

Medical Coverage Policy | Laboratory Tests Post Transplant and for Heart Failure



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OVERVIEW

Clinical assessment and noninvasive imaging of chronic heart failure can be limited in accurately diagnosing patients with heart failure because symptoms and signs can poorly correlate with objective methods of assessing cardiac dysfunction. For management of heart failure, clinical signs and symptoms (eg, shortness of breath) are relatively crude markers of decompensation and occur late in the course of an exacerbation. Thus, circulating biomarkers have potential benefit in heart failure diagnosis and management.

In transplant recipients, despite the progress in immunosuppressant therapy, risk of rejection remains. Diagnosis of allograft rejection continues to rely on clinical monitoring and histologic confirmation by tissue biopsy. However, due to limitations of tissue biopsy, including a high degree of interobserver variability in the grading of results and its potential complications, less invasive alternatives have been investigated. Several laboratory-tested biomarkers of transplant rejection have been evaluated and are commercially available for use.

The following tests are addressed in this policy:

- AlloMap (CareDx) CPT code 81595
- AlloSure Heart (CareDx) CPT code 81479
- AlloSure Kidney (CareDx) CPT code 81479
- AlloSure Lung (CareDx) CPT code 81479
- HeartCare (CareDx) CPT code 81479
- Heartsbreath (Menssana Research) CPT code 81479
- Molecular Microscope® MMDx—Heart (Kashi Clinical Laboratories) CPT code 0087U
- Molecular Microscope® MMDx—Kidney (Kashi Clinical Laboratories) CPT code 0088U
- myTAIHEART (TAI Diagnostics) CPT code 0055U
- Pleximark™ (Plexision, Inc.) CPT code 0018M
- Presage ST2 Assay (Critical Diagnostics) CPT code 83006
- Prospera™ (Natera™) CPT code 0493U
- QSant™ (NephroSant) CPT code 81599
- TRAC™ dd-cfDNA (Transplant Genomics Inc) CPT code 0118U (Formerly Known as Viracor TRAC dd-cfDNA (Viracor Eurofins) Prior to 10/1/2024)
- VitaGraft™ Kidney Baseline + 1st Plasma Test (Oncocyte Corporation) CPT code 0508U (New Code Effective 10/1/2024)
- VitaGraft™ Kidney Subsequent (Oncocyte Corporation) CPT code 0509U (New Code Effective 10/1/2024)

MEDICAL CRITERIA

Medicare Advantage Plans and Commercial Products

AlloSure Heart (CPT code 81479), **AlloSure Kidney** (CPT code 81479), **Prospera™** (CPT code 0493U), **QSant™** (CPT code 81599), **TRAC™ dd-cfDNA** (Formerly Known as Viracor TRAC dd-cfDNA; CPT code 0118U), **VitaGraft™ Kidney Baseline + 1st Plasma Test** (CPT code 0508U) and **VitaGraft™ Kidney Subsequent** (CPT code 0509U):

AlloSure Heart, AlloSure Kidney, Prospera™, QSant™, TRAC™ dd-cfDNA (Formerly Known as Viracor TRAC dd-cfDNA), VitaGraft™ Kidney Baseline + 1st Plasma Test, VitaGraft™ Kidney Subsequent may be considered medically necessary when all of the following criteria are met:

- The test must provide information about at least one of the two following clinical status determinations:
 - Active Rejection (AR) status, OR
 - Cellular or Antibody-mediated rejection (ACR or AMR) status
- The intended use of the test must be:
 - To assist in the evaluation of adequacy of immunosuppression, wherein a non-invasive or minimally invasive test can be used in lieu of a tissue biopsy in a patient for whom information from a tissue biopsy would be used to make a management decision regarding immunosuppression, OR
 - As a rule-out test for AR in validated populations of patients with clinical suspicion of rejection with a non-invasive or minimally invasive test to make a clinical decision regarding obtaining a biopsy, OR
 - For further evaluation of allograft status for the probability of allograft rejection after a physician assessed pretest, OR
 - To assess rejection status in patients that have received a biopsy, but the biopsy results are inconclusive or limited by insufficient material.
- The test is being used in a patient who is part of the population in which the test was analytically validated and has demonstrated clinical validity (CV).
- For a given patient encounter, only one molecular test for assessing allograft status may be performed UNLESS a second test, meeting all the criteria established herein, is reasonable and necessary as an adjunct to the first test.
- The test successfully completes a Technical Assessment that will ensure that analytical validity (AV), CV, and clinical utility criteria set in this policy are met to establish the test as reasonable and necessary.

HeartCare* (CPT code 81479)

***Note:** HeartCare provides a comprehensive assessment of graft rejection by combining AlloMap with AlloSure Heart. Therefore, as AlloMap is a covered service for Medicare Advantage Plans, HeartCare may be medically necessary dependent on the medical necessity determination of AlloSure Heart, in accordance with the medical criteria found above. For Commercial Products, both the criteria for AlloMap (found in the online authorization tool) and the criteria for AlloSure Heart (found above) need to be met for coverage of the HeartCare test.

Commercial Products

Prior authorization is recommended for the following test. Medical necessity is determined using the medical criteria found in the online authorization tool. Please refer to the Related Policies section below:

- **AlloMap** (CPT code 81595)

PRIOR AUTHORIZATION

Medicare Advantage Plans and Commercial Products

Prior authorization is required for the following tests:

- AlloSure Heart
- AlloSure Kidney
- HeartCare
- Prospera™
- QSant™
- TRAC™ dd-cfDNA (Formerly Known as Viracor TRAC dd-cfDNA)
- VitaGraft™ Kidney Baseline + 1st Plasma Test
- VitaGraft™ Kidney Subsequent

Commercial Products

Prior authorization is recommended for the following test via the online authorization tool. Please refer to the Related Policies section below:

- **AlloMap**

Medicare Advantage Plans and Commercial Products

There is no specific CPT coding for some of the services referenced in this policy. Therefore, an Unlisted CPT code should be used (see Coding Section for details). All Unlisted genetic testing CPT codes require prior authorization to determine what service is being rendered and if the service is covered or not medically necessary. See the Related Policies section.

Note: Laboratories are not allowed to obtain clinical authorization or participate in the authorization process on behalf of the ordering physician. Only the ordering physician shall be involved in the authorization, appeal or other administrative processes related to prior authorization/medical necessity.

In no circumstance shall a laboratory or a physician/provider use a representative of a laboratory or anyone with a relationship to a laboratory and/or a third party to obtain authorization on behalf of the ordering physician, to facilitate any portion of the authorization process or any subsequent appeal of a claim where the authorization process was not followed and/or a denial for clinical appropriateness was issued, including any element of the preparation of necessary documentation of clinical appropriateness. If a laboratory or a third party is found to be supporting any portion of the authorization process, BCBSRI will deem the action a violation of this policy and severe action will be taken up to and including termination from the BCBSRI provider network. If a laboratory provides a laboratory service that has not been authorized, the service will be denied as the financial liability of the participating laboratory and may not be billed to the member.

POLICY STATEMENT

Medicare Advantage Plans and Commercial Products

The following test is covered for Medicare Advantage Plans and is considered medically necessary for Commercial Products when the criteria found in the online authorization tool has been met:

- AlloMap

The following tests may be considered medically necessary when the medical criteria above are met:

- AlloSure Heart
- AlloSure Kidney
- HeartCare*
- Prospera™
- QSant™
- TRAC™ dd-cfDNA (Formerly Known as Viracor TRAC dd-cfDNA)
- VitaGraft™ Kidney Baseline + 1st Plasma Test
- VitaGraft™ Kidney Subsequent

***Note:** HeartCare provides a comprehensive assessment of graft rejection by combining AlloMap with AlloSure Heart. Therefore, as AlloMap is a covered service for Medicare Advantage Plans, HeartCare may be medically necessary dependent on the medical necessity determination of AlloSure Heart, in accordance with the medical criteria found above. For Commercial Products, both the criteria for AlloMap (found in the online authorization tool) and the criteria for AlloSure Heart (found above) need to be met for coverage of the HeartCare test.

The following tests are not covered for Medicare Advantage Plans and not medically necessary for Commercial Products as the evidence is insufficient to determine the effects of the technology on health outcomes:

- AlloSure Lung
- Heartsbreath
- Molecular Microscope® MMDx—Heart

- Molecular Microscope® MMDx—Kidney
- myTAIHEART
- Pleximark™
- Presage ST2 Assay

Commercial Products

Some genetic testing services are not covered and a contract exclusion for any self-funded group that has excluded the expanded coverage of biomarker testing related to the state mandate, R.I.G.L. §27-19-81 described in the Biomarker Testing Mandate policy. For these groups, a list of which genetic testing services are covered with prior authorization, are not medically necessary or are not covered because they are a contract exclusion can be found in the Coding section of the Genetic Testing Services or Proprietary Laboratory Analyses policies. Please refer to the appropriate Benefit Booklet to determine whether the member's plan has customized benefit coverage. Please refer to the list of Related Policies for more information.

COVERAGE

Benefits may vary between groups and contracts. Please refer to the appropriate Benefit Booklet, Evidence of Coverage or Subscriber Agreement for applicable laboratory benefits/coverage.

BACKGROUND

HEART FAILURE

Heart failure is a major cause of morbidity and mortality worldwide. The term *heart failure* refers to a complex clinical syndrome that impairs the heart's ability to move blood through the circulatory system. The prevalence of heart failure in the U.S. between 2013 and 2016 was an estimated 6.2 million for Americans ≥ 20 years old, up from 5.7 million from between 2009 and 2012. Heart failure is the leading cause of hospitalization among people older than age 65 years, with direct and indirect costs estimated at \$37 billion annually in the U.S. Although survival has improved with treatment advances, absolute mortality rates of heart failure remain near 50% within 5 years of diagnosis.

Physiology

Heart failure can be caused by disorders of the pericardium, myocardium, endocardium, heart valves or great vessels, or metabolic abnormalities. Individuals with heart failure may present with a wide range of left ventricular (LV) anatomy and function. Some have normal LV size and preserved ejection fraction; others have severe LV dilatation and depressed ejection fraction. However, most patients present with key signs and symptoms secondary to congestion in the lungs from impaired LV myocardial function. They include dyspnea, orthopnea, and paroxysmal dyspnea. Other symptoms include weight gain due to fluid retention, fatigue, weakness, and exercise intolerance secondary to diminished cardiac output.

Diagnosis

Initial evaluation of a patient with suspected heart failure is typically based on clinical history, physical examination, and chest radiograph. Because people with heart failure may present with nonspecific signs and symptoms (eg, dyspnea), accurate diagnosis can be challenging. Therefore, noninvasive imaging procedures (eg, echocardiography, radionuclide angiography) are used to quantify pump function of the heart, thus identifying or excluding heart failure in patients with characteristic signs and symptoms. These tests can also be used to assess prognosis by determining the severity of the underlying cardiac dysfunction. However, clinical assessment and noninvasive imaging can be limited in accurately evaluating patients with heart failure because symptoms and signs can poorly correlate with objective methods of assessing cardiac dysfunction. Thus, invasive procedures (eg, cardiac angiography, catheterization) are used in select patients with presumed heart failure symptoms to determine the etiology (ie, ischemic vs. nonischemic) and physiologic characteristics of the condition.

Treatment

Patients with heart failure may be treated using a number of interventions. Lifestyle factors such as the restriction of salt and fluid intake, monitoring for increased weight, and structured exercise programs are

beneficial components of self-management. A variety of medications are available to treat heart failure. They include diuretics (eg, furosemide, hydrochlorothiazide, spironolactone), angiotensin-converting enzyme inhibitors (eg, captopril, enalapril, lisinopril), angiotensin receptor blockers (eg, losartan, valsartan, candesartan), b-blockers (eg, carvedilol, metoprolol succinate), and vasodilators (eg, hydralazine, isosorbide dinitrate). Numerous device-based therapies also are available. Implantable cardioverter defibrillators reduce mortality in patients with an increased risk of sudden cardiac death. Cardiac resynchronization therapy improves symptoms and reduces mortality for patients who have disordered LV conduction evidenced by a wide QRS complex on electrocardiogram. Ventricular assist devices are indicated for patients with end-stage heart failure who have failed all other therapies and are also used as a bridge to cardiac transplantation in select patients.

Heart Failure Biomarkers

Because of limitations inherent in standard clinical assessments of patients with heart failure, a number of objective disease biomarkers have been investigated to diagnose and assess heart failure patient prognosis, with the additional goal of using biomarkers to guide therapy.⁷ They include a number of proteins, peptides, or other small molecules whose production and release into circulation reflect the activation of remodeling and neurohormonal pathways that lead to LV impairment. Examples include B-type natriuretic peptide (BNP), its analogue N-terminal pro B-type natriuretic peptide (NT-proBNP), troponin T and I, renin, angiotensin, arginine vasopressin, C-reactive protein, and norepinephrine.

BNP and NT-proBNP are considered the reference standards for biomarkers in assessing heart failure patients. They have had substantial impact on the standard of care for diagnosis of heart failure and are included in the recommendations of all major medical societies, including the American College of Cardiology Foundation and American Heart Association, European Society of Cardiology, and the Heart Failure Society of America. Although natriuretic peptide levels are not 100% specific for the clinical diagnosis of heart failure, elevated BNP or NT-proBNP levels in the presence of clinical signs and symptoms reliably identify the presence of structural heart disease due to remodeling and heightened risk for adverse events. Natriuretic peptides also can help in determining prognosis of heart failure patients, with elevated blood levels portending poorer prognosis.

In addition to diagnosing and assessing prognosis of heart failure patients, blood levels of BNP or NT-proBNP have been proposed as an aid for managing patients diagnosed with chronic heart failure. Levels of either biomarker rise in response to myocardial damage and LV remodeling, whereas they tend to fall as drug therapy ameliorates symptoms of heart failure. Evidence from a large number of randomized controlled trials (RCTs) that have compared BNP- or NT-proBNP-guided therapy with clinically guided adjustment of pharmacologic treatment of patients who had chronic heart failure has been assessed in recent systematic reviews and meta-analyses. However, these analyses have not consistently reported a benefit for BNP-guided management. Savarese et al (2013) published the largest meta-analysis to date, a patient-level meta-analysis that evaluated 2686 patients from 12 RCTs. This meta-analysis showed that NT-proBNP-guided management was associated with significant reductions in all-cause mortality and heart failure–related hospitalization compared with clinically guided treatment. Although BNP-guided management in this meta-analysis was not associated with significant reductions in these parameters, differences in patient numbers and characteristics may explain the discrepancy. Troughton et al (2014) conducted a second patient-level meta-analysis that included 11 RCTs with 2000 patients randomized to natriuretic peptide-guided pharmacologic therapy or usual care. The results showed that, among patients 75 years of age or younger with chronic heart failure, most of whom had impaired left ventricular ejection fraction, natriuretic peptide-guided therapy was associated with significant reductions in all-cause mortality compared with clinically guided therapy. Natriuretic-guided therapy also was associated with significant reductions in hospitalization due to heart failure or cardiovascular disease.

Suppression of Tumorigenicity-2 Protein Biomarker

A protein biomarker, ST2, has elicited interest as a potential aid to predict prognosis and manage therapy of heart failure. This protein is a member of the interleukin-1 (IL-1) receptor family. It is found as a transmembrane isoform (ST2L) and a soluble isoform (sST2), both of which have circulating IL-33 as their

primary ligand. ST2 is a unique biomarker that has pluripotent effects in vivo. Thus, binding between IL-33 and ST2L is believed to have an immunomodulatory function via T-helper type 2 lymphocytes and was initially described in the context of cell proliferation, inflammatory states, and autoimmune diseases. However, the IL-33/ST2L signaling cascade is also strongly induced through mechanical strain of cardiac fibroblasts or cardiomyocytes. The net result is mitigation of adverse cardiac remodeling and myocardial fibrosis, which are key processes in the development of heart failure. The soluble isoform of ST2 is produced by lung epithelial cells and cardiomyocytes and is secreted into circulation in response to exogenous stimuli, mechanical stress, and cellular stretch. This form of ST2 binds to circulating IL-33, acting as a "decoy," thus inhibiting the IL-33-associated antiremodeling effects of the IL-33/ST2L signaling pathway. Thus, on a biologic level, IL-33/ST2L signaling plays a role in modulating the balance of inflammation and neurohormonal activation and is viewed as pivotal for protection from myocardial remodeling, whereas sST2 is viewed as attenuating this protection. In the clinic, blood concentrations of sST2 appear to correlate closely with adverse cardiac structure and functional changes consistent with remodeling in patients with heart failure, including abnormalities in filling pressures, chamber size, and systolic and diastolic function.

An enzyme-linked immunosorbent-based assay is commercially available for determining sST2 blood levels (Presage ST2 Assay). The manufacturer claims a limit of detection of 1.8 ng/mL for sST2, and a limit of quantification of 2.4 ng/mL, as determined according to Clinical and Laboratory Standards Institute guideline EP-17-A. Mueller and Dieplinger (2013) reported a limit of detection of 2.0 ng/mL for sST2 in their study. In the same study, the assay had a within-run coefficient of variation of 2.5% and a total coefficient of variation less than 4.0%, demonstrated linearity within the dynamic range of the assay calibration curve, and exhibited no relevant interference or cross-reactivity.

The ST2 biomarker is not intended to diagnosis heart failure because it is a relatively nonspecific marker that is increased in many other disparate conditions that may be associated with acute or chronic manifestations of heart failure. Although the natriuretic peptides (BNP, NT-proBNP) reflect different physiologic aspects of heart failure compared with sST2, they are considered the reference standard biomarkers when used with clinical findings to diagnose, prognosticate, and manage heart failure and as such are the comparator to sST2.

HEART TRANSPLANT REJECTION

Most cardiac transplant recipients experience at least a single episode of rejection in the first year after transplantation.

Acute cellular rejection is most likely to occur in the first 6 months after transplantation, with a significant decline in the incidence of rejection after this time. Although immunosuppressants are required on a life-long basis, dosing is adjusted based on graft function and the grade of acute cellular rejection determined by histopathology. Endomyocardial biopsies are typically taken from the right ventricle via the jugular vein periodically during the first 6 to 12 months post-transplant. The interval between biopsies varies among clinical centers. A typical schedule is weekly for the first month, once or twice monthly for the following 6 months, and several times (monthly to quarterly) between 6 months and 1-year post-transplant. Surveillance biopsies may also be performed after the first postoperative year (eg, on a quarterly or semiannual basis). This practice, although common, has not been demonstrated to improve transplant outcomes. Some centers no longer routinely perform endomyocardial biopsies after 1 year in patients who are clinically stable.

While the endomyocardial biopsy is the criterion standard for assessing heart transplant rejection, it is limited by a high degree of interobserver variability in the grading of results and potential morbidity that can occur with the biopsy procedure. Also, the severity of rejection may not always coincide with the grading of the rejection by biopsy. Finally, a biopsy cannot be used to identify patients at risk of rejection, limiting the ability to initiate therapy to interrupt the development of rejection. For these reasons, an endomyocardial biopsy is considered a flawed criterion standard by many. Therefore, noninvasive methods of detecting cellular rejection have been explored. It is hoped that noninvasive tests will assist in determining appropriate patient management and avoid overuse or underuse of treatment with steroids and other immunosuppressants that can occur with false-negative and false-positive biopsy reports. Two techniques are commercially available for the detection of heart transplant rejection.

NONINVASIVE HEART TRANSPLANT REJECTION TESTS

In addition to those below, other laboratory-tested biomarkers of heart transplant rejection have been evaluated. They include brain natriuretic peptide, troponin, and soluble inflammatory cytokines. Most have had low accuracy in diagnosing rejection. Preliminary studies have evaluated the association between heart transplant rejection and micro-RNAs or high-sensitivity cardiac troponin in cross-sectional analyses but the clinical use has not been evaluated.

Heartsbreath Test

The Heartsbreath test, a noninvasive test that measures breath markers of oxidative stress, has been developed to assist in the detection of heart transplant rejection. In heart transplant recipients, oxidative stress appears to accompany allograft rejection, which degrades membrane polyunsaturated fatty acids and evolving alkanes and methylalkanes that are, in turn, excreted as volatile organic compounds in breath. The Heartsbreath test analyzes the breath methylated alkane contour, which is derived from the abundance of C4 to C20 alkanes and monomethylalkanes and has been identified as a marker to detect grade 3 (clinically significant) heart transplant rejection.

For individuals who have a heart transplant who receive measurement of volatile organic compounds to assess cardiac allograft rejection, the evidence includes a diagnostic accuracy study. Relevant outcomes are overall survival, test validity, morbid events, and hospitalizations. The published study found that, for identifying grade 3 (now grade 2R) rejection, the negative predictive value of the breath test the study evaluated (97.2%) was similar to endomyocardial biopsy (96.7%) and the sensitivity of the breath test (78.6%) was better than that for biopsy (42.4%). However, the breath test had a lower specificity (62.4%) and a lower positive predictive value (5.6%) in assessing grade 3 rejection than a biopsy (specificity, 97%; positive predictive value, 45.2%). The breath test was also not evaluated for grade 4 rejection. This single study is not sufficient to determine the clinical validity of the test measuring volatile organic compounds and no studies on clinical utility were identified. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

AlloMap

Another approach has focused on patterns of gene expression of immunomodulatory cells, as detected in the peripheral blood. For example, microarray technology permits the analysis of the expression of thousands of genes, including those with functions known or unknown. Patterns of gene expression can then be correlated with known clinical conditions, permitting a selection of a finite number of genes to compose a custom multigene test panel, which then can be evaluated using polymerase chain reaction techniques. AlloMap is a commercially available molecular expression test that has been developed to detect acute heart transplant rejection or the development of graft dysfunction. The test involves polymerase chain reaction–expression measurement of a panel of genes derived from peripheral blood cells and applies an algorithm to the results. The proprietary algorithm produces a single score that considers the contribution of each gene in the panel. The score ranges from 0 to 40. The AlloMap website states that a lower score indicates a lower risk of graft rejection; the website does not cite a specific cutoff for a positive test. All AlloMap testing is performed at the CareDx reference laboratory in California.

AlloMap®, an In Vitro Diagnostic Multivariate Index assay (IVDMIA) test service performed in a single laboratory, is FDA approved to aid in the identification of heart transplant recipients with stable allograft function who have a low probability of moderate/severe acute cellular rejection (ACR) at the time of testing in conjunction with standard clinical assessment.

AlloMap® is marketed by CareDx® for cardiac transplantation as a noninvasive means to assess allograft rejection status. AlloMap® has been characterized as a “rule-out” test for rejection that can be complemented by a cell-free DNA “rule-in” test. The utility of the combination of these 2 tests when used together was assessed and found that together these tests enhance the accuracy of assessing rejection status than either test alone.

A test using Gene-Expression Profiling, AlloMap® is marketed by CareDx® for cardiac transplantation and has been covered under the Centers for Medicare and Medicaid Services (CMS) MoIDX program as a non-invasive means to assess allograft rejection status.

AlloSure Heart

The premise for AlloSure is that rejection entails injury, including increased cell death in the allograft, leading to increased donor-derived cell-free DNA (dd-cfDNA) released into the bloodstream. The AlloSure test for dd-cfDNA detected in the blood of transplant recipients has been developed as a noninvasive marker for diagnosis of graft rejection. The AlloSure assay is a targeted next-generation sequencing assay that uses 266 single-nucleotide polymorphisms (SNPs) to accurately quantify dd-cfDNA in transplant recipients without separate genotyping of donor or recipient. The assay quantifies the fraction of dd-cfDNA in both unrelated and related donor-recipient pairs and can be completed within 3 days of peripheral blood collection, a practical turnaround time for management of transplant recipients. AlloSure assay results are reported as the percentage of dd-cfDNA in total cfDNA.

HeartCare

Cell-free DNA (cfDNA), released by damaged cells, is normally present in healthy individuals. In patients who have received transplants, donor-derived cell-free DNA (dd-cfDNA) may be also present. It is proposed that allograft rejection, which is associated with damage to transplanted cells, may result in an increase in dd-cfDNA. HeartCare (CareDx) is a commercially-available test that combines AlloMap gene expression profiling with a next-generation sequencing assay that quantifies the fraction of dd-cfDNA in cardiac transplant recipients relative to total cfDNA. The AlloMap score, AlloMap score variability, and AlloSure % dd-cfDNA are reported.

It is well accepted within the renal and cardiac transplant communities that immunosuppression management is an important component of post-transplant care to both optimize graft longevity while avoiding side effects and toxicity of immunosuppressive therapies. Graft assessment is an important decision tool used to help clinicians optimize immunosuppressive treatment. The gold standard for assessing rejection or a solid organ allograft rejection or injury has historically and remains a biopsy in conjunction with serologic criteria. However, given the invasive nature and risks associated with a biopsy, tests that can potentially mitigate the need for a biopsy while still providing clinicians with actionable information that can be used to help optimize immunosuppressive therapy are reasonable and necessary. Thus there is adequate evidence to support that the AlloSure assay when used in combination provides incremental information to change clinician management in a way that will be expected to improve outcomes.

Presage ST2 Assay

In addition to its use as a potential aid to predict prognosis and manage therapy of heart failure, elevated serum ST2 levels have also been associated with increased risk of antibody-mediated rejection following heart transplant. For this reason, ST2 has also been proposed as a prognostic marker post heart transplantation and as a test to predict acute cellular rejection (graft-versus-host disease). The Presage ST2 Assay, described above, is a commercially available sST2 test that has been investigated as a biomarker of heart transplant rejection.

For individuals who have chronic heart failure who receive the sST2 assay to determine prognosis and/or to guide management, the evidence includes correlational studies and 2 meta-analyses. Relevant outcomes are overall survival, quality of life, and hospitalization. Most of the evidence is from reanalysis of existing randomized controlled trials and not from studies specifically designed to evaluate the predictive accuracy of sST2, and prospective and retrospective cross-sectional studies made up a large part of 1 meta-analysis. Studies have mainly found that elevated sST2 levels are statistically associated with elevated risk of mortality. A pooled analysis of study results found that sST2 significantly predicted overall mortality and cardiovascular mortality. Several studies, however, found that sST2 test results did not provide additional prognostic information compared with N-terminal pro B-type natriuretic peptide levels. Moreover, no comparative studies were identified on the use of the sST2 assay to guide management of patients diagnosed with chronic heart failure. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have heart transplantation who receive sST2 assay to determine prognosis and/or to predict acute cellular rejection, the evidence includes a small number of retrospective observational studies on the Presage ST2 Assay. Relevant outcomes are overall survival, morbid events, and hospitalization. No prospective studies were identified that provide high-quality evidence on the ability of sST2 to predict transplant outcomes. One retrospective study (n = 241) found that sST2 levels were associated with acute cellular rejection and mortality; another study (n = 26) found that sST2 levels were higher during an acute rejection episode than before rejection. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

myTAIHEART Biomarker

Using proprietary myTAIHEART software, the myTAIHEART test uses multiplexed, high-fidelity amplification followed by allele-specific qPCR of a panel of 94 highly informative bi-allelic single nucleotide polymorphisms (SNPs) and two controls to quantitatively genotype cell free DNA in the patient's plasma after cardiac transplant, and accurately distinguish "donor specific" cell free DNA originating from the engrafted heart from "self-specific" cell free DNA originating from the recipient's native cells. The ratio of donor specific cell free DNA to total cell free DNA is reported as the donor fraction (%) and categorizes the patient as at low or increased risk of moderate (grade 2R) to severe (grade 3R) acute cellular rejection: low donor fractions indicate less damage to the transplanted heart and a lower risk for rejection, while increased donor fractions indicate more damage to the transplanted heart and an increased risk for rejection. Testing with myTAIHEART does not require a donor specimen. The test is indicated for use in heart transplant recipients who are 2 months of age or older and ≥ 8 days post-transplant, restricted to use in single organ post-heart transplant patients, and is contraindicated in patients who:

- are pregnant
- currently have or in the past have had another transplanted organ (solid organ or allogeneic bone marrow)
- have post-transplant lymphoproliferative disease
- have cancer or have had cancer within the previous 2 years
- are on mechanical circulatory support
- are closely related to the transplant donor

For individuals who have heart transplantation who receive myTAIHEART assay to determine acute cellular rejection, the evidence includes observational studies. A validation study using 158 matched endomyocardial biopsy-plasma pairs from 76 pediatric and adult heart transplant recipients (ages 2 months or older, and 8 days more post-transplant) found a donor-specific fraction cutoff (0.32%) that produced a 100% negative predictive value for Grade 2 or higher acute cellular rejection. A prospective observational blinded study (n=174; pediatric=101, adult=73) using biopsy-paired samples found that myTAIHEART level was associated with acute cellular and antibody-mediated rejection in both adult and pediatric heart transplant populations, and that an optimal donor fraction threshold (0.3%) ruled out the presence of either acute cellular rejection or antibody-mediated rejection. Both studies received industry funding. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

RENAL TRANSPLANT REJECTION

Allograft dysfunction is typically asymptomatic and has a broad differential, including graft rejection. Diagnosis and rapid treatment are recommended to preserve graft function and prevent loss of the transplanted organ. For a primary kidney transplant, graft survival at 1 year is 94.7%; at 5 years, graft survival is 78.6%.

Surveillance of transplant kidney function relies on routine monitoring of serum creatinine, urine protein levels, and urinalysis. Allograft dysfunction may also be demonstrated by a drop in urine output or, rarely, as pain over the transplant site. With clinical suspicion of allograft dysfunction, additional noninvasive workup including ultrasonography or radionuclide imaging may be used. A renal biopsy allows a definitive assessment of graft dysfunction and is typically a percutaneous procedure performed with ultrasonography or computed tomography guidance. Biopsy of a transplanted kidney is associated with fewer complications than biopsy of a

native kidney because the allograft is typically transplanted more superficially than a native kidney. Renal biopsy is a low-risk invasive procedure that may result in bleeding complications; loss of a renal transplant, as a complication of renal biopsy, is rare.

Kidney biopsies allow for diagnosis of acute and chronic graft rejection, which may be graded using the Banff Classification. Pathologic assessment of biopsies demonstrating acute rejection allows clinicians to further distinguish between acute cellular rejection and antibody-mediated rejection, which are treated differently.

NONINVASIVE RENAL TRANSPLANT REJECTION TESTS

AlloSure Kidney

AlloSure Kidney (CareDx) is a commercially available, next-generation sequencing assay that quantifies the fraction of dd-cfDNA in renal transplant recipients relative to total cfDNA by measuring 266 single nucleotide variants. Separate genotyping of the donor or recipient is not required but patients who receive a kidney transplant from a monozygotic (identical) twin are not eligible for this test. The fraction of dd-cfDNA relative to total cfDNA present in the peripheral blood sample is cited in the report. For patients undergoing surveillance, a routine testing schedule is recommended for longitudinal monitoring.

The premise for AlloSure is that rejection entails injury, including increased cell death in the allograft, leading to increased donor-derived cell-free DNA (dd-cfDNA) released into the bloodstream. The AlloSure® test for dd-cfDNA detected in the blood of transplant recipients has been developed as a noninvasive marker for diagnosis of graft rejection. The AlloSure® assay is a targeted next-generation sequencing assay that uses 266 single-nucleotide polymorphisms (SNPs) to accurately quantify dd-cfDNA in transplant recipients without separate genotyping of donor or recipient. The assay quantifies the fraction of dd-cfDNA in both unrelated and related donor-recipient pairs and can be completed within 3 days of peripheral blood collection, a practical turnaround time for management of transplant recipients. AlloSure assay results are reported as the percentage of dd-cfDNA in total cfDNA.

It is well accepted within the renal and cardiac transplant communities that immunosuppression management is an important component of post-transplant care to both optimize graft longevity while avoiding side effects and toxicity of immunosuppressive therapies. Graft assessment is an important decision tool used to help clinicians optimize immunosuppressive treatment. The gold standard for assessing rejection or a solid organ allograft rejection or injury has historically and remains a biopsy in conjunction with serologic criteria. However, given the invasive nature and risks associated with a biopsy, tests that can potentially mitigate the need for a biopsy while still providing clinicians with actionable information that can be used to help optimize immunosuppressive therapy are reasonable and necessary. Thus there is adequate evidence to support that the AlloSure assay when used in combination provides incremental information to change clinician management in a way that will be expected to improve outcomes.

Prospera™

Prospera™ Kidney (Natera) is a commercially available assay that uses massively multiplexed PCR (mmPCR) followed by next-generation sequencing (NGS) to quantify the fraction of dd-cfDNA in renal transplant recipients. Donor versus recipient cfDNA is differentiated via an advanced bioinformatics analysis of >13,000 single-nucleotide polymorphisms (SNPs) without the need for prior recipient or donor genotyping or computational adjustments for related donors. The manufacturer recommends use of the test when there is clinical suspicion of active rejection and for regular surveillance of subclinical rejection. In a surveillance scenario, regular testing is recommended at 1, 2, 3, 4, 6, 9 and 12 months after renal transplant or most recent rejection. Thereafter, the test should be repeated quarterly. The proportion of ddcfDNA relative to total cfDNA is reported, with detection of greater than or equal to 1% dd-cfDNA indicating increased risk for active rejection. The percent dd-cfDNA change between tests is also reported.

TRAC™ dd-cfDNA (Formerly Known as Viracor TRAC dd-cfDNA)

The TRAC™ dd-cfDNA test is intended to assess the probability of allograft rejection in transplant recipients with clinical suspicion of rejection and to inform clinical decision-making about the necessity of biopsy in such patients at least 2 weeks posttransplant in conjunction with standard clinical assessment.

QSant™

QSant™ is designed to supplement the evaluation and management of acute rejection in patients who have undergone renal transplantation by determining a Q-score to demonstrate the probability of rejection risk. QSant™ rules IN and rules OUT active risk of rejection.

It is also well accepted within the transplant community that immunosuppression management is an important component of post-transplant care to both optimize graft longevity while avoiding side effects and toxicity of immunosuppressive therapies. Graft assessment is an important decision tool used to help clinicians optimize immunosuppressive treatment. The gold standard for assessing rejection or injury has historically been and remains a biopsy in conjunction with serologic criteria. However, given the invasive nature and risks associated with a biopsy, tests that can potentially mitigate the need for a biopsy while still providing clinicians with actionable information that can be used to help optimize immunosuppressive therapy are reasonable and necessary. Additionally, ongoing studies have supported that cfDNA and GEP can accurately determine allograft status in several organ types, and that molecular characterization can both precede and enhance histologic findings. As such, these approaches, as a service type, are reasonable and necessary for graft assessment.

LUNG TRANSPLANT REJECTION

Despite advances in induction and maintenance immunosuppressive regimens, lung transplant recipients have a median overall survival of 6 years, with more than a third of patients receiving treatment for acute rejection in the first year after transplant. Acute cellular rejection, lymphocytic bronchiolitis, and antibody-mediated rejection are all risk factors for subsequent development of chronic lung allograft dysfunction (CLAD). Pathologic grading of acute cellular rejection is based on the histological assessment of perivascular and interstitial mononuclear cell infiltrates. Antibody-mediated rejection may be clinical (symptomatic or asymptomatic allograft dysfunction) or subclinical (normal allograft function). Key diagnostic criteria established via consensus by the International Society for Heart and Lung Transplantation include the presence of antibodies directed toward donor human leukocyte antigens and characteristic lung histology with or without evidence of complement 4d within the graft. The most common phenotype of CLAD is a persistent obstructive decline in lung function known as bronchiolitis obliterans syndrome (BOS), which is graded based on the degree of decrease in FEV1. Approximately 50% of patients develop BOS within 5 years post-transplant. Median survival following a diagnosis of BOS is 3-5 years. Acute rejection may present with non-specific physical symptoms or be asymptomatic. However, the role of surveillance bronchoscopy for screening asymptomatic patients for acute rejection is controversial, and performance of surveillance bronchoscopies varies across transplant centers.

NONINVASIVE LUNG TRANSPLANT REJECTION TESTS

AlloSure Lung

AlloSure Lung (CareDx) is a commercially available, NGS assay that quantifies the fraction of dd-cfDNA in lung transplant patients relative to total cfDNA by measuring single nucleotide polymorphisms. The test is intended to provide a direct, noninvasive measure of organ injury in lung transplant patients who are undergoing surveillance. Suggested thresholds for severe injury, injury, and quiescence are 1%, 0.85%, and <0.5%, respectively.

For individuals with a lung transplant who receive testing of dd-cfDNA to assess lung allograft rejection, the evidence includes 2 small diagnostic accuracy studies utilizing biorepository samples. Relevant outcomes are OS, test validity, morbid events, and hospitalizations. One study examined the diagnostic performance of AlloSure dd-cfDNA testing at a threshold of 0.87% for detecting acute cellular rejection, yielding a PPV of 34.1% and a NPV of 85.5%. A second study reported a PPV of 43.3% and NPV of 83.6% for an aggregate rejection cohort composed of patients with acute cellular rejection, antibody-mediated rejection, and chronic lung allograft dysfunction. These studies have raised concerns regarding the ability of dd-cfDNA testing to discriminate between rejection and infection or injury, and larger prospective clinical validation studies are required. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

CODING

Medicare Advantage Plans and Commercial Products

The following CPT code(s) is covered for Medicare Advantage Plans and considered medically necessary when the criteria found in online authorization tool has been met for Commercial Products.

This code can be used for AlloMap:

81595 Cardiology (heart transplant), mRNA, gene expression profiling by real-time quantitative PCR of 20 genes (11 content and 9 housekeeping), utilizing subfraction of peripheral blood, algorithm reported as a rejection risk score

The following CPT code(s) are medically necessary for Medicare Advantage Plans and Commercial Products when the criteria above has been met.

This code can be used for TRAC™ dd-cfDNA (Formerly Known as Viracor TRAC dd-cfDNA):

0118U Transplantation medicine, quantification of donor-derived cell-free DNA using whole genome next-generation sequencing, plasma, reported as percentage of donor-derived cell-free DNA in the total cell-free DNA (Test Name and Laboratory Revised Effective 10/1/2024)

This code can be used for Prospera™:

0493U Transplantation medicine, quantification of donor-derived cell-free DNA (cfDNA) using next-generation sequencing, plasma, reported as percentage of donor-derived cell-free DNA (New Code Effective 10/1/2024. For Dates of Service prior to 10/1/2024, CPT Code 81479 should be used)

This code can be used for VitaGraft™ Kidney Baseline + 1st Plasma Test:

0508U Transplantation medicine, quantification of donor-derived cell-free DNA using 40 single-nucleotide polymorphisms (SNPs), plasma, and urine, initial evaluation reported as percentage of donor-derived cell-free DNA with risk for active rejection (New Code Effective 10/1/2024)

This code can be used for VitaGraft™ Kidney Subsequent:

0509U Transplantation medicine, quantification of donor-derived cell-free DNA using up to 12 single-nucleotide polymorphisms (SNPs) previously identified, plasma, reported as percentage of donor-derived cell-free DNA with risk for active rejection (New Code Effective 10/1/2024)

The following CPT codes are not covered for Medicare Advantage Plans and not medically necessary for Commercial Products.

This code can be used for Presage® ST2 Assay:

83006 Growth stimulation expressed gene 2 (ST2, Interleukin 1 receptor like-1)

This code can be used for Pleximark™:

0018M Transplantation medicine (allograft rejection, renal), measurement of donor and third-party-induced CD154+T-cytotoxic memory cells, utilizing whole peripheral blood, algorithm reported as a rejection risk score

This code can be used for myTAIHEART:

0055U Cardiology (heart transplant), cell-free DNA, PCR assay of 96 DNA target sequences (94 single nucleotide polymorphism targets and two control targets), plasma

This code can be used for Molecular Microscope® MMDx—Heart:

0087U Cardiology (heart transplant), mRNA gene expression profiling by microarray of 1283 genes, transplant biopsy tissue, allograft rejection and injury algorithm reported as a probability score

This code can be used for Molecular Microscope® MMDx—Kidney:

0088U Transplantation medicine (kidney allograft rejection), microarray gene expression profiling of 1494 genes, utilizing transplant biopsy tissue, algorithm reported as a probability score for rejection

The following Unlisted CPT code requires prior authorization for Medicare Advantage Plans and Commercial Products. The code can be used for any test identified in this policy that does not have a specific CPT code.

81479 Unlisted molecular pathology procedure

81599 Unlisted multianalyte assay with algorithmic analysis

RELATED POLICIES

Biomarker Testing Mandate

Genetic Testing Services

Proprietary Laboratory Analyses (PLA)

PUBLISHED

Provider Update, August 2024

Provider Update, November 2023

Provider Update, May 2022

Provider Update, April 2021

Provider Update, June 2020

Provider Update, April 2019

REFERENCES

1. Centers for Medicare & Medicaid Services. Local Coverage Determination (LCD): MolDX: Molecular Diagnostic Tests (MDT) (L35160)
2. Centers for Medicare & Medicaid Services. Local Coverage Article: Billing and Coding: MolDx: AlloMap (A54364)
3. Centers for Medicare & Medicaid Services. Local Coverage Determination (LCD): MolDX: Molecular Testing for Solid Organ Allograft Rejection (L38629)
4. Centers for Medicare & Medicaid Services. Local Coverage Article: Billing and Coding: MolDx: Molecular Testing for Solid Organ Allograft Rejection (A58168)
5. Centers for Medicare & Medicaid Services. Local Coverage Determination (LCD): MolDX: Molecular Testing for Solid Organ Allograft Rejection (L38680)
6. Centers for Medicare & Medicaid Services. Local Coverage Article: Billing and Coding: MolDx: Molecular Testing for Solid Organ Allograft Rejection (A58207)
7. Centers for Medicare & Medicaid Services. National Coverage Determination (NCD) for HEARTSBREATH Test for Heart Transplant Rejection (260.10)
8. Lindenfeld J, Albert NM, Boehmer JP, et al. HFSA 2010 Comprehensive Heart Failure Practice Guideline. *J Card Fail.* Jun 2010; 16(6): e1-194. PMID 20610207
9. McMurray JJ, Adamopoulos S, Anker SD, et al. ESC guidelines for the diagnosis and treatment of acute and chronic heart failure 2012: The Task Force for the Diagnosis and Treatment of Acute and Chronic Heart Failure 2012 of the European Society of Cardiology. Developed in collaboration with the Heart Failure Association (HFA) of the ESC. *Eur J Heart Fail.* Aug 2012; 14(8): 803-69. PMID 22828712
10. Lindenfeld J, Albert NM, Boehmer JP, et al. HFSA 2010 Comprehensive Heart Failure Practice Guideline. *J Card Fail.* Jun 2010; 16(6): e1-194. PMID 20610207
11. Savarese G, Trimarco B, Dellegrottaglie S, et al. Natriuretic peptide-guided therapy in chronic heart failure: a meta-analysis of 2,686 patients in 12 randomized trials. *PLoS One.* 2013; 8(3): e58287. PMID 23472172
12. Troughton RW, Frampton CM, Brunner-La Rocca HP, et al. Effect of B-type natriuretic peptide-guided treatment of chronic heart failure on total mortality and hospitalization: an individual patient meta-analysis. *Eur Heart J.* Jun 14 2014; 35(23):1559-67. PMID 24603309
13. Bhardwaj A, Januzzi JL. ST2: a novel biomarker for heart failure. *Expert Rev Mol Diagn.* May 2010; 10(4): 459-64. PMID 20465500

14. Chowdhury P, Kehl D, Choudhary R, et al. The use of biomarkers in the patient with heart failure. *Curr Cardiol Rep.* Jun2013; 15(6): 372. PMID 23644993
15. Ciccone MM, Cortese F, Gesualdo M, et al. A novel cardiac bio-marker: ST2: a review. *Molecules.* Dec 11 2013; 18(12):15314-28. PMID 24335613
16. Daniels LB, Bayes-Genis A. Using ST2 in cardiovascular patients: a review. *Future Cardiol.* Jul 2014; 10(4): 525-39. PMID25301315
17. Dieplinger B, Mueller T. Soluble ST2 in heart failure. *Clin Chim Acta.* Mar 30 2015; 443: 57-70. PMID 25269091
18. Mueller T, Dieplinger B. The Presage(R) ST2 Assay: analytical considerations and clinical applications for a high-sensitivity assay for measurement of soluble ST2. *Expert Rev Mol Diagn.* Jan 2013; 13(1): 13-30. PMID 23256700
19. Shah RV, Januzzi JL. ST2: a novel remodeling biomarker in acute and chronic heart failure. *Curr Heart Fail Rep.* Mar2010; 7(1): 9-14. PMID 20425491
20. Xu D, Chan WL, Leung BP, et al. Selective expression of a stable cell surface molecule on type 2 but not type 1 helper Tcells. *J Exp Med.* Mar 02 1998; 187(5): 787-94. PMID 9480988
21. Weinberg EO, Shimp M, De Keulenaer GW, et al. Expression and regulation of ST2, an interleukin-1 receptor family member, in cardiomyocytes and myocardial infarction. *Circulation.* Dec 03 2002; 106(23): 2961-6. PMID 12460879
22. Stewart S, Winters GL, Fishbein MC, et al. Revision of the 1990 working formulation for the standardization of nomenclature in the diagnosis of heart rejection. *J Heart Lung Transplant.* Nov 2005; 24(11): 1710-20. PMID 16297770
23. Celec P, Vlkova B, Laukova L, et al. Cell-free DNA: the role in pathophysiology and as a biomarker in kidney diseases. *Expert Rev Mol Med.* Jan 18 2018; 20: e1. PMID 29343314
24. Natera. Prospera Heart Overview. 2022. Accessed September 1, 2022.
25. North PE, Ziegler E, Mahnke DK, et al. Cell-free DNA donor fraction analysis in pediatric and adult heart transplant patients by multiplexed allele-specific quantitative PCR: Validation of a rapid and highly sensitive clinical test for stratification of rejection probability. *PLoS One.* 2020; 15(1): e0227385. PMID 31929557
26. CareDx. Overview: AlloMap Testing: Answering Unmet Needs in Heart Transplant Surveillance. n.d.; <http://www.allomap.com/providers/overview/>. Accessed August 30, 2022.
27. Duong Van Huyen JP, Tible M, Gay A, et al. MicroRNAs as non-invasive biomarkers of heart transplant rejection. *Eur Heart J.* Dec 01 2014; 35(45): 3194-202. PMID 25176944
28. Patel PC, Hill DA, Ayers CR, et al. High-sensitivity cardiac troponin I assay to screen for acute rejection in patients with heart transplant. *Circ Heart Fail.* May 2014; 7(3): 463-9. PMID 24733367
29. Organ Procurement and Transplantation Network. National Data. 2018; <https://optn.transplant.hrsa.gov/data/view-data-reports/national-data/#>. Accessed August 30, 2022.
30. Hariharan S, Israni AK, Danovitch G. Long-Term Survival after Kidney Transplantation. *N Engl J Med.* Aug 19 2021; 385(8): 729-743. PMID 34407344
31. Goldberg RJ, Weng FL, Kandula P. Acute and Chronic Allograft Dysfunction in Kidney Transplant Recipients. *Med Clin North Am.* May 2016; 100(3): 487-503. PMID 27095641
32. Ahmad I. Biopsy of the transplanted kidney. *Semin Intervent Radiol.* Dec 2004; 21(4): 275-81. PMID 21331139
33. Solez K, Colvin RB, Racusen LC, et al. Banff 07 classification of renal allograft pathology: updates and future directions. *Am J Transplant.* Apr 2008; 8(4): 753-60. PMID 18294345
34. Haas M. The Revised (2013) Banff Classification for Antibody-Mediated Rejection of Renal Allografts: Update, Difficulties, and Future Considerations. *Am J Transplant.* May 2016; 16(5): 1352-7. PMID 26696524
35. Natera. Prospera Transplant Assessment: Indications for Use. 2020; <https://www.natera.com/wp-content/uploads/2020/11/Organ-Health-Clinician-Indications-for-use.pdf>. Accessed August 29, 2022.
36. Natera. Prospera Transplant Assessment: Clinician's Guide to Results. 2019; <https://www.natera.com/wp-content/uploads/2020/11/Organ-Health-Clinician-Clinicians-guide-to-results.pdf>. Accessed August 29, 2022.
37. Parulekar AD, Kao CC. Detection, classification, and management of rejection after lung transplantation. *J Thorac Dis.* Sep 2019; 11(Suppl 14): S1732-S1739. PMID 31632750

38. Yusen RD, Edwards LB, Kucheryavaya AY, et al. The Registry of the International Society for Heart and Lung Transplantation: Thirty-second Official Adult Lung and Heart-Lung Transplantation Report--2015; Focus Theme: Early Graft Failure. *J Heart Lung Transplant*. Oct 2015; 34(10): 1264-77. PMID 26454740
39. Levine DJ, Glanville AR, Aboyou C, et al. Antibody-mediated rejection of the lung: A consensus report of the International Society for Heart and Lung Transplantation. *J Heart Lung Transplant*. Apr 2016; 35(4): 397-406. PMID 27044531
40. CareDx. Allosure Lung. 2021. Accessed August 30, 2022.
41. Natera. Prospera Lung Overview. 2022. Accessed September 1, 2022.
42. Cohn JN, Tognoni G. A randomized trial of the angiotensin-receptor blocker valsartan in chronic heart failure. *N Engl J Med*. Dec 06 2001; 345(23): 1667-75. PMID 11759645
43. O'Connor CM, Whellan DJ, Lee KL, et al. Efficacy and safety of exercise training in patients with chronic heart failure: HF-ACTION randomized controlled trial. *JAMA*. Apr 08 2009; 301(14): 1439-50. PMID 19351941
44. Kjekshus J, Apetrei E, Barrios V, et al. Rosuvastatin in older patients with systolic heart failure. *N Engl J Med*. Nov 29 2007; 357(22): 2248-61. PMID 17984166
45. Januzzi JL, Rehman SU, Mohammed AA, et al. Use of amino-terminal pro-B-type natriuretic peptide to guide outpatient therapy of patients with chronic left ventricular systolic dysfunction. *J Am Coll Cardiol*. Oct 25 2011; 58(18): 1881-9. PMID 22018299
46. Ky B, French B, McCloskey K, et al. High-sensitivity ST2 for prediction of adverse outcomes in chronic heart failure. *Circ Heart Fail*. Mar 2011; 4(2): 180-7. PMID 21178018
47. Bayes-Genis A, de Antonio M, Galan A, et al. Combined use of high-sensitivity ST2 and NT-proBNP to improve the prediction of death in heart failure. *Eur J Heart Fail*. Jan 2012; 14(1): 32-8. PMID 22179033
48. Broch K, Ueland T, Nymo SH, et al. Soluble ST2 is associated with adverse outcome in patients with heart failure of ischaemic aetiology. *Eur J Heart Fail*. Mar 2012; 14(3): 268-77. PMID 22302661
49. Felker GM, Fiuzat M, Thompson V, et al. Soluble ST2 in ambulatory patients with heart failure: Association with functional capacity and long-term outcomes. *Circ Heart Fail*. Nov 2013; 6(6): 1172-9. PMID 24103327
50. Gaggin HK, Motiwala S, Bhardwaj A, et al. Soluble concentrations of the interleukin receptor family member ST2 and -blocker therapy in chronic heart failure. *Circ Heart Fail*. Nov 2013; 6(6): 1206-13. PMID 24114865
51. Anand IS, Rector TS, Kuskowski M, et al. Prognostic value of soluble ST2 in the Valsartan Heart Failure Trial. *Circ Heart Fail*. May 2014; 7(3): 418-26. PMID 24622243
52. Zhang R, Zhang Y, An T, et al. Prognostic value of sST2 and galectin-3 for death relative to renal function in patients hospitalized for heart failure. *Biomark Med*. 2015; 9(5): 433-41. PMID 25985174
53. Dupuy AM, Curinier C, Kuster N, et al. Multi-Marker Strategy in Heart Failure: Combination of ST2 and CRP Predicts Poor Outcome. *PLoS One*. 2016; 11(6): e0157159. PMID 27311068
54. Aimo A, Vergaro G, Passino C, et al. Prognostic Value of Soluble Suppression of Tumorigenicity-2 in Chronic Heart Failure: A Meta-Analysis. *JACC Heart Fail*. Apr 2017; 5(4): 280-286. PMID 27816512
55. Januzzi JL, Horne BD, Moore SA, et al. Interleukin receptor family member ST2 concentrations in patients following heart transplantation. *Biomarkers*. May 2013; 18(3): 250-6. PMID 23557127
56. Pascual-Figal DA, Garrido IP, Blanco R, et al. Soluble ST2 is a marker for acute cardiac allograft rejection. *Ann Thorac Surg*. Dec 2011; 92(6): 2118-24. PMID 22035779
57. Phillips M, Boehmer JP, Cataneo RN, et al. Heart allograft rejection: detection with breath alkanes in low levels (the HARD BALL study). *J Heart Lung Transplant*. Jun 2004; 23(6): 701-8. PMID 15366430
58. Khush KK, Patel J, Pinney S, et al. Noninvasive detection of graft injury after heart transplant using donor-derived cell-free DNA: A prospective multicenter study. *Am J Transplant*. Oct 2019; 19(10): 2889-2899. PMID 30835940
59. Richmond ME, Deshpande SR, Zangwill SD, et al. Validation of donor fraction cell-free DNA with biopsy-proven cardiac allograft rejection in children and adults. *J Thorac Cardiovasc Surg*. Feb 2023; 165(2): 460-468.e2. PMID 35643770
60. Kim PJ, Olymbios M, Siu A, et al. A novel donor-derived cell-free DNA assay for the detection of acute rejection in heart transplantation. *J Heart Lung Transplant*. Jul 2022; 41(7): 919-927. PMID 35577713

61. Rodgers N, Gerding B, Cusi V, et al. Comparison of two donor-derived cell-free DNA tests and a blood gene-expressionprofile test in heart transplantation. *Clin Transplant*. Jun 2023; 37(6): e14984. PMID 37036133
62. Richmond ME, Zangwill SD, Kindel SJ, et al. Donor fraction cell-free DNA and rejection in adult and pediatric hearttransplantation. *J Heart Lung Transplant*. May 2020; 39(5): 454-463. PMID 31983667
63. CareDx. HeartCare Interpretive Guide. April 2021; <https://caredx.com/wp-content/uploads/2021/09/LK-10482-Heartcare-Interpretive-Guide.pdf>. Accessed August 30, 2022.
64. Blue Cross Blue Shield Technology Evaluation Center (TEC). Gene expression profiling as a noninvasive method to monitor for cardiac allograft rejection. *TEC Assessment Program*. 2011;26(8).
65. Deng MC, Eisen HJ, Mehra MR, et al. Noninvasive discrimination of rejection in cardiac allograft recipients using geneexpression profiling. *Am J Transplant*. Jan 2006; 6(1): 150-60. PMID 16433769
66. Crespo-Leiro MG, Stypmann J, Schulz U, et al. Clinical usefulness of gene-expression profile to rule out acute rejectionafter heart transplantation: CARGO II. *Eur Heart J*. Sep 01 2016; 37(33): 2591-601. PMID 26746629
67. Kanwar MK, Khush KK, Pinney S, et al. Impact of cytomegalovirus infection on gene expression profile in heart transplantrecipients. *J Heart Lung Transplant*. Feb 2021; 40(2): 101-107. PMID 33341360
68. Gondi KT, Kao A, Linard J, et al. Single-center utilization of donor-derived cell-free DNA testing in the management ofheart transplant patients. *Clin Transplant*. May 2021; 35(5): e14258. PMID 33606316
69. Kobashigawa J, Patel J, Azarbal B, et al. Randomized pilot trial of gene expression profiling versus heart biopsy in the firstyear after heart transplant: early invasive monitoring attenuation through gene expression trial. *Circ Heart Fail*. May 2015;8(3): 557-64. PMID 25697852
70. Pham MX, Deng MC, Kfoury AG, et al. Molecular testing for long-term rejection surveillance in heart transplant recipients:design of the Invasive Monitoring Attenuation Through Gene Expression (IMAGE) trial. *J Heart Lung Transplant*. Aug2007; 26(8): 808-14. PMID 17692784
71. Pham MX, Teuteberg JJ, Kfoury AG, et al. Gene-expression profiling for rejection surveillance after cardiactransplantation. *N Engl J Med*. May 20 2010; 362(20): 1890-900. PMID 20413602
72. CareDx. Allosure Kidney. 2021; <https://go.caredx.com/allosure/>. Accessed August 30, 2022.
73. Pai A, Swan JT, Wojciechowski D, et al. Clinical Rationale for a Routine Testing Schedule Using Donor-Derived Cell-FreeDNA After Kidney Transplantation. *Ann Transplant*. Jul 02 2021; 26: e932249. PMID 34210952
74. Wijtvliet VPWM, Plaeke P, Abrams S, et al. Donor-derived cell-free DNA as a biomarker for rejection after kidneytransplantation: a systematic review and meta-analysis. *Transpl Int*. Dec 2020; 33(12): 1626-1642. PMID 32981117
75. Xiao H, Gao F, Pang Q, et al. Diagnostic Accuracy of Donor-derived Cell-free DNA in Renal-allograft Rejection: A Meta-analysis. *Transplantation*. Jun 01 2021; 105(6): 1303-1310. PMID 32890130
76. Bloom RD, Bromberg JS, Poggio ED, et al. Cell-Free DNA and Active Rejection in Kidney Allografts. *J Am Soc Nephrol*. Jul 2017; 28(7): 2221-2232. PMID 28280140
77. Huang E, Sethi S, Peng A, et al. Early clinical experience using donor-derived cell-free DNA to detect rejection in kidneytransplant recipients. *Am J Transplant*. Jun 2019; 19(6): 1663-1670. PMID 30725531
78. Stites E, Kumar D, Olaitan O, et al. High levels of dd-cfDNA identify patients with TCMR 1A and borderline allograftrejection at elevated risk of graft injury. *Am J Transplant*. Sep 2020; 20(9): 2491-2498. PMID 32056331
79. Sawinski DL, Mehta S, Alhamad T, et al. Association between dd-cfDNA levels, de novo donor specific antibodies, and eGFR decline: An analysis of the DART cohort. *Clin Transplant*. Sep 2021; 35(9): e14402. PMID 34184326
80. Jordan SC, Bunnapradist S, Bromberg JS, et al. Donor-derived Cell-free DNA Identifies Antibody-mediated Rejection inDonor Specific Antibody Positive Kidney Transplant Recipients. *Transplant Direct*. Sep 2018; 4(9): e379. PMID 30234148
81. Mayer KA, Doberer K, Tillgren A, et al. Diagnostic value of donor-derived cell-free DNA to predict antibody-mediatedrejection in donor-specific antibody-positive renal allograft recipients. *Transpl Int*. Sep 2021; 34(9): 1689-1702. PMID34448270
82. Puliyaanda DP, Swinford R, Pizzo H, et al. Donor-derived cell-free DNA (dd-cfDNA) for detection of allograft rejection inpediatric kidney transplants. *Pediatr Transplant*. Mar 2021; 25(2): e13850. PMID 33217125

83. Dandamudi R, Gu H, Goss CW, et al. Longitudinal Evaluation of Donor-Derived Cellfree DNA in Pediatric Kidney Transplantation. *Clin J Am Soc Nephrol*. Nov 2022; 17(11): 1646-1655. PMID 36302566
84. Bu L, Gupta G, Pai A, et al. Clinical outcomes from the Assessing Donor-derived cell-free DNA Monitoring Insights of kidney Allografts with Longitudinal surveillance (ADMIRAL) study. *Kidney Int*. Apr 2022; 101(4): 793-803. PMID 34953773
85. Sigdel TK, Archila FA, Constantin T, et al. Optimizing Detection of Kidney Transplant Injury by Assessment of Donor-Derived Cell-Free DNA via Massively Multiplex PCR. *J Clin Med*. Dec 23 2018; 8(1). PMID 30583588
86. Bunnapradist S, Homkrais P, Ahmed E, et al. Using both the Fraction and Quantity of Donor-Derived Cell-Free DNA to Detect Kidney Allograft Rejection. *J Am Soc Nephrol*. Oct 2021; 32(10): 2439-2441. PMID 34162734
87. Halloran PF, Reeve J, Madill-Thomsen KS, et al. Combining Donor-derived Cell-free DNA Fraction and Quantity to Detect Kidney Transplant Rejection Using Molecular Diagnoses and Histology as Confirmation. *Transplantation*. Jun 29 2022. PMID 35765145
88. Halloran PF, Reeve J, Madill-Thomsen KS, et al. The Trifecta Study: Comparing Plasma Levels of Donor-derived Cell-Free DNA with the Molecular Phenotype of Kidney Transplant Biopsies. *J Am Soc Nephrol*. Feb 2022; 33(2): 387-400. PMID 35058354
89. Sayah D, Weigt SS, Ramsey A, et al. Plasma Donor-derived Cell-free DNA Levels Are Increased During Acute Cellular Rejection After Lung Transplant: Pilot Data. *Transplant Direct*. Oct 2020; 6(10): e608. PMID 33062841
90. Khush KK, De Vlaminck I, Luikart H, et al. Donor-derived, cell-free DNA levels by next-generation targeted sequencing are elevated in allograft rejection after lung transplantation. *ERJ Open Res*. Jan 2021; 7(1). PMID 33532456
91. Keller M, Sun J, Mutebi C, et al. Donor-derived cell-free DNA as a composite marker of acute lung allograft dysfunction in clinical care. *J Heart Lung Transplant*. Apr 2022; 41(4): 458-466. PMID 35063338
92. Rosenheck JP, Ross DJ, Botros M, et al. Clinical Validation of a Plasma Donor-derived Cell-free DNA Assay to Detect Allograft Rejection and Injury in Lung Transplant. *Transplant Direct*. Apr 2022; 8(4): e1317. PMID 35372675
93. Yancy CW, Jessup M, Bozkurt B, et al. 2017 ACC/AHA/HFSA Focused Update of the 2013 ACCF/AHA Guideline for the Management of Heart Failure: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Failure Society of America. *J Card Fail*. Aug 2017; 23(8): 628-651. PMID 28461259
94. American Society of Transplant Surgeons (ASTS). ASTS Statement on donor-derived cell-free DNA (dd-cf-DNA). 2023. Accessed on October 4, 2023. Available at: <https://asts.org/docs/default-source/position-statements/dd-cfdna-position-statement.pdf?sfvrsn=143d4bd3>
95. Costanzo MR, Dipchand A, Starling R, et al. The International Society of Heart and Lung Transplantation Guidelines for the care of heart transplant recipients. *J Heart Lung Transplant*. Aug 2010; 29(8): 914-56. PMID 20643330
96. Kasiske BL, Zeier MG, Chapman JR, et al. KDIGO clinical practice guideline for the care of kidney transplant recipients: a summary. *Kidney Int*. Feb 2010; 77(4): 299-311. PMID 19847156
97. Centers for Medicare & Medicaid Services (CMS). National Coverage Determination for HEARTSBREATH Test for Heart Transplant Rejection (260.10). 2008; <https://www.cms.gov/medicare-coverage-database/details/ncd-details.aspx?NCDId=325>. Accessed August 29, 2022.

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