Methylmalonic Aciduria: \textit{MMAA} \& \textit{MMAB} Gene Sequencing

\textbf{Test Code:} MU  
\textbf{Turnaround time:} 6 weeks  
\textbf{CPT Codes:} 81479 x1

\section*{Condition Description}

Methylmalonic aciduria (MMA) is an autosomal recessive inborn error of organic acid metabolism resulting from partial or complete deficiency of the enzyme L-methylmalonyl CoA mutase. The most common form of MMA is mutase deficient MMA, which may present lethargy, recurrent vomiting, hepatomegaly, metabolic acidosis, encephalopathy, and may lead to multiorgan failure. Other forms of MMA may be B12 responsive, and affected infants may show failure to thrive, chronic or episodic acidemia, benign persistent methylmalonic aciduria, or developmental delay. These symptoms may be associated with times of infection or stress. Patients with defects in the synthesis of adenosyl cobalamin (CblA and CblB) generally show a decrease in urine and blood concentration of methylmalonic acid in response to B12 supplementation. The prevalence of MMA is approximately 1 in 30,000 newborns.

Methylmalonyl CoA mutase catalyzes the isomerization of methylmalonyl CoA into succinyl-CoA. The coenzyme adenosylcobalamin (AdoCbl) is also required for this reaction. Mutations in the \textit{MUT} gene cause mutase-deficient MMA. \textit{MUT} is a nuclear gene (6q21) that codes for the mitochondrial enzyme, methylmalonyl CoA mutase. Based on enzymatic activity in cultured fibroblasts, two phenotypic variants of mutase deficient MMA have been defined. The mut0 phenotype has no detectable enzymatic activity and is associated with severe symptoms in patients. The mut- phenotype has residual activity that is increased by supplementation of hydroxycobalamin and is associated with variable severity.

Apart from primary deficiency of mutase activity, insufficient metabolism of cobalamin can also result in deficient mutase activity. \textit{MMAA} and \textit{MMAB} genes are involved in the adenosylcobalamin metabolism (associated with the cblA and cblB complementation groups of MMA, respectively). (Refer to \textit{MUT} gene sequencing for more information.)

For patients with mutations not identified by full gene sequencing, a separate deletion/duplication assay is available using a targeted CGH array (NJ). Click here for the GeneReviews summary on this condition.

\section*{Genes}

\textbf{MMAA, MMAB}

\section*{Indications}

This test is indicated for:

- Clinical symptoms of possible non-B12 responsive MMA
- Follow up to abnormal newborn screening results suggestive of MMA
- Clinical symptoms of MMA, with negative \textit{MMAA/MMAB} gene sequencing
- Family members who are at risk to be carriers of MMA, when the proband is unavailable for testing.

Sequencing is not appropriate for prenatal samples in which familial mutations have not been identified.

\section*{Methodology}

The 13 exons and flanking regions of the \textit{MUT} gene are amplified by PCR and sequenced in both the forward and reverse directions. Patient gene sequences are compared to a normal reference sequence. Sequence variations are then classified as previously described mutations, novel mutations, or variations of unknown significance. This analysis may detect novel variants of unclear effect, which may require further studies.

\section*{Detection}

This assay will detect over 95\% of sequence variants in the coding region and splice junctions. Mutations in the promoter region, some mutations in the introns, and other regulatory elements cannot be detected by this analysis. Large deletion and insertion mutations will not be detected by this assay. It is possible that some patients with a typical presentation may not carry a mutation detected by this analysis. Results of molecular analysis should be interpreted in the context of the patient's biochemical phenotype.

\section*{Specimen Requirements}

Submit only 1 of the following specimen types

* Preferred specimen type: Whole Blood

\textbf{Type: Whole Blood}

Specimen Requirements:

In EDTA (purple top) or ACD (yellow top) tube:
Infants (2 years): 3-5 ml  
Older Children & Adults: 5-10 ml

Disclaimer: This information is confidential and subject to change without notice. It may not be reproduced in whole or part unless authorized in writing by an authorized EGL representative.
Specimen Collection and Shipping: Refrigerate until time of shipment. Ship sample within 5 days of collection at room temperature with overnight delivery.

**Type: Saliva**

Specimen Requirements:

Oragene™ Saliva Collection kit (available through EGL) used according to manufacturer instructions.

Specimen Collection and Shipping: Store sample at room temperature. Ship sample within 5 days of collection at room temperature with overnight delivery.

**Special Instructions**

Submit copies of diagnostic biochemical test results with the sample. Sequence analysis is required before deletion/duplication analysis by targeted CGH array. If sequencing is performed outside of Emory Genetics Laboratory, please submit a copy of the sequencing report with the test requisition. Contact the laboratory if further information is needed.

**Related Tests**

- Organic Acid Analysis (OA) is used in the diagnosis of patients with MMA
- Methylmalonic Acid Quantitation (MQ) is used in diagnosis and follow up of propionate and methylmalonic disorders, as well as defects of cobalamin synthesis; it can also detect acquired cobalamin, and/or folate deficiency
- MMAA/MMAB (MU) Gene Sequencing may be considered in patients with a biochemical diagnosis of MMA but with normal MUT gene sequencing
- Custom Diagnostic Mutation Analysis (KM) is available to family members if mutations are identified by sequencing.
- Deletion/Duplication Assay is available separately for individuals where mutations are not identified by sequence analysis. Refer to the test requisition or contact the laboratory for more information.
- Prenatal testing is available to couples who are confirmed carriers of gene mutations. Please contact the laboratory genetic counselor prior to sending a specimen.