

Fatty Acid Oxidation Disorders Panel, Sequencing

Fatty acid oxidation disorders are a heterogeneous group of disorders, and clinical presentation varies in both severity and age of onset. Specific symptoms may differ depending on whether an individual experiences neonatal onset or a later onset but may include hypoketotic hypoglycemia, lethargy, episodic emesis, seizures, hepatomegaly, cardiomyopathy, Reye-like symptoms, skeletal myopathy, myalgia, exercise intolerance, coma, or sudden death.

Disease Overview

Symptoms

Common Symptoms Based on Age of Onset	
Neonatal Onset	Later Onset
<ul style="list-style-type: none"> • Hypoketotic hypoglycemia • Lethargy • Episodic emesis • Seizures • Arrhythmia • Reye-like symptoms • Hypertrophic cardiomyopathy • Hepatomegaly, hepatic failure • Encephalopathy • Coma • Sudden death 	<ul style="list-style-type: none"> • Myopathy • Myalgia • Muscle weakness • Exercise intolerance or exercise-induced rhabdomyolysis • Acute metabolic episodes triggered by fasting, infection, surgery

Testing Strategy

When a disorder of fatty acid oxidation is suspected, the following tests should be ordered:

- Plasma acylcarnitines
- Carnitine panel
- Urine organic acids

In addition, acylglycines may be helpful for some disorders.

Because biochemical studies may be completely normal if obtained while patient is metabolically stable, molecular testing or functional studies are often needed for definitive diagnosis.

See [Related Tests](#).

Incidence

Approximately 1 in 5,000 to 1 in 10,000 births

Tests to Consider

[Fatty Acid Oxidation Disorders Panel, Sequencing 3001851](#)

Method: Massively Parallel Sequencing

Preferred molecular test to confirm or rule out a diagnosis of a fatty acid oxidation disorder following clinical and/or biochemical presentation

Also refer to Acylcarnitine Quantitative Profile, Plasma (0040033), Carnitine Panel (0081110), and Organic Acids, Urine (0098389)

See [Related Tests](#).



Genetics

Etiology

Pathogenic germline variants in genes associated with fatty acid oxidation disorders (see [Genes Tested](#) table)

Inheritance

Mostly autosomal recessive (AR); rarely autosomal dominant (AD) or X-linked (XL)

Test Interpretation

Clinical Sensitivity

Approximately 96%

Analytical Sensitivity

For massively parallel sequencing:

Variant Class	Analytical Sensitivity (PPA) Estimate ^a (%)	Analytical Sensitivity (PPA) 95% Credibility Region ^a (%)
SNVs	99.2	96.9-99.4
Deletions 1-10 bp	93.8	84.3-98.2
Deletions 11-44 bp	99.9	87.8-100
Insertions 1-10 bp	94.8	86.8-98.5
Insertions 11-23 bp	99.9	62.1-100

^aGenes included on this test are a subset of a larger methods-based validation from which the PPA values are derived.

bp, base pairs; PPA, positive percent agreement; SNVs, single nucleotide variants

Results

Result	Variant(s) Detected	Clinical Significance
Positive	One or more pathogenic or likely pathogenic variants detected	Diagnosis of heritable fatty acid oxidation defect is confirmed Specific diagnosis depends on the variant(s) detected
Inconclusive	One or more variants of uncertain significance detected	Diagnosis of fatty acid oxidation defect remains uncertain
Negative	No pathogenic variants detected	Diagnosis of heritable fatty acid oxidation defect is less likely, but not excluded

Limitations

- A negative result does not exclude a diagnosis of a fatty acid oxidation disorder.



- Diagnostic errors can occur due to rare sequence variations.
- Interpretation of this test result may be impacted if this patient has had an allogeneic stem cell transplantation.
- The following will not be evaluated:
 - Variants outside the coding regions and intron-exon boundaries of targeted genes
 - Regulatory region and deep intronic variants
 - Noncoding transcripts
 - The following exons are not sequenced due to technical limitations of the assay:
 - LPIN1(NM_001349200) exon 13
 - LPIN1(NM_001349201) exon 12
 - Large deletions/duplications in any of the tested genes
- The following may not be detected:
 - Deletions/duplications/insertions of any size by massively parallel sequencing
 - Low-level somatic variants

Genes Tested

Gene	MIM No.	Disorders	Inheritance
<i>ACAD9</i>	611103	Mitochondrial complex I nuclear type 20 deficiency (ACAD9 deficiency)	AR
<i>ACADM</i>	607008	Medium chain acyl-CoA dehydrogenase deficiency (MCAD deficiency)	AR
<i>ACADS</i>	606885	Short chain acyl-CoA dehydrogenase deficiency (SCAD deficiency)	AR
<i>ACADVL</i>	609575	Very long chain acyl-CoA dehydrogenase deficiency (VLCAD deficiency)	AR
<i>ACAT1</i>	607809	Beta-ketothiolase deficiency (B-ketothiolase deficiency, alpha-methylacetoacetic aciduria, 2-methyl-3-hydroxybutyric acidemia, 2-methylacetoacetyl-coenzyme A thiolase deficiency, 3-alpha-oxothiolase deficiency, 3-ketothiolase deficiency, 3-oxothiolase deficiency, MAT deficiency, methylacetoacetyl-coenzyme A thiolase deficiency, mitochondrial 2-methylacetoacetyl-CoA thiolase deficiency, mitochondrial acetoacetyl-CoA thiolase deficiency, or T2 deficiency)	AR
<i>CPT1A</i>	600528	Carnitine palmitoyltransferase 1A deficiency (CPT1A deficiency)	AR
<i>CPT2</i>	600650	Carnitine palmitoyltransferase II (CPT II deficiency), lethal neonatal, and severe infantile onset CPT II deficiency, myopathic form	AR AR, AD
<i>ECHS1</i>	602292	Mitochondrial short-chain enoyl-CoA hydratase 1 deficiency (ECHS1 Deficiency)	AR
<i>ETFA</i>	608053	Multiple acyl-CoA dehydrogenase deficiency (MADD types I and II, Glutaric acidemia II, Glutaric aciduria II)	AR
<i>ETFB</i>	130410	Multiple acyl-CoA dehydrogenase deficiency (MADD types I and II, glutaric acidemia II, glutaric aciduria II)	AR
<i>ETFDH</i>	231675	Multiple acyl-CoA dehydrogenase deficiency (MADD type III, glutaric acidemia II, glutaric aciduria II)	AR
<i>FLAD1</i>	610595	Lipid storage myopathy due to flavin adenine dinucleotide synthetase deficiency (MADD-like illness)	AR
<i>HADH</i>	601609	Familial hyperinsulinism (3-hydroxyacyl-CoA dehydrogenase deficiency, familial hyperinsulinemic hypoglycemia, congenital hyperinsulinism [CHI], persistent hyperinsulinemic hypoglycemia of infancy [PHHI])	AR
<i>HADHA</i>	600890	Long-chain 3-hydroxyacyl-CoA dehydrogenase deficiency (LCHAD deficiency, acute fatty liver pregnancy [AFLP] and hypertension, elevated liver enzymes, and low platelet [HELLP] syndromes, mitochondrial trifunctional protein deficiency)	AR
<i>HADHB</i>	143450	Trifunctional protein deficiency	AR



Gene	MIM No.	Disorders	Inheritance
<i>HMGCL</i>	613898	3-hydroxy-3-methylglutaryl-CoA lyase deficiency (HMG-CoA lyase deficiency)	AR
<i>HMGCS2</i>	600234	3-hydroxy-3-methylglutaryl-CoA synthase 2 deficiency (HMG-CoA synthase-2 deficiency)	AR
<i>HSD17B10</i>	300256	Hydroxysteroid 17-Beta Dehydrogenase Type 10 deficiency (HSD10 mitochondrial disease, HSD17B10 deficiency)	XL
<i>LPIN1</i>	605518	Acute recurrent myoglobinuria (LPIN1 deficiency)	AR
<i>MLYCD</i>	606761	Malonyl-CoA decarboxylase deficiency	AR
<i>SLC22A5</i>	603377	Systemic primary carnitine deficiency (carnitine transport defect, carnitine uptake defect, CDSP)	AR
<i>SLC25A20</i>	613698	Carnitine-acylcarnitine translocase deficiency (CACT deficiency)	AR
<i>SLC52A1</i>	607883	Riboflavin transporter deficiency 1 (riboflavin deficiency)	AD
<i>SLC52A2</i>	607882	Riboflavin transporter deficiency 2 (Brown-Vialetto-Van Laere syndrome 2)	AR
<i>SLC52A3</i>	613350	Riboflavin transporter deficiency 3 (Brown-Vialetto-Van Laere syndrome 1, Fazio-Londe syndrome)	AR

Additional Resources

Houten SM, Violante S, Ventura FV, et al. [The biochemistry and physiology of mitochondrial fatty acid \$\beta\$ -oxidation and its genetic disorders](#). *Annu Rev Physiol*. 2016;78:23-44.

Knottnerus SJG, Bleeker JC, Wüst RCI, et al. [Disorders of mitochondrial long-chain fatty acid oxidation and the carnitine shuttle](#). *Rev Endocr Metab Disord*. 2018;19(1):93-106.

Kompare M, Rizzo WB. [Mitochondrial fatty-acid oxidation disorders](#). *Semin Pediatr Neurol*. 2008;15(3):140-149.

Merritt JL 2nd, MacLeod E, Jurecka A, et al. [Clinical manifestations and management of fatty acid oxidation disorders](#). *Rev Endocr Metab Disord*. 2020;21(4):479-493.

Merritt JL 2nd, Norris M, Kanungo S. [Fatty acid oxidation disorders](#). *Ann Transl Med*. 2018;6(24):473.

Wilcken B. [Fatty acid oxidation disorders: outcome and long-term prognosis](#). *J Inherit Metab Dis*. 2010;33(5):501-506.

Related Tests

[Acylcarnitine Quantitative Profile, Plasma 0040033](#)

Method: Tandem Mass Spectrometry

[Carnitine Panel 0081110](#)

Method: Tandem Mass Spectrometry

[Organic Acids, Urine 0098389](#)

Method: Gas Chromatography-Mass Spectrometry (GC-MS)

[Acylglycines, Quantitative, Urine 0081170](#)

Method: Liquid Chromatography-Tandem Mass Spectrometry (LC-MS/MS)

[Medium Chain Acyl-CoA Dehydrogenase \(ACADM\) 2 Mutations 0051205](#)

Method: Polymerase Chain Reaction/Fluorescence Monitoring

[Medium Chain Acyl-CoA Dehydrogenase Deficiency \(ACADM\) Sequencing \(INACTIVE as of 11/15/21: Refer to 3001851 in the November Hotline\) 0051758](#)



Method: Polymerase Chain Reaction/Sequencing

Very Long-Chain Acyl-CoA Dehydrogenase Deficiency (ACADVL) Sequencing and Deletion/Duplication 2004212

Method: Polymerase Chain Reaction/Sequencing/Multiplex Ligation-dependent Probe Amplification

ARUP Laboratories is a nonprofit enterprise of the University of Utah and its Department of Pathology, 500 Chipeta Way, Salt Lake City, UT 84108
(800) 522-2787 | (801) 583-2787 | aruplab.com | arupconsult.com
Content Review June 2021 | Last Update September 2021

© 2021 ARUP Laboratories. All Rights Reserved.

Client Services - (800) 522-2787

