Overview

Useful For

Preemptive or reactive genotyping of patients for pharmacogenomic purposes

Providing an assessment for genes with strong drug-gene associations

Genetics Test Information

This test includes targeted testing to evaluate the following genes:

CYP1A2, CYP2C9, CYP2C19, CYP2D6, CYP3A4, CYP3A5, SLCO1B1, VKORC1, CYP4F2, and rs12777823

CYP2D6 testing is done in 2 tiers when needed. Tier 1 uses a PCR-based 5'-nuclease assay to determine the variants present. All samples also have copy number determined by PCR-based 5'-nuclease assay. Testing in tier 1 allows for the detection of all common *CYP2D6* variants (eg, **2, *3, *4, *5, *6, *7, *8, *9, *10, *17, *29, *35, *41*) and rarer alleles such as **11*, **12, *14A, *14B*, and **15*. Duplications and multiplications of alleles are also identified. Unitary and tandem *CYP2D7-2D6* (**13*) alleles and *CYP2D6-2D7* (eg, **4N*, **36*, and **68*) alleles can also be detected. Tier 2 testing involves sequencing using fluorescent dye-terminator chemistry and is only done if an ambiguous phenotype results from tier 1 testing. Approximately 3% of samples require tier 2 testing.

Reflex Tests

Test ID	Reporting Name	Available Separately	Always Performed
2D6S1	CYP2D6 FULL GENE SEQUENCE	No, (Bill Only)	No
2D6S2	CYP2D6 GEN CYP2D6-2D7 HYBRID	No, (Bill Only)	No
2D6S3	CYP2D6 GEN CYP2D7-2D6 HYBRID	No, (Bill Only)	No
2D6S4	CYP2D6 NONDUPLICATED GENE	No, (Bill Only)	No
2D6S5	CYP2D6 5' GENE DUP/MLT	No, (Bill Only)	No
2D6S6	CYP2D6 3' GENE DUP/MLT	No, (Bill Only)	No

Testing Algorithm

If a specimen requires follow-up for *CYP2D6*, then reflex testing will be performed as appropriate at an additional charge.

See CYP2D6 Comprehensive Cascade Testing Algorithm in Special Instructions.

Special Instructions

- Informed Consent for Genetic Testing
- CYP2D6 Comprehensive Cascade Testing Algorithm
- Pharmacogenomic Associations Tables

- Informed Consent for Genetic Testing (Spanish)

Method Name

Real Time Polymerase Chain Reaction (RT-PCR) with Allelic Discrimination Analysis with Polymerase Chain Reaction (PCR) Followed by DNA Sequence Analysis when appropriate

NY State Available

Yes

Specimen

Specimen Type

Varies

Specimen Required

Submit only 1 of the following specimens:

Specimen Type: Whole blood

Container/Tube: Lavender top (EDTA)

Specimen Volume: 3 mL

Collection Instructions:

1. Invert several times to mix blood.

2. Send specimen in original tube.

Specimen Stability Information: Ambient (preferred)/Refrigerated

Specimen Type: Saliva

Patient Preparation: Patient should not eat, drink smoke, or chew gum 30 minutes prior to collection.

Supplies: DNA Saliva Collection Kit (T786)

Container/Tube: Saliva Swab Collection Kit

Specimen Volume: 1 swab

Collection Instructions: Collect and send specimen per kit instructions.

Specimen Stability Information: Ambient

Additional Information: Due to lower concentration of DNA yielded from saliva, testing cannot proceed to reflex testing for 2D6 sequencing and will stop after initial testing is complete.

Specimen Type: DNA

Container/Tube: 2 mL screw top tube

Specimen Volume: 100 mcL (microliters)

Collection Instructions:

1. The preferred volume is 100 mcL at a concentration of 50 ng/mcL.

2. Include concentration and volume on tube.

Specimen Stability Information: Frozen (preferred)/Ambient/Refrigerated

Forms

1. **New York Clients-Informed consent is required.** Document on the request form or electronic order that a copy is on file. The following documents are available in Special Instructions:

-Informed Consent for Genetic Testing (T576)

-Informed Consent for Genetic Testing-Spanish (T826)

2. If not ordering electronically, complete, print, and send 1 of the following forms with the specimen:

-Neurology Specialty Testing Client Test Request (T732)

-Cardiovascular Test Request (T724)

-Therapeutics Test Request (T831)

Specimen Minimum Volume

Blood: 1 mL
Saliva: 1 swab

Reject Due To

All specimens will be evaluated at Mayo Clinic Laboratories for test suitability.

Specimen Stability Information

Specimen Type	Temperature	Time	Special Container
Varies	Varies		

Clinical and Interpretive

Clinical Information

This panel provides a comprehensive analysis for multiple genes with strong drug phenotype associations. Each sample is tested for specific variations with known functional impact. Pharmacogenomic data for the following specific variants are reviewed and reported (if present):

CYP1A2 *1F, *1K, *6, and *7

CYP2C9 *2, *3, *4, *5, *6, *8, *9, *11, *12, *13, *14, *15, *16, *17, *18, *25, *26, *28, *30, *33, and *35

CYP2C19 *2, *3, *4, *5, *6, *7, *8, *9, *10, *17, and *35

CYP2D6 *2, *2A, *3, *4, *4N, *5, *6, *7, *8, *9, *10, *11, *12, *13, *14A, *14B,*15, *17, *29, *35, *36, *41, *68, and *CYP2D6* gene duplication; additional *CYP2D6* variants may be detected through the reflex testing process

CYP3A4 *8, *11, *12, *13, *16, *17, *18, *22, and *26

CYP3A5 *3, *5, *6, *7, *8, and *9

CYP4F2 *3

rs12777823G->A

SLCO1B1 rs4149056 variant found in the *5, *15 and *17 alleles, and rs4149015 found in the *17 and *21 alleles

VKORC1 c. -1639G>A, c.85G->T, c.106G->T, c.121G->T, c.134T->C, c.172A->G, c.196G->A, c.358C->T, and c.383T->G

Based on the results of each assay, a genotype is assigned and a phenotype is predicted for each gene. Assessment of multiple genes may assist the ordering clinician with personalized drug recommendations, avoidance of adverse drug reactions, and optimization of drug treatment.

Reference Values

An interpretive report will be provided.

Interpretation

An interpretive report will be provided that focuses on only drugs and genes with published pharmacogenomic practice guidance by the Clinical Pharmacogenetics Implementation Consortium, other professional organizations or where strong FDA guidance has been issued in drug labels.

For additional information regarding pharmacogenomic genes and their associated drugs, see Pharmacogenomic Associations Tables in Special Instructions. This resource also includes information regarding enzyme inhibitors and inducers, as well as potential alternate drug choices.

Cautions

Samples may contain donor DNA if obtained from patients who received heterologous blood transfusions or allogeneic blood or marrow transplantation. Results from samples obtained under these circumstances may not accurately reflect the recipient's genotype. For individuals who have received blood transfusions, the genotype usually reverts to that of the recipient within 6 weeks. For individuals who have received allogeneic blood or marrow transplantation, a pretransplant DNA specimen is recommended for testing.

Genetic test results in patients who have undergone liver transplantation may not accurately reflect the patient's genetic status for the genes on this panel.

This test is not designed to provide specific dosing recommendations and is to be used as an aid to clinical decision making only. Drug-label guidance should be used when dosing patients with medications regardless of the predicted phenotype.

For additional information, see the following tests:

1A2V / Cytochrome P450 1A2 Genotype

2C9GV / Cytochrome P450 2C9 Genotype

2C19V / Cytochrome P450 2C19 Genotype

2D6CV / Cytochrome P450 2D6 (CYP2D6) Comprehensive Cascade

3A4V / Cytochrome P450 3A4 Genotype

3A5V / Cytochrome P450 3A5 Genotype

SLC1V / Solute Carrier Organic Anion Transporter Family Member 1B1 (SLCO1B1) Genotype, Statin

WARSV / Warfarin Response Genotype

Clinical Reference

1. Ji Y, Skierka JM, Blommel JH, et al: Preemptive Pharmacogenomic Testing for Precision Medicine: A Comprehensive Analysis of Five Actionable Pharmacogenomic Genes Using Next-Generation DNA Sequencing and a Customized CYP2D6 Genotyping Cascade. J Mol Diagn 2016 May;18(3):438-445

2. Samwald M, Xu H, Blagec K, et al: Incidence of Exposure of Patients in the United States to Multiple Drugs for Which Pharmacogenomic Guidelines Are Available. PLoS One 2016 Oct 20;11(10):e0164972

3. Clinical Pharmacogenetic Implementation Committee Gene-Drug Table. Accessed 5/4/2017. Available at https://cpicpgx.org/genes-drugs/

4. Pharmacogenomics Knowledgebase (PharmGKB). Accessed 5/4/2017. Available at www.pharmgkb.org/

Performance

Method Description

Genomic DNA is extracted from whole blood. Genotyping for each allele is performed using a PCR-based 5'-nuclease assay. Fluorescently labeled detection probes anneal to the target DNA. PCR is used to amplify the section of DNA that contains the variant. If the detection probe is an exact match to the target DNA, the 5'-nuclease polymerase degrades the probe, the reporter dye is released from the effects of the quencher dye, and a fluorescent signal is detected. Genotypes are assigned based on the allele-specific fluorescent signals that are detected.(Instruction manual: TaqMan SNP Genotyping Assay, Applied Biosystems Revision A.0 January 2014)

PDF Report

No

Day(s) and Time(s) Test Performed

Monday through Friday; 8 a.m.

Analytic Time

3 days (not reported Saturday or Sunday)

Maximum Laboratory Time

14 days

Specimen Retention Time

Whole Blood/Saliva Swab: 2 weeks; Extracted DNA: 2 months

Performing Laboratory Location

Rochester

Fees and Codes

Fees

- Authorized users can sign in to Test Prices for detailed fee information.
- Clients without access to Test Prices can contact Customer Service 24 hours a day, seven days a week.
- Prospective clients should contact their Regional Manager. For assistance, contact Customer Service.

Test Classification

This test was developed and its performance characteristics determined by Mayo Clinic in a manner consistent with CLIA requirements. This test has not been cleared or approved by the U.S. Food and Drug Administration.

CPT Code Information

0029U

2D6S1-2D6S6 reflex tests

0071U-0076U (if appropriate)

LOINC® Information

Test ID	Test Order Name	Order LOINC Value
PGXFP	Focused Pharmacogenomics Panel	82118-1

Result ID	Test Result Name	Result LOINC Value
BA0902	Medications	52418-1
BA0903	Amitriptyline	83010-9
BA0904	Aripiprazole	83010-9
BA0905	Atomoxetine	83010-9
BA0906	Atorvastatin	83010-9
BA0914	Brexpiprazole	83010-9
BA0907	Carvedilol	83010-9
BA0915	Carisoprodol	83010-9
BA0908	Celecoxib	83010-9
BA0909	Citalopram	83010-9
BA0152	Clobazam	83010-9
BA0910	Clomipramine	83010-9
BA0911	Clopidogrel	83010-9

Result ID	Test Result Name	Result LOINC Value
BA0912	Codeine	83010-9
BA0913	Desipramine	83010-9
BA0263	Dexlansoprazole	83010-9
BA0235	Dextromethorphan	83010-9
BA0916	Diclofenac	83010-9
BA0917	Doxepin	83010-9
BA0233	Eliglustat	83010-9
BA0918	Escitalopram	83010-9
BA0919	Esomeprazole	83010-9
BA0244	Flecainide	83010-9
BA0920	Fluoxetine	83010-9
BA0921	Fluvoxamine	83010-9
BA0922	Fosphenytoin	83010-9
BA0245	Haloperidol	83010-9
BA1630	Iloperidone	83010-9
BA0923	Imipramine	83010-9
BA0924	Lansoprazole	83010-9
BA0925	Metoprolol	83010-9
BA0926	Nortriptyline	83010-9
BA0927	Omeprazole	83010-9
BA0928	Ondansetron	83010-9
BA0929	Oxycodone	83010-9
BA0930	Pantoprazole	83010-9
BA0931	Paroxetine	83010-9
BA1631	Perphenazine	83010-9
BA0932	Phenytoin	83010-9
BA1632	Pimozide	83010-9
BA0933	Pravastatin	83010-9
BA1633	Propafenone	83010-9
BA1634	Risperidone	83010-9
BA0934	Rosuvastatin	83010-9
BA0935	Sertraline	83010-9
BA0936	Simvastatin	83010-9
BA0937	Sirolimus	83010-9
BA0938	Tacrolimus	83010-9
BA0939	Tamoxifen	83010-9
BA0940	Tamsulosin	83010-9
BA1635	Tetrabenazine	83010-9

Result ID	Test Result Name	Result LOINC Value
BA1636	Thioridazine	83010-9
BA0941	Tramadol	83010-9
BA0942	Trimipramine	83010-9
BA0943	Tropisetron	83010-9
BA0944	Venlafaxine	83010-9
BA0945	Voriconazole	83010-9
BA0946	Warfarin	83010-9
BA0947	Other Medications	30964-1
BA0261	CYP1A2 Genotype	72884-0
BA0262	CYP1A2 Phenotype	94254-0
BA0258	CYP2C19 Genotype	57132-3
BA0259	CYP2C19 Phenotype	79714-2
BA0264	CYP2C9 Genotype	46724-1
BA0265	CYP2C9 Phenotype	79716-7
BA0255	CYP2D6 Genotype	40425-1
BA0256	CYP2D6 Phenotype	79715-9
BA0252	CYP3A4 Genotype	81139-8
BA0253	CYP3A4 Phenotype	81145-5
BA0249	CYP3A5 Genotype	81140-6
BA0250	CYP3A5 Phenotype	79717-5
BA0246	SLCO1B1 Genotype	93412-5
BA0247	SLCO1B1 Phenotype	79722-5
BA0228	WARF CYP2C9 Genotype	46724-1
BA0229	WARF VKORC1 Genotype	72512-7
BA0150	Additional VKORC1 Variants	82939-0
BA0230	CYP4F2 *3 Genotype	93197-2
BA0231	rs12777823 Genotype	93198-0
BA0151	Interpretation	69047-9
BA0267	Additional Information	48767-8
BA0268	Method	49549-9
BA0269	Disclaimer	62364-5
BA0270	Reviewed by	18771-6