MEDICAL POLICY – 12.04.517
CYP450 Genotyping to Determine Drug Metabolizer Status

BCBSA Ref. Policy: 2.04.38

Effective Date: Aug. 1, 2017
Last Revised: July 25, 2017
Replaces: 12.04.38

RELATED MEDICAL POLICIES:
2.04.509 Cardiovascular Risk Panels
12.04.48 Genetic Testing for Warfarin Dose
12.04.51 Genetic Testing for Tamoxifen Treatment
12.04.121 Miscellaneous Genetic and Molecular Diagnostic Tests
12.04.131 Pharmacogenetic Testing for Pain Management
12.04.515 Genetic Testing for Mental Health Conditions

Introduction

Metabolism is the term for how the body processes substances. Just as the body processes (metabolizes) foods, it also metabolizes medications. One gene in particular, cytochrome P450 (also called CYP450), is known to be involved in processing a large number of drugs. Certain changes, called mutations, may affect how well or poorly a drug is metabolized. Medical studies have shown that genetic testing for certain CYP450 gene mutations is helpful in determining how a person would metabolize some drugs. For example, drugs like clopidogrel for heart disease, eliglustat for Gaucher disease, and tetrabenazine for Huntington disease. However, reliable and large studies have not yet shown that this type of genetic testing is useful for other drugs. This policy describes when CYP450 genetic testing is covered.

Note: The Introduction section is for your general knowledge and is not to be taken as policy coverage criteria. The rest of the policy uses specific words and concepts familiar to medical professionals. It is intended for providers. A provider can be a person, such as a doctor, nurse, psychologist, or dentist. A provider also can be a place where medical care is given, like a hospital, clinic, or lab. This policy informs them about when a service may be covered.
# Policy Coverage Criteria

## Test | Medical Necessity
---|---
**Genotype testing for the CYP2C19 variant of CYP450** | **Genotype testing for the CYP2C19 variant of CYP450 is considered medically necessary in following situations:**
1. When using clopidogrel (selection of best drug, or determine optimal dose)
   
   **OR**

2. Patient with Gaucher disease, and considering treatment with eliglustat
   
   **OR**

3. Patient with Huntington disease treated with tetrabenazine in a dosage greater than 50 mg per day

## Test | Investigational
---|---
**Genotype testing for the CYP2C19 variant of CYP450** | **Genotype testing of CYP450 to determine drug choice or dose for all other drugs not listed in the Medical Necessity section above is considered investigational, unless there is a separate policy (see Related Medical Policies).**

The use of genetic testing panels that include multiple CYP450 variants/mutations/polymorphisms is considered investigational.

**Note:** Multigene testing panels that include CYP450 and other non CYP450 genes are addressed in other policies. (See Related Medical Policies)

This policy only addresses individual genetic tests for CYP450.

This policy only addresses individual variants of the CYP450 gene and does not address the use of Multigene panel tests which include CYP450. Panels that include CYP450 and other genes (eg, the Genecept Assay), are discussed in separate medical policies (see Related Medical Policies).

Several manufacturers market panels of diagnostic genotyping tests for CYP450 genes, that include but are not limited to the following:
The YouScript Panel (Genelex Corporation, Seattle, WA), which includes the following variants: CYP2D6, CYP2C19, CYP2C9, VKORC1, CYP3A4 and CYP3A5

Another panel test that includes both CYP450 genes and other non-CYP450 genes involved in drug metabolism is the GeneSight Psychotropic panel (Assurex Health, Inc., Mason, OH).

For panel testing for CYP450 polymorphisms, the individual components of the tests generally have not demonstrated clinical utility.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tr>
<td>81225</td>
<td>CYP2C19 (cytochrome P450, family 2, subfamily C, polypeptide 19) (e.g., drug metabolism), gene analysis, common variants (e.g., *2, *3, *4, *8, *17)</td>
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<td>81227</td>
<td>CYP2C9 (cytochrome P450, family 2, subfamily C, polypeptide 9) (e.g., drug metabolism), gene analysis, common variants (e.g., *2, *3, *5, *6)</td>
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</table>
| 81401 | Molecular pathology procedure, Level 2 (e.g., 2-10 SNPs, 1 methylated variant, or 1 somatic variant [typically using non-sequencing target variant analysis], or detection of a dynamic mutation disorder/triplet repeat) includes:  
  - CYP3A4 (cytochrome P450, family 3, subfamily A, polypeptide 4) (e.g., drug metabolism), common variants (e.g., *2,*3,*4,*5,*6)  
  - CYP3A5 (cytochrome P450, family 3, subfamily A, polypeptide 5) (e.g., drug metabolism), common variants (e.g., *2,*3,*4,*5,*6) |
| 81402 | Molecular pathology procedure, Level 3 (e.g., >10 SNPs, 2-10 methylated variants, or 2-10 somatic variants [typically using non-sequencing target variant analysis], immunoglobulin and T-cell receptor gene rearrangements, duplication/deletion variants of 1 exon, loss of heterozygosity [LOH], uniparental disomy [UPD]) includes:  
  - CYP21A2 (cytochrome P450, family 21, subfamily A, polypeptide 2) (e.g., congenital adrenal hyperplasia, 21-hydroxylase deficiency), common variants (e.g., IVS2-13G, P30L, I172N, exon 6 mutation cluster [I235N,V236E, M238K], V281L, L307FsX6, Q318X, R356W, P453S, G110VfsX21, 30-kb deletion variant) |
| 81404 | Molecular pathology procedure, Level 5 (e.g., analysis of 2-5 exons by DNA sequence analysis, mutation scanning or duplication/deletion variants of 6-10 exons, or
<table>
<thead>
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<tbody>
<tr>
<td></td>
<td>characterization of a dynamic mutation disorder/triplet repeat by Southern blot analysis includes:</td>
</tr>
<tr>
<td></td>
<td>• CYP1B1 (cytochrome P450, family 1, subfamily B, polypeptide 1) (e.g., primary congenital glaucoma), full gene sequence</td>
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<tr>
<td>81405</td>
<td>Molecular pathology procedure, Level 6 (e.g., analysis of 6-10 exons by DNA sequence analysis, mutation scanning or duplication/deletion variants of 11-25 exons, regionally targeted cytogenomic array analysis) includes:</td>
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<td>• CYP11B1 (cytochrome P450, family 11, subfamily B, polypeptide 1) (e.g., congenital adrenal hyperplasia), full gene sequence</td>
</tr>
<tr>
<td></td>
<td>• CYP17A1 (cytochrome P450, family 17, subfamily A, polypeptide 1) (e.g., congenital adrenal hyperplasia), full gene sequence</td>
</tr>
<tr>
<td></td>
<td>• CYP21A2 (cytochrome P450, family 21, subfamily A, polypeptide 2) (e.g., steroid 21-hydroxylase isoform, congenital adrenal hyperplasia), full gene sequence</td>
</tr>
</tbody>
</table>

**Note:** The CPT genetic modifier that is specific to CYP2 genes is: -9B CYP2 genes, commonly called cytochrome p450 (drug metabolism)

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### Related Information

### Definition of Terms

**Cytochrome P450:** This refers to a family of 60 different enzymes involved in drug and toxin metabolism.

**Genotype testing:** This is a type of testing used to determine the DNA sequence in genes.

**Metabolize:** This is a term that refers to breaking down a molecule into smaller units. If a drug is metabolized, it is no longer clinically active.

**Polymorphisms:** This is a genetic variation between individuals resulting in differences in form or gene expression, in this case differing activity of various enzymes.
**Background**

Drug efficacy and toxicity can vary substantially between individuals. Because trial and error are typically used to select drugs and adjust their doses, it may take some time before the best therapy can be found, and in the meantime there may be serious adverse events.

The effect that drugs have may be influenced by many factors including age, liver function, concomitant diseases, nutrition, smoking, and drug-drug interactions. Genetic variations between people may also have an effect. For example, DNA sequence variations may have an influence on drug metabolism, drug receptors and transporters, and the molecules involved in signal transduction pathways. All of these things can affect the efficacy and/or toxicity of a drug.

Pharmacogenomics is the study of how an individual's genetic makeup affects the body's response to drugs. It may be possible to predict therapeutic failures or severe adverse drug reactions in individual patients by testing the genes involved with the metabolic pathway (pharmacokinetics) or signal transduction pathway (pharmacodynamics) of the drug. Potentially, test results could be used to optimize drug choice and/or dose for more effective therapy, avoid serious adverse effects, and decrease medical costs.

**Cytochrome p450 System**

The cytochrome P450 (CYP450) family is involved in the metabolism of many currently administered drugs, and genetic variants in cytochrome P450 are associated with altered metabolism of many drugs. Genetic testing for cytochrome P450 variants may assist in choosing appropriate drugs and their dosages.

Many drugs are metabolized to varying degrees by more than one enzyme, either within or outside of the CYP450 superfamily. In addition, interaction between different metabolizing genes, interaction of genes and environment, and interactions among different non-genetic factors also influence CYP450-specific metabolizing functions. Thus, identification of a variant in a single gene in the metabolic pathway may be insufficient in all but a small proportion of drugs to explain inter-individual differences in metabolism and consequent efficacy or toxicity.
The objective of this policy is to evaluate the effect on health outcomes associated with genetic testing for cytochrome P450 variants for the selection and dosing of drugs that are affected by CYP450 metabolism.

Validation of the clinical use of any genetic test focuses on 3 main principles:

1. Analytic validity: refers to the technical accuracy of the test in either detecting a variant that is present or in excluding a variant that is absent
2. Clinical validity: refers to the diagnostic performance of the test (sensitivity, specificity, positive and negative predictive values) in detecting clinical disease, and
3. Clinical utility: how the results of the diagnostic test will be used to change management of the patient and whether these changes in management lead to clinically important improvements in health outcomes.

Further discussion of the validation process is provided in a 2004 TEC Special Report, Genotyping for Cytochrome P450 Polymorphisms to Determine Drug-Metabolizer Status, on which this policy is based.¹

### Selection and Dosing of Clopidogrel

Individuals with genetic variants of cytochrome P450 have a decreased ability to metabolize clopidogrel, but the impact on clinically meaningful outcomes is uncertain. Some observational studies have reported increased rates of cardiovascular events in patients with genetic variants, but others have not. Systematic reviews of observational studies report that genetic variants may be associated with a modest increase in the rate of stent thrombosis and clinical end points. However, the evidence addressing whether the use of CYP2C19 genotype-directed therapy improves outcomes is limited. While genotyping appears in some studies to be helpful in identifying patients at higher risk of treatment failure and may be very useful in selected patients, more information is needed to refine optimal use of testing and to better understand the relative merit of management options.

FDA has required the package insert for clopidogrel carry a black box warning concerning possible worse outcomes with clopidogrel treatment in patients with genetic variants. The FDA warning suggests changes in doses or changes in drug.
Selection or Dosing of Eliglustat

Gaucher disease is a rare autosomal recessive lipid storage disease in which deficiency or absence of the enzyme β-glucocerebrosidase leads to lysosomal accumulation of the glycosphingolipid glucosylceramide. Untreated, this accumulation can lead to a range of effects, including anemia and thrombocytopenia, splenomegaly, bone disease, pulmonary fibrosis, and central nervous system involvement. Gaucher disease has been treated through enzyme replacement, for which 3 drugs have FDA approval as orphan drugs (imiglucerase, velaglucerase alfa, and taliglucerase alfa) or substrate reduction therapy, for which 2 drugs have FDA approval as orphan drugs (miglustat and eliglustat tartrate). Eliglustat tartrate is an orally administered selective inhibitor of glucosylceramide synthase that received FDA approval in 2014 and has been found in 3 phase 3 clinical trials to lead to improvements in hematologic metrics and organomegaly.

Eliglustat tartrate is primarily metabolized by CYP2D6. FDA labeling requires that patients be tested for CYP2D6 metabolizer status as determined by genotype and UMs be excluded from being prescribed eliglustat because these patients may not achieve adequate concentrations to achieve a therapeutic effect. FDA reviews report that at doses as high of 200 mg twice daily the exposure in UMs was about 57% and about 82% lower than the exposures for EMs and IMs at 100 mg twice daily, respectively. The approved dose is 84 mg twice daily for EMs and IMs and 84 mg once daily for PMs.

No published studies were identified that report that genetic variants associated with CYP2D6 and CYP3A may be associated with differential rate of drug metabolism or drug-related adverse events compared to those without the variants. Information submitted to FDA by the manufacturer as part of regulatory approval reports that patients who are classified as UMs by a CYP450 genotype testing may fail to achieve adequate therapeutic concentrations and therefore should not be prescribed eliglustat.

Selection or Dosing of Tetrabenazine

Huntington disease is an autosomal dominant genetic neurodegenerative disorder characterized by progressive cognitive and motor dysfunction, including chorea. In 2008, FDA approved tetrabenazine, a centrally acting vesicular monoamine transporter inhibitor, as an orphan drug for the treatment of chorea in Huntington disease, based on evidence from an RCT of improved chorea symptoms in ambulatory patients with Huntington disease. Tetrabenazine's primary metabolites are metabolized mainly by CYP2D6. FDA labeling for tetrabenazine includes recommendations for genotyping for CYP2D6 in patients who are being considered for doses
above 50 mg per day. The labeling states: “Patients requiring doses above 50 mg per day should be genotyped for the drug metabolizing enzyme CYP2D6 to determine if the patient is a poor metabolizer (PM) or an extensive metabolizer (EM). Maximum daily dose in PMs: 50 mg with a maximum single dose of 25 mg. Maximum daily dose in EMs and intermediate metabolizers (IMs): 100 mg with a maximum single dose of 37.5 mg.”

Mehanna et al (2013) reported the results of a cohort study in which CYP2D6 genotyping was performed sequentially in 127 patients receiving tetrabenazine and a reviewer blinded to the test results analyzed charts data to assess dose, titration, response to treatment and adverse effects. Treating physician was not aware of the test results at the time of initiation or titration of tetrabenazine.

Majority of patients were categorized as EMs (n=100) while the remaining were categorized as IMs (n=14) and PMs (n=11). There were only 2 patients categorized as UMs. The mean duration of titration to achieve optimal benefit was longer in UMs compared to EMs, IMs and PMs (8 weeks vs 3.3, 4.4, and 3 weeks, respectively; p<0.01) and required a higher average daily dose than the other patients (138 mg/d vs 63, 66 and 41 mg/d, respectively). The difference in dose did not reach statistical significance. Authors concluded that there were no distinguishing features of patients with various CYP2D6 genotypes, and therefore the current recommendation to systematically genotype all patients prescribed more than 50 mg/day of tetrabenazine should be reconsidered.

Selection or Dosing of Tetrabenazine One published study was identified that report that patients categorized as UMs by a CYP450 genotype test require high dose of tetrabenazine compared to those who are not categorized as UMs. However, this finding was based in a sample with only 2 patients categorized as UMs. Therefore, these findings have to be reproduced in a larger cohort.

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Clinical Trials

Some currently unpublished trials that might influence this review are listed in Table 1 below.

Table 1. Summary of Key Trials

<table>
<thead>
<tr>
<th>NCT No.</th>
<th>Trial Name</th>
<th>Planned Enrollment</th>
<th>Completion Date</th>
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<tr>
<td>Ongoing</td>
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<tr>
<td>NCT01742117</td>
<td>Tailored Antiplatelet Initiation to Lesson Outcomes Due to Decreased Clopidogrel Response After Percutaneous Coronary Intervention (TAILOR-PCI)</td>
<td>5270</td>
<td>Aug 2016</td>
</tr>
</tbody>
</table>

NCT: national clinical trial.

Summary of Evidence

The evidence for testing for CYP2C19 metabolizer status by CYP2C19 genotyping in patients who need antiplatelet therapy and are undergoing or being considered for clopidogrel therapy includes 1 randomized controlled trial (RCT) of CYP2C19 genotype-directed antiplatelet therapy, observational studies, and analyses or RCTs of clopidogrel therapy, and meta-analyses of these studies. Relevant outcomes are morbid events and treatment-related morbidity and mortality. Systematic reviews of observational studies report that genetic variants may be associated with a modest increase in the rate of stent thrombosis and clinical end points. CYP2C19 genotype has
been associated with increased risk of thrombosis in patients with coronary disease or cardiac interventions being considered as candidates for clopidogrel treatment. This observation is most pronounced for stent thrombosis in patients undergoing percutaneous coronary intervention. The evidence addressing whether the use of CYP2C19 genotype-directed therapy improves outcomes is limited. One RCT comparing CYP2C19 genotype-directed antiplatelet therapy reported that patients receiving genotype-directed therapy had higher on-treatment platelet reactivity. However, the effect on clinical end points is not well understood. The evidence is insufficient to determine the effects of the technology on health outcomes, however given the black label warning, the plan covers the test when ordered by the provider.

The evidence for cytochrome P450 genotyping in patients with various clinical conditions undergoing or being considered for treatment with a drug metabolized by CYP450 enzyme(s) includes prospective and retrospective observational studies reporting associations with CYP450 metabolizer status and medication response or adverse effects. Relevant outcomes are symptoms, change in disease status, morbid events, medication use, and treatment-related morbidity and mortality. Most published studies of CYP450 pharmacogenomics are retrospective evaluations of CYP450 genotype association with intermediate (eg, circulating drug concentrations) or, less often, final outcomes (eg, adverse events or efficacy) and are largely small and underpowered or not designed to examine the clinical effects of homozygous variant poor metabolizers and of ultrarapid metabolizers, where the strongest effects, if any, would be seen. The hazards associated with different metabolizer status are therefore uncertain. Decision-making regarding dose or medication selection changes in response to CYP450 metabolizer status is poorly defined, and outcome changes are uncertain. The evidence is insufficient to determine the effects of the technology on health outcomes.

Practice Guidelines and Position Statements

A consensus statement by the American College of Cardiology Foundation (ACCF) and the American Heart Association (AHA) on genetic testing for selection and dosing of clopidogrel was published in 2010.40 The recommendations for practice included the following statements:

- Adherence to existing ACCF/AHA guidelines for the use of antiplatelet therapy should remain the foundation for therapy. Careful clinical judgment is required to assess the importance of the variability in response to clopidogrel for an individual patient and its associated risk to the patient.

- Clinicians must be aware that genetic variability in CYP enzymes alter clopidogrel metabolism, which in turn can affect its inhibition of platelet function. Diminished
responsiveness to clopidogrel has been associated with adverse patient outcomes in registry experiences and clinical trials.

- The specific impact of the individual genetic polymorphisms on clinical outcome remains to be determined

- Information regarding the predictive value of pharmacogenomic testing is very limited at this time; resolution of this issue is the focus of multiple ongoing studies. The selection of the specific test, as well as the issue of reimbursement, is both important additional considerations.

- The evidence base is insufficient to recommend either routine genetic or platelet function testing at the present time.

- There are several possible therapeutic options for patients who experience an adverse event while taking clopidogrel in the absence of any concern about medication compliance.

**U.S. Preventive Services Task Force Recommendations**

No U.S. Preventive Services Task Force recommendations for cytochrome p450 have been identified.

**Medicare National Coverage Decisions**

There is no national coverage determination (NCD). In the absence of an NCD, coverage decisions are left to the discretion of local Medicare carriers.

**Regulatory Status**

Diagnostic genotyping tests for certain CYP450 enzymes are now available. Some tests are offered as in-house laboratory-developed test services, which do not require U.S. Food and Drug Administration (FDA) approval but which must meet Clinical Laboratory Improvement Act (CLIA) quality standards for high-complexity testing.

Several testing kits for CYP450 genotyping have been cleared for marketing by FDA (FDA product code: NTI). These include:
• The AmpliChip® (Roche Molecular Systems, Inc.) was cleared for marketing in January 2005. The AmpliChip® is a microarray consisting of many DNA sequences complementary to 2 CYP450 genes and applied in microscopic quantities at ordered locations on a solid surface (chip). The AmpliChip® tests the DNA from a patient’s white blood cells collected in a standard anticoagulated blood sample for 29 polymorphisms and mutations for the CYP2D6 gene and 2 polymorphisms for the CYP2C19 gene. FDA cleared the test “based on results of a study conducted by the manufacturers of hundreds of DNA samples as well as on a broad range of supporting peer-reviewed literature.” According to FDA labeling, “Information about CYP2D6 genotype may be used as an aid to clinicians in determining therapeutic strategy and treatment doses for therapeutics that are metabolized by the CYP2D6 product.”

• The xTAG® CYP2D6 Kit (Luminex Molecular Diagnostics, Toronto) was cleared for marketing in August 2010 based on substantial equivalence to the Amplichip CYP450 test. It is designed to identify a panel of nucleotide variants within the polymorphic CYP2D6 gene on chromosome 22.

• The INFINITI CYP2C19 Assay (AutoGenomics, Inc., Vista, CA) was cleared for marketing in October 2010 based on substantial equivalence to the Amplichip CYP450 test. It is designed to identify variants within the CYP2C19 gene (*2, *3, and *17).

• Verigene CYP2C19 Nucleic Acid Test (Nanosphere, Inc., Northbrook, IL), designed to identify variants within the CYP2C19 gene, was cleared for marketing in November 2013 based on substantial equivalence to the INFINITI CYP2C19 Assay.

• The Spartan RX CYP2C19 Test System (Spartan Bioscience, Redwood Shores, CA), designed to identify variants in the CYP2C19 gene (*2, *3, and *17 alleles), was cleared for marketing in August 2013 based on substantial equivalence to the INFINITI CYP2C19 Assay.

• The xTAG® CYP2C19 Kit v3 (Luminex Molecular Diagnostics, Toronto), designed to identify variants in the CYP2C19 gene (*2, *3, and *17 alleles) was cleared for marketing in September 2013 based on substantial equivalence to the INFINITI CYP2C19 Assay.

Several manufacturers market panels of diagnostic genotyping tests for CYP450 genes, such as:

• The YouScript Panel (Genelex Corporation, Seattle, WA), which includes CYP2D6, CYP2C19, CYP2C9, VKORC1, CYP3A4 and CYP3A5.

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### History

<table>
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<th>Date</th>
<th>Comments</th>
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<td>03/08/16</td>
<td>New policy, replaces 12.04.38.</td>
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<tr>
<td>05/04/16</td>
<td>Update Related Policies. 12.04.92 was deleted and replaced with 12.04.520.</td>
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<tr>
<td>06/01/16</td>
<td>Update Related Policies. Removed 12.04.67 as it was deleted; information moved to 2.04.509.</td>
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<tr>
<td>02/10/17</td>
<td>Policy moved into new format; no change to policy statements.</td>
</tr>
<tr>
<td>04/14/17</td>
<td>Updated Related Policies; removed 12.04.520 as it was archived. Minor formatting update.</td>
</tr>
<tr>
<td>08/01/17</td>
<td>Annual review. Policy approved on July 25, 2017. Selection or Dosing of Tetrabenazine and Eliglustat were added to the Evidence Review section. No changes to policy statement.</td>
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</tbody>
</table>

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Email AppealsDepartmentInquiries@Premera.com

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U.S. Department of Health and Human Services
200 Independence Avenue SW, Room 509F, HHH Building
Washington, D.C. 20201, 1-800-368-1019, 800-537-7697 (TDD)
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German (German):

Hmong (Hmong):

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For assistance in other languages, call 800-722-1471 (TTY: 800-842-5357), at least 3 days before your deadline.

Call 800-722-1471 (TTY: 800-842-5357) for help with your health insurance and support services.