaluate whether tumor growth is inhibited by a known chemotherapy drug or, more commonly, a panel of drugs (Hatok et al., 2009; Schrag et al., 2004).

******Note: This Medical Policy is complex and technical. For questions concerning the technical language and/or specific clinical indications for its use, please consult your physician.***

Policy

In vitro chemoresistance and chemosensitivity assays are not covered. BCBSNC will not reimburse for non-covered services or procedures.

Benefits Application

This medical policy relates only to the services or supplies described herein. Please refer to the Member's Benefit Booklet for availability of benefits. Member's benefits may vary according to benefit design; therefore member benefit language should be reviewed before applying the terms of this medical policy.

When In Vitro Chemoresistance and Chemosensitivity Assays are covered

Not applicable

When In Vitro Chemoresistance and Chemosensitivity Assays are not covered

Reimbursement is not allowed for in vitro chemosensitivity assays, including, but not limited to, the histoculture drug response assay or a fluorescent cytoprint assay.

Reimbursement is not allowed for in vitro chemoresistance assays, including, but not limited to, extreme drug resistance assays.

Policy Guidelines

Chemotherapy treatment recommendation has long been based on carefully designed clinical studies in large patient populations and provide an individual patient with a probability for response based on clinically observed response rates. This approach has led to major progress in clinical oncology and has helped to identify successful therapeutic regimens for patients with many cancers. However, the response rates are relatively low and there are still many cancers for which there is only marginal treatment. Tumor cells isolated from these patients often are resistant to a wide range of anticancer drugs. In addition, it is becoming clear that each individual patient's tumor is genotypically and phenotypically different (Hatok et al., 2009).

Chemotherapy sensitivity and resistance assays were developed to determine if a cancer might be resistant or sensitive to a specific chemotherapy treatment prior to use. A chemosensitivity assay detects the effects (cytoxic, apoptotic, and so on) of a given chemotherapeutic agent outside an organism. The assays vary, but typically they follow the same steps: cells from the patient are isolated, incubated with the chemotherapeutic agent, and assessed for cell survival and cell response (Hatok et al., 2009; Tatar et al., 2016). This assay allows clinicians to evaluate the effects of the chemotherapeutic agent without unnecessary exposure to cells. However, there are difficulties with these assays; for example, the potency of a chemotherapeutic agent may only be seen after time has elapsed. Many assays have been created to assess the potency of chemotherapeutic agents, including proprietary tests such as ChemoFX and ChemoINTEL, as well as non-proprietary assays such as 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolyum bromide (MTT), adenosine triphosphate-tumor chemosensitivity (ATP-TCA), and differential staining cytotoxicity (DISC) (Tatar et al., 2016).

Chemosensitivity assays typically rely on the use of cell cultures within the presence of the anticancer agent(s). For example, the MTT procedure involves culturing tumor cells with anticancer agents, then adding MTT, which is reduced to a blue dye in the cell. The intensity of the uptake allows the user to estimate the drug resistance of the tumor cells. DISC cultures tumor cells in three different concentrations of the drug, incubates them for 6 days, then uses differential dye staining to identify viable cells (Hatok et al., 2009). Several proprietary assays exist, such as ChemoFX (from Precision Therapeutics now merged with Helomics), which exposes tumor cells to increasing doses of chemotherapeutic drugs, and the number of live cells remaining post-treatment is counted. These counts are combined into a dose-response curve, which is used to categorize a tumor's response as "responsive," "intermediate response," or "non-responsive" (Brower et al., 2008). Another proprietary test is the Microculture-Kinetic (MiCK) assay (Pierian Biosciences) (Grendys et al., 2014; Pierian, 2021). This test relies on drug-induced apoptosis with the quantification of tumor cells' response to chemotherapeutic agents. This test is now branded as ChemoINTEL (Pierian, 2021). A third proprietary test comes from RGCC, titled "Onconomics". This test evaluates both molecular markers and viability assessments to determine efficacy of certain drugs. However, this test does follow the same pattern as the previously discussed tests; developing cell cultures and examining effects of chemotherapeutic agents on their population (RGCC, 2021). Other proprietary assays include human tumor cell assays (HTCA) and human tumor cloning assays.

Recent advances have led to new proprietary tests on the market, such as the KIYATEC Inc. ex vivo 3D cell culture technology, which predicts "in vivo cancer drug efficacy through precision ex vivo response profiling," by using live cancer cells from surgical and/or biopsy specimens to create a tumor specific to the patient genetic profile (KIYATEC, 2021). This manufactured tumor is then used to investigate the patient's potential responses to chemotherapy regimens or drugs. A second new proprietary test, from Theralink, uses a reverse phase protein array (RPPA) test to evaluate over 600 different protein and phosphoprotein targets on a cell's surface. The test is used to evaluate whether FDA-approved cancer therapies and investigational treatments will be effective based on cell surface proteins. Theralink's technology seeks to reduce exposure of patients to cytotoxic treatments and therapies through analysis of drug-protein interactions that drive treatment responses (Theralink, 2021).

Clinical Utility and Validity

Tatar et al (2016) conducted a study assess three in vitro chemosensitivity assays in ovarian carcinoma. 26 patients diagnosed with ovarian carcinoma contributed tumoral tissue, and three assays (the MTT assay, the ATP-TCA assay, and the DISC assay) were used to evaluate the chemosensitivity of paclitaxel, carboplatin, docetaxel, topotecan, gemcitabine, and doxorubicin. The authors stated that all three assays correlated reasonably well with each other and are "particularly useful for serous and advanced cancers." However, they caution that "large prospective studies comparing standard versus assay-directed therapy with an endpoint of overall survival are required before the routine clinical utilization of these assays." (Tatar et al., 2016.

Kwon et al (2016) "evaluated the usefulness of the in vitro adenosine triphosphate-based chemotherapy response assay (ATP-CRA) for prediction of clinical response to fluorouracil-based adjuvant chemotherapy in stage II colorectal cancer. Tumor specimens of 86 patients with stage II colorectal adenocarcinoma were tested for chemosensitivity to fluorouracil, and chemosensitivity was determined by cell death rate (CDR) of the drug-exposed cells. In total, 11 of the 86 patients had a recurrence, and the group with CDR >20% was associated with better disease-free survival than the group under 20%. The authors concluded that “in stage II colorectal cancer, the in vitro ATP-CRA may be useful in identifying patients likely to benefit from fluorouracil-based adjuvant chemotherapy” (Kwon et al., 2016).

Krivak et al (2014) conducted an observational study to evaluate if a ChemoFx assay can identify patients who are platinum-resistant prior to treatment. The study included 276 women with International Federation of Gynecology and Obstetrics stage III-IV ovarian, fallopian, and peritoneal cancer, and the responsiveness of their tumors was evaluated. All patients were treated with a platinum/taxane regimen following cytoreductive surgery. The authors found that the patients whose tumors were resistant to carboplatin were at increased risk of disease progression compared to those who were nonresistant. The authors stated that “assay resistance to carboplatin is strongly associated with shortened PFS among advanced-stage epithelial ovarian cancer patients treated with carboplatin + paclitaxel therapy, supporting use of this assay (ChemoFx) to identify patients likely to experience early recurrence on standard platinum-based therapy” (Krivak et al., 2014).

Rutherford et al (2013) conducted a prospective study evaluating the use of a ChemoFx assay in recurrent ovarian cancer patients. The study included 252 women with persistent or recurrent ovarian cancer and fresh tissue samples were collected for chemoresponse testing. Patients were treated with one of 15 protocol-designated treatments empirically selected by the oncologist, blinded to the assay results. Patients were prospectively monitored for progression-free survival (PFS) and overall survival (OS). Patients treated with an assay-sensitive regimen demonstrated significantly improved PFS and OS while there was no difference in clinical outcomes between intermediate and resistant groups. The researchers concluded that the “study demonstrated improved PFS and OS for patients with either platinum-sensitive or platinum-resistant recurrent ovarian cancer treated with assay-sensitive agents” (Rutherford et al., 2013).

Hoffman (2018) conducted a study investigating the clinical correlation of histoculture drug response assay (HDRA) in 29 advanced gastric and colon cancer patients. The authors revealed that all 29 were being treated with drugs considered “ineffective” by the HDRA. However, nine patients were also being treated with drugs identified as “effective” by the HDRA, and these patients showed response or arrest of disease progression. The authors investigated another subset of 32 patients treated with mitomycin C and 5-fluorouracil (5-FU) and whom had advanced gastric cancer. Ten patients were identified as “sensitive” to these drugs, and their survival rates were higher than the other 22 whose tumors were “insensitive”.” A separate 128-patient subset had their tumors evaluated by the HDRA, and the overall and disease-free survival rate was higher for the sensitive group compared to the resistant group. Overall, both “sensitive” groups experienced higher survival rates (Hoffman, 2018).

Strickland et al., (2013) evaluated the correlation of the MiCK assay with patient outcomes in initial treatment of adult acute myelocytic leukemia (AML). 109 patients with untreated AML contributed samples for the MiCK assay. The amount of apoptosis was measured over 48 hours and standardized to “kinetic units” of apoptosis (KU). The authors observed that complete remission (CR) was “significantly” higher in patients with high idarubicin-induced apoptosis (>3 KU) compared to patients with <3 KU. A multivariate analysis indicated the only significant variable to be idarubicin-induced apoptosis. The authors concluded, “Chemotherapy-induced apoptosis measured by the MiCK assay demonstrated significant correlation with outcomes and appears predictive of complete remission and overall survival for patients receiving standard induction chemotherapy” (Strickland et al., 2013).

Howard et al. (2017) developed and assessed a “chemopredictive” assay (ChemoID), which was intended to identify the most effective chemotherapy out of a panel of selected treatments. ChemoID evaluates the efficacy of chemotherapies using a patient’s live tumor cells, as well as the cancer stem cells (CSC) that are purported to cause recurrence in patients. The study included 42 glioblastoma patients were treated with standard of card temozolomide (TMZ). Clinical outcomes such as “tumor response, time to recurrence, progression-free survival (PFS), and overall survival (OS). Odds ratio (OR) associations of

12-month recurrence, PFS, and OS outcomes" were estimated. The authors found that for every 5% increase in CSC kill by TMZ, 12-month patient response (defined as "nonrecurrence of cancer") increased by 2.2-fold. The authors also identified a less significant association with the bulk tumor cells; a 5% increase in bulk tumor cell kill corresponded with a 2.75-fold increase in nonresponse ($p = .07$). At >40% cell kill for CSC and >55% cell kill for bulk tumor cells, the area under curve was 0.989. Median recurrence time was 20 months for patients with a positive (defined as >40%) CSC test, compared to three months for patients with a negative test. Similarly, median recurrence time was 13 months for patients with a positive bulk tumor cell test (>55%), compared to 4 months for a negative test. Finally, the ChemoID CSC results were found to "potentially" identify more optimal treatments in 34 patients, while the bulk tumor results may have resulted in more optimal treatments in 27 patients. Overall, the authors concluded that "the ChemoID CSC drug response assay has the potential to increase the accuracy of bulk tumor assays to help guide individualized chemotherapy choices" (Howard et al., 2017).

Chen et al. (2018) evaluated in vitro chemosensitivity and multiple drug resistance (MDR) using an ATP-based tumor chemosensitivity assay (ATP-TCA). The authors evaluated 120 lung cancer patients' chemosensitivity to eight single drug chemotherapies and 291 lung cancer patients' chemosensitivity to seven chemotherapy regimens. Additionally, 284 lung adenocarcinoma patients and 90 lung squamous cell carcinoma patients were evaluated for chemosensitivity to both single-drug and chemotherapy regimens. Authors found that "PTX (51.7%), TXT (43.3%), GEM (12.5%), PTX+DDP (62.5%), TXT+L-OHP (54.3%) and VP-16+DDP (16.2%) had the highest in vitro chemosensitivity rates." Additionally, approximately 37.1% of patients developed resistance to eight single-drug chemotherapies. 25.8% showed resistance to all seven chemotherapy regimens. In conclusion, testing for drug sensitivity before chemotherapy could assist in preventing the "occurrence of primary drug resistance and inappropriate drug treatment" (Chen et al., 2018).

State and Federal Regulations, as applicable

Food and Drug Administration (FDA)

Many labs have developed specific tests that they must validate and perform in house. These laboratory-developed tests (LDTs) are regulated by the Centers for Medicare and Medicaid (CMS) as high-complexity tests under the Clinical Laboratory Improvement Amendments of 1988 (CLIA '88). LDTs are not approved or cleared by the U. S. Food and Drug Administration; however, FDA clearance or approval is not currently required for clinical use.-

Practice Guidelines and Position Statements

American Society of Clinical Oncology (ASCO)

The 2011 clinical practice guideline update (Burstein et al., 2011) states that: "The use of chemotherapy sensitivity and resistance assays to select chemotherapeutic agents for individual patients is not recommended outside of the clinical trial setting. Oncologists should make chemotherapy treatment recommendations on the basis of published reports of clinical trials and a patient's health status and treatment preferences. Because the in-vitro analytic strategy has potential importance, participation in clinical trials evaluating these technologies remains a priority" (Burstein et al., 2011).

National Comprehensive Cancer Network (NCCN)

The NCCN Practice Guidelines in Oncology for Ovarian Cancer (NCCN, 2021b) state that: "chemosensitivity/resistance and/or other biomarker assays are being used at 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". This is a category 3 recommendation (based on any level of evidence but reflects major disagreement).

Chemosensitivity/resistance testing is not mentioned in the guidelines for gastric, colon, or prostate cancers (NCCN, 2021a).

Billing/Coding/Physician Documentation Information

This policy may apply to the following codes. Inclusion of a code in this section does not guarantee that it will be reimbursed. For further information on reimbursement guidelines, please see Administrative Policies on the Blue Cross Blue Shield of North Carolina web site at www.bcbsnc.com. They are listed in the Category Search on the Medical Policy search page.

Applicable service codes: 0083U, 0248U, 0249U, 0285U, 81535, 81536, 86849, 88104, 88199, 88305, 88313, 88358, 89050, 89240

ICD-10 Codes- All within range C00.0-D09.9

BCBSNC may request medical records for determination of medical necessity. When medical records are requested, letters of support and/or explanation are often useful, but are not sufficient documentation unless all specific information needed to make a medical necessity determination is included.

Scientific Background and Reference Sources

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Medical Director review 11/2019

Specialty Matched Consultant Advisory Panel 4/2020

Medical Director review 4/2020

Medical Director review 10/2020

Specialty Matched Consultant Advisory Panel 3/2021

Medical Director review 3/2021

Medical Director review 11/2022

Policy Implementation/Update Information

1/1/2019 New policy developed. In vitro chemoresistance and chemosensitivity assays are considered investigational for all applications. Medical Director review 1/1/2019. Policy noticed 1/1/2019 for effective date 4/1/2019. (lpr)

12/10/19 Reviewed by Avalon 3rd Quarter 2019 CAB. Coding table removed and CPT code 0083U added to Billing/Coding section. No change to policy statement. Medical Director review 11/2019. (lpr)

5/26/20 Specialty Matched Consultant Advisory Panel review 4/15/2020. No change to policy statement. (lpr)

11/10/20 Reviewed by Avalon 3rd Quarter 2020 CAB. Wording in the Policy, When Covered, and/or Not Covered section(s) changed from Medical Necessity to Reimbursement language, where appropriate. Updated references and policy guidelines section. Literature review. Medical Director review 10/2020. (lpr)

4/6/21 Specialty Matched Consultant Advisory Panel review 3/17/2021. No change to policy statement. (lpr)

11/16/21 Reviewed by Avalon 3rd Quarter 2021 CAB. Updated policy guidelines and references. Added PLA code 0248U to Billing/Coding section. Medical Director review 10/2021. (lpr)

2/8/22 Reviewed by Avalon Q4 2021 CAB. Added CPT code 0564T to Billing/Coding section. Medical Director review 1/2022. No change to policy statement. (lpr)

12/13/22 Reviewed by Avalon Q3 2022 CAB. Added CPT codes 0249U, 0285U, 0324U, 0325U; deleted CPT 0564T in Billing/Coding section. References updated. Medical Director review 11/2022. No change to policy statement. (lpr)

5/16/23 Deleted CPT codes 0324U and 0325U from Billing/Coding section per Avalon Q1 2023 CAB. No change to policy statement. (lpr)