Methylmalonic acidemia

Methylmalonic acidemia is an inherited disorder in which the body is unable to process certain proteins and fats (lipids) properly. The effects of methylmalonic acidemia, which usually appear in early infancy, vary from mild to life-threatening. Affected infants can experience vomiting, dehydration, weak muscle tone (hypotonia), developmental delay, excessive tiredness (lethargy), an enlarged liver (hepatomegaly), and failure to gain weight and grow at the expected rate (failure to thrive). Long-term complications can include feeding problems, intellectual disability, chronic kidney disease, and inflammation of the pancreas (pancreatitis). Without treatment, this disorder can lead to coma and death in some cases.

Frequency
This condition occurs in an estimated 1 in 50,000 to 100,000 people.

Causes
Mutations in the $\textit{MMUT}$, $\textit{MMAA}$, $\textit{MMAB}$, $\textit{MMADHC}$, and $\textit{MCEE}$ genes cause methylmalonic acidemia. The long term effects of methylmalonic acidemia depend on which gene is mutated and the severity of the mutation.

About 60 percent of methylmalonic acidemia cases are caused by mutations in the $\textit{MMUT}$ gene. This gene provides instructions for making an enzyme called methylmalonyl CoA mutase. This enzyme works with vitamin B12 (also called cobalamin) to break down several protein building blocks (amino acids), certain lipids, and cholesterol. Mutations in the $\textit{MMUT}$ gene alter the enzyme’s structure or reduce the amount of the enzyme, which prevents these molecules from being broken down properly. As a result, a substance called methylmalonyl CoA and other potentially toxic compounds can accumulate in the body’s organs and tissues, causing the signs and symptoms of methylmalonic acidemia.

Mutations in the $\textit{MMUT}$ gene that prevent the production of any functional enzyme result in a form of the condition designated mut$^0$. Mut$^0$ is the most severe form of methylmalonic acidemia and has the poorest outcome. Mutations that change the structure of methylmalonyl CoA mutase but do not eliminate its activity cause a form of the condition designated mut$^-$. The mut$^-$ form is typically less severe, with more variable symptoms than the mut$^0$ form.

Some cases of methylmalonic acidemia are caused by mutations in the $\textit{MMAA}$, $\textit{MMAB}$, or $\textit{MMADHC}$ gene. Proteins produced from the $\textit{MMAA}$, $\textit{MMAB}$, and $\textit{MMADHC}$ genes are needed for the proper function of methylmalonyl CoA mutase. Mutations that affect
proteins produced from these three genes can impair the activity of methylmalonyl CoA mutase, leading to methylmalonic acidemia.

A few other cases of methylmalonic acidemia are caused by mutations in the \textit{MCEE} gene. This gene provides instructions for producing an enzyme called methylmalonyl CoA epimerase. Like methylmalonyl CoA mutase, this enzyme also plays a role in the breakdown of amino acids, certain lipids, and cholesterol. Disruption in the function of methylmalonyl CoA epimerase leads to a mild form of methylmalonic acidemia.

It is likely that mutations in other, unidentified genes also cause methylmalonic acidemia.

\textbf{Inheritance Pattern}

This condition is inherited in an autosomal recessive pattern, which means both copies of the \textit{MMUT, MMAA, MMAB, MMADHC}, or \textit{MCEE} gene in each cell have mutations. Most often, the parents of an individual with an autosomal recessive condition are carriers of one copy of the mutated gene but do not show signs and symptoms of the condition.

\textbf{Other Names for This Condition}

- isolated methylmalonic acidemia
- methylmalonic aciduria
- MMA

\textbf{Diagnosis & Management}

\textbf{Formal Diagnostic Criteria}

- ACT Sheet: Elevated C3 acylcarnitine
  https://www.ncbi.nlm.nih.gov/books/NBK55827/bin/C3.pdf

\textbf{Genetic Testing Information}

- What is genetic testing?
  /primer/testing/genetictesting
- Genetic Testing Registry: Methylmalonic acidemia
- Genetic Testing Registry: Methylmalonic aciduria cblA type
- Genetic Testing Registry: Methylmalonic aciduria cblB type
• Genetic Testing Registry: Methylmalonic aciduria due to methylmalonyl-CoA mutase deficiency

• Genetic Testing Registry: Methylmalonyl-CoA epimerase deficiency

Research Studies from ClinicalTrials.gov
• ClinicalTrials.gov
  https://clinicaltrials.gov/ct2/results?cond=%22methylmalonic+acidemia%22

Other Diagnosis and Management Resources
• Baby's First Test: Methylmalonic Acidemia (Cobalamin Disorders)
  https://www.babysfirsttest.org/newborn-screening/conditions/methylmalonic-acidemia-cobalamin-disorders

• Baby's First Test: Methylmalonic Acidemia (Methymalonyl-CoA Mutase Deficiency)
  https://www.babysfirsttest.org/newborn-screening/conditions/methylmalonic-acidemia-methymalonyl-coa-mutase-deficiency

• GeneReview: Isolated Methylmalonic Acidemia
  https://www.ncbi.nlm.nih.gov/books/NBK1231

• MedlinePlus Encyclopedia: Methylmalonic acid
  https://medlineplus.gov/ency/article/003565.htm

• MedlinePlus Encyclopedia: Methylmalonic acidemia
  https://medlineplus.gov/ency/article/001162.htm

Additional Information & Resources
Health Information from MedlinePlus
• Encyclopedia: Methylmalonic acid
  https://medlineplus.gov/ency/article/003565.htm

• Encyclopedia: Methylmalonic acidemia
  https://medlineplus.gov/ency/article/001162.htm

• Health Topic: Amino Acid Metabolism Disorders
  https://medlineplus.gov/aminoacidmetabolismdisorders.html

• Health Topic: Lipid Metabolism Disorders
  https://medlineplus.gov/lipidmetabolismdisorders.html

• Health Topic: Newborn Screening
  https://medlineplus.gov/newbornscreening.html
Genetic and Rare Diseases Information Center

•  Methylmalonic acidemia
  https://rarediseases.info.nih.gov/diseases/7033/methylmalonic-acidemia

Additional NIH Resources

•  National Human Genome Research Institute
  https://www.genome.gov/Genetic-Disorders/MMA-Study-General-Information

Educational Resources

•  MalaCards: isolated methylmalonic acidemia
  https://www.malacards.org/card/isolated_methylmalonic_acidemia

•  Orphanet: Methylmalonic acidemia without homocystinuria
  https://www.orpha.net/consor/cgi-bin/OC_Exp.php?Lng=EN&Expert=293355

•  Screening, Technology, and Research in Genetics
  http://www.newbornscreening.info/Parents/organicaciddisorders/MMA.html

•  Virginia Department of Health: Methylmalonic Aciduria (cblA and cblB)

•  Virginia Department of Health: Methylmalonic Aciduria (MUT)

Patient Support and Advocacy Resources

•  Medical Home Portal
  https://www.medicalhomeportal.org/newborn/methylmalonic-acidemias

•  Metabolic Support UK
  https://www.metabolicsupportuk.org/

•  National Organization for Rare Disorders (NORD)
  https://rarediseases.org/rare-diseases/acidemia-methylmalonic/

•  Organic Acidemia Association
  https://www.oaanews.org/mma.html

Clinical Information from GeneReviews

•  Isolated Methylmalonic Acidemia
  https://www.ncbi.nlm.nih.gov/books/NBK1231
Scientific Articles on PubMed

- PubMed
  https://www.ncbi.nlm.nih.gov/pubmed?term=%28Amino+Acid+Metabolism,+Inborn+Errors%5BMAJR%5D%29+AND+%28%28methylmalonic+acidemia%5BTIAB%5D%29+OR+%28methylmalonic+aciduria%5BTIAB%5D%29+OR+%28mma%5BTIAB%5D%29+OR+%28methylmalonicacidemia%5BTIAB%5D%29+OR+%28methylmalonicaciduria%5BTIAB%5D%29+AND+english%5Bla%5D+AND+human%5Bmh%5D+AND+%22last+1800+days%22%5Bdp%5D

Catalog of Genes and Diseases from OMIM

- METHYLMALONIC ACIDURIA AND HOMOCYSTINURIA, cblD TYPE
  http://omim.org/entry/277410
- METHYLMALONIC ACIDURIA DUE TO METHYLMALONYL-CoA MUTASE DEFICIENCY
  http://omim.org/entry/251000
- METHYLMALONIC ACIDURIA, cblA TYPE
  http://omim.org/entry/251100
- METHYLMALONIC ACIDURIA, cblB TYPE
  http://omim.org/entry/251110
- METHYLMALONYL-CoA EPIMERASE DEFICIENCY
  http://omim.org/entry/251120

Medical Genetics Database from MedGen

- Methylmalonic acidemia

Sources for This Summary

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/15293040

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/20301409

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/19058814

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/12069539

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/15959932

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