



Genetic Fact Sheets for Parents

Organic Acid Disorders

Screening, Technology, and Research in Genetics is a multi-state project to improve information about the financial, ethical, legal, and social issues surrounding expanded newborn screening and genetic testing – [http:// www.newbornscreening.info](http://www.newbornscreening.info)

Disorder name: Methylmalonic Acidemia
Acronym: MMA

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This fact sheet contains general information about MMA. Every child is different and some of these facts may not apply to your child specifically. Certain treatments may be recommended for some children but not others. All children with MMA should be followed by a metabolic doctor in addition to their primary care provider.

What is MMA?

MMA stands for “methylmalonic acidemia.” It is one type of organic acid disorder. People with MMA have problems breaking down and using certain amino acids and fatty acids from the food they eat.

Organic Acid Disorders:

Organic acid disorders (OAs) are a group of rare inherited conditions. They are caused by enzymes that do not work properly. A number of enzymes are needed to process protein from the food we eat for use by the body. Problems with one or more of these enzymes can cause an organic acid disorder.

People with organic acid disorders cannot break down protein properly. This causes harmful substances to build up in their blood and urine. These substances can affect health, growth, and learning.

The symptoms and treatment vary between different organic acid disorders. They can also vary from person to person with the same organic acid disorder. See the fact sheets for each specific organic acid disorder.

Organic acid disorders are inherited in an autosomal recessive manner and affect both males and females.

What causes MMA?

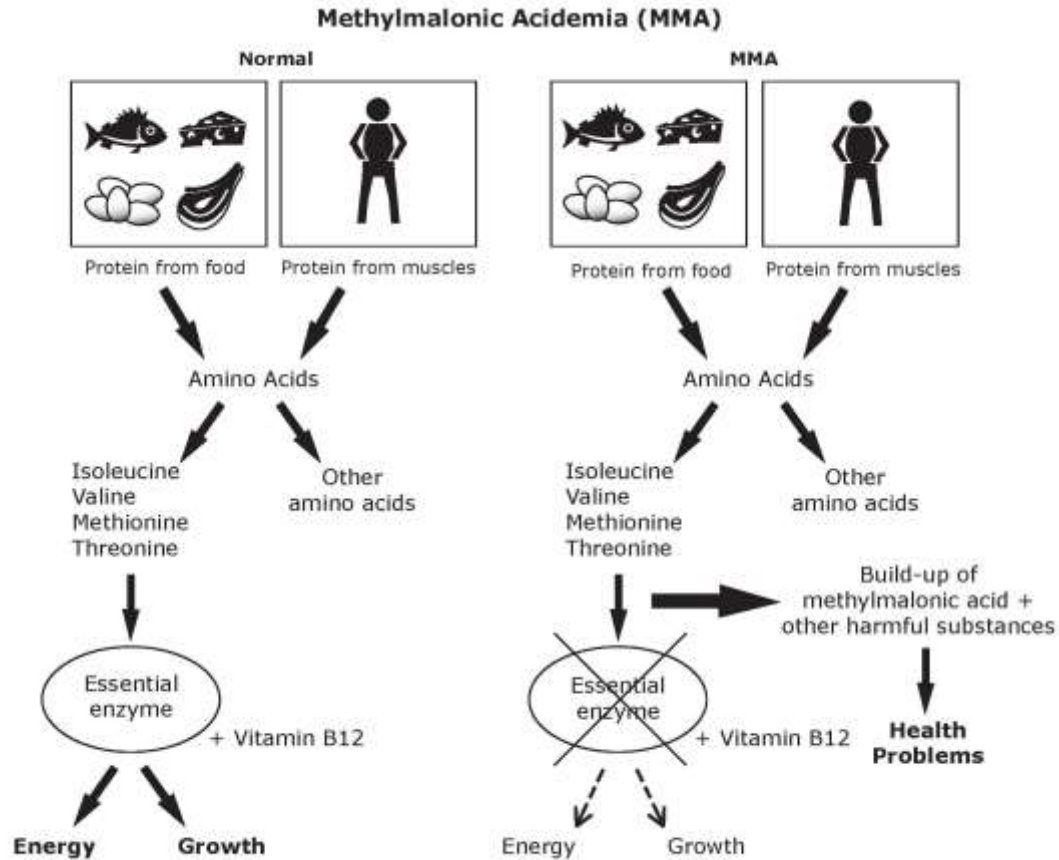
In order for the body to use protein from the food we eat, it is broken down into smaller parts called amino acids. Special enzymes then make changes to the amino acids so the body can use them. In the same way, fat from the food we eat is broken down by enzymes into fatty acids that the body can use for energy.

MMA occurs when one of these special enzymes is either missing or not working properly. Without this enzyme, certain amino acids and fatty acids cannot be used correctly. This causes glycine, methylmalonic acid, and other harmful substances to build up in the blood and urine and cause health problems.

There are a number of different types of MMA. Some types can be treated with vitamin B12 injections. These types are called 'vitamin B12 responsive.' Two types of MMA that often can be treated with vitamin B12 are Cobalamin A (CblA) deficiency and Cobalamin B (CblB) deficiency.

There are other types of MMA which cannot be treated with vitamin B12. These types are called 'vitamin B12 non-responsive.' One of these is called 'Mut 0.' It is caused by the absence of an enzyme called methylmalonyl-CoA mutase (MCM). Another type of MMA that does not respond to vitamin B12 treatment is called 'Mut -.' People with the 'Mut-' type of MMA have too little of the MCM enzyme.

Another type of MMA, called 'MMA with homocystinuria,' is described in a separate fact sheet. See the fact sheet [MMA+HCU](#) for more information about this condition.



Isoleucine, valine, methionine, and threonine are the four amino acids that cannot be used correctly by people with MMA. These amino acids are found in all foods that contain protein. Large amounts are found in meat, eggs, milk, and other dairy products. Smaller amounts are found in flour, cereal, and some vegetables and fruits.

If MMA is not treated, what problems occur?

Each child with MMA is likely to have somewhat different effects. Many babies with MMA start having symptoms in the first few days of life. Others begin to show symptoms sometime in infancy or childhood. Some people with MMA may never develop symptoms.

MMA causes episodes of illness called metabolic crises. Some of the first symptoms of a metabolic crisis are:

- poor appetite
- vomiting
- extreme sleepiness or lack of energy
- low muscle tone (floppy muscles and joints)

Common blood and urine findings are:

- ketones in the urine
- high levels of acidic substances in the blood, called metabolic acidosis
- high blood ammonia levels
- high blood and urine levels of glycine
- high blood and urine levels of methylmalonic acid and propionic acid
- high levels of other harmful substances
- low platelets
- low white blood cells
- anemia

If a metabolic crisis is not treated, a child with MMA can develop:

- breathing problems
- seizures
- stroke
- coma, sometimes leading to death

A metabolic crisis can be triggered by:

- eating large amounts of protein
- illness or infection
- going too long without food
- stressful events such as surgery

Between episodes of metabolic crisis, children with MMA may be healthy. However, some continue to have problems with health and development. Some children have long-term problems even if they have never had a metabolic crisis. These can include:

- learning problems or intellectual disabilities
- delays in walking and motor skills
- abnormal involuntary movements (dystonia and chorea)
- rigid muscle tone, called spasticity
- poor growth with short stature
- skin rashes and infections
- osteoporosis
- enlarged liver
- kidney disease or failure
- vision loss due to problems with the nerves in the eye

Without treatment, brain and nerve damage can occur. This can cause intellectual disabilities and problems with involuntary movements. Death is common in untreated babies and children.

A small number of people with MMA never have any symptoms.

What is the treatment for MMA?

Your baby's primary doctor will work with a metabolic doctor and a dietician familiar with MMA to care for your child.

Prompt treatment is needed to reduce the chance for intellectual disabilities and serious medical problems. Children with vitamin B12 responsive-MMA are given vitamin B12. In addition, most children need to be on a low-protein diet and drink a special medical formula. You should start the treatments as soon as you know your child has MMA.

The following are treatments often recommended for children with MMA:

1. Medication

The main treatment for vitamin B12 responsive-MMA is vitamin B12 injections in the form of hydroxocobalamin (OH-cbl) or cyanocobalamin (CN-cbl). Vitamin B12 injections can prevent symptoms in children with this type of MMA.

Over 90% of children with CblA deficiency respond to vitamin B12 injections. About 40% of children with CblB deficiency are helped by this treatment. Your doctors may need to treat your child with vitamin B12 for a short period of time to determine whether this treatment is useful.

Children with MMA may benefit by taking L-carnitine. This is a safe and natural substance that helps the body make energy. It also helps get rid of harmful wastes. Your doctor will decide whether or not your child needs L-carnitine. Unless you are advised otherwise, use only L-carnitine prescribed by your doctor.

Antibiotics taken by mouth can help lower the amount of methylmalonic acid made in the intestines. Your doctor will decide if your child needs antibiotics and, if so, what type.

Children who are having symptoms of a metabolic crisis should be treated in the hospital. During a metabolic crisis, your child may be given medications such as bicarbonate through an IV to help reduce the acid levels in the blood. Glucose is given by IV to prevent the breakdown of protein and fat stored in the body.

Do not use any medication without checking with your doctor.

2. Low-protein diet, medical formula and foods

Low-protein diet

A food plan low in the amino acids leucine, valine, methionine, and threonine with limited amounts of protein is often recommended. Most food in the diet will be carbohydrates (bread, cereal, pasta, fruit, vegetables, etc.). Carbohydrates give

the body many types of sugar that can be used as energy. Eating a diet high in carbohydrates and low in protein and fat can help prevent metabolic crises.

Foods high in protein that may need to be avoided or limited include:

- milk and dairy products
- meat and poultry
- fish
- eggs
- dried beans and legumes
- nuts and peanut butter

Many vegetables and fruits have only small amounts of protein and can be eaten in carefully measured amounts. Do not remove all protein from the diet. Children with MMA need a certain amount to grow properly.

Your dietician can create a food plan that contains the right amount of protein, nutrients, and energy to keep your child healthy. It is likely your child will need to be on a special food plan throughout life.

Medical formula and foods

In addition to a low-protein diet, your child may be given a special medical formula. This formula contains the correct amount of protein and nutrients your child needs for normal growth and development. Your metabolic doctor and dietician will tell you what type of formula is best and how much to use.

There are also medical foods such as special low-protein flours, pastas, and rice that are made especially for people with organic acid disorders. Your dietician will tell you how to use these foods as part of your child's diet.

Some states offer help with payment for this formula and special foods, and others require private insurance to pay for the formula and other special medical foods.

3. Avoid going a long time without food

Infants and young children with MMA need to eat frequently to prevent a metabolic crisis. Your metabolic doctor will tell you how often your child needs to be fed. In general, it is often suggested that infants be fed every four to six hours. Some babies need to eat even more frequently than this. It is important that infants be fed during the night. They may need to be woken up to eat if they do not wake up on their own. Your metabolic doctor and dietician will give you an appropriate feeding plan for your infant. Your doctor will also give you a 'sick day' plan, tailored to your child's needs, for you to follow during illnesses or other times when your child will not eat.

Your metabolic doctor will continue to advise you on how often your child should eat as he or she gets older.

4. Regular blood and urine tests

Tracking of ketones

Periodic urine tests to check the level of ketones can be done at home or at the doctor's office. Ketones are substances formed when body fat is broken down for energy. This happens after going without food for long periods of time, during illnesses, and during periods of heavy exercise. Too many ketones in the urine may signal the start of a metabolic crisis.

Blood tests

Your child will have regular blood tests to measure the level of amino acids. Urine tests may also be done. Your child's diet and medication may need to be adjusted based on the results of these tests.

5. Call your doctor at the start of any illness

For children with MMA, even minor illnesses could lead to a metabolic crisis. To prevent serious health problems, call your doctor right away when your child has any of the following:

- loss of appetite
- vomiting
- diarrhea
- infection or illness
- fever

When ill, your child needs extra fluids and carbohydrates in order to prevent a metabolic crisis. During an illness, you should restrict protein and give your child starchy foods and fluids. Children with MMA may need to be treated in the hospital during illnesses to avoid serious health problems. Ask your metabolic doctor if you should carry a special travel letter with medical instructions for your child's care.

6. Organ transplantation

Some children with MMA are given liver or kidney transplants, or both. This may reduce some of the symptoms. However, transplant surgery has serious risks and may or may not be right for your child. Talk with your doctor or metabolic specialist if you have questions about the risks and benefits of transplantation.

What happens when MMA is treated?

Babies and children who have prompt and ongoing treatment may be able to live healthy lives with normal growth and development. In general, the earlier treatment is started, the better the outcome.

Children who respond to vitamin B12 treatment tend to do very well as long as treatment is continued. Children who are not treated until after they have symptoms may have lasting health and learning problems.

Even with treatment, some children develop life-long learning disabilities problems or intellectual disabilities. In addition, despite treatment, seizures, involuntary movement disorders, and kidney failure have occurred in some children.

What causes the enzyme to be absent or not working correctly?

Genes tell the body how to make enzymes. MMA is caused by changes in one of five sets of genes - MMUT, MMAA, MMAB, MMADHC, and MCEE. Each of these genes provides the instructions for a specific enzyme. Everyone has two copies of each of these five genes. People with MMA have changes (variants) in both copies of one of these five genes. Because of the variants in their genes, one of their enzymes either does not work properly or is not made at all.

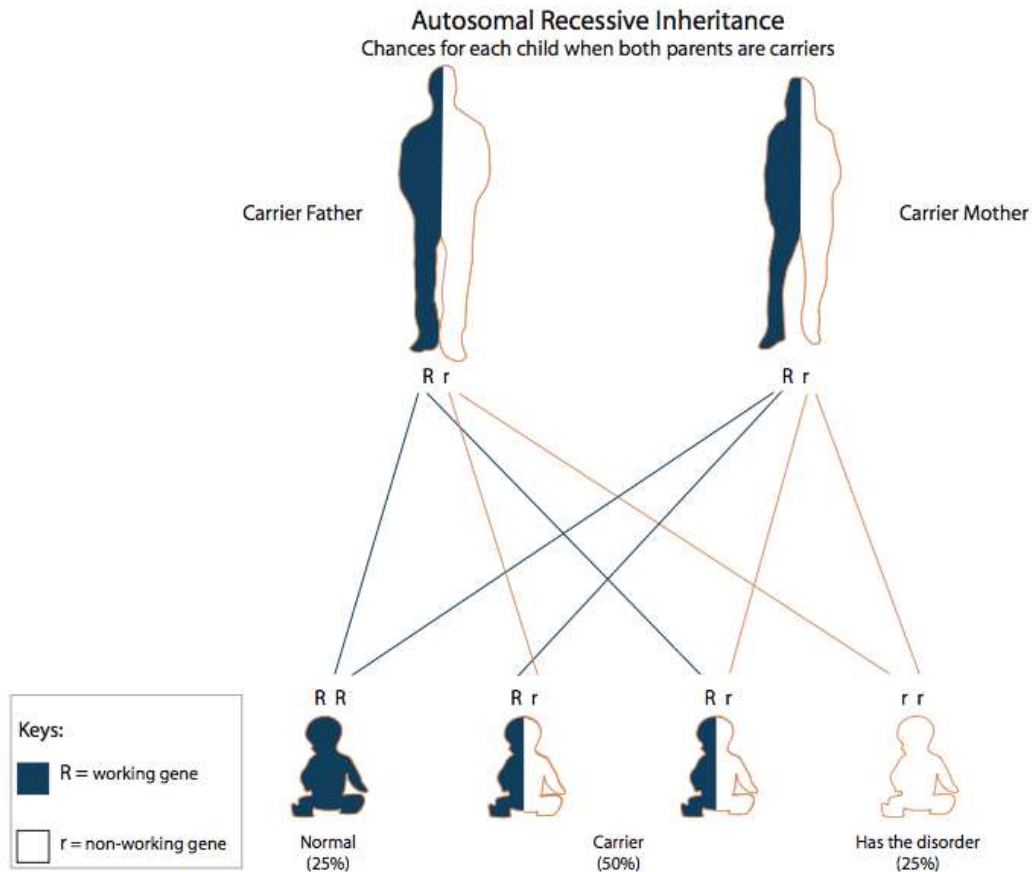
How is MMA inherited?

MMA is inherited in an autosomal recessive manner. It affects both boys and girls equally.

Everyone has two copies of the genes that make the MMA enzymes. In children with MMA, both copies of these genes do not work correctly. These children inherit one non-working gene for MMA from each parent.

Parents of children with MMA rarely have the disorder. Instead, each parent has a single non-working gene for MMA. They are called carriers. Carriers do not have MMA because their other gene is working correctly.

When both parents are carriers, there is a 25% chance in each pregnancy for the child to have MMA. There is a 50% chance for the child to be a carrier, just like the parents. And, there is a 25% chance for the child to have two working genes.



Genetic counseling is available to families who have children with MMA. Genetic counselors can answer your questions about how MMA is inherited, choices during future pregnancies, and how to test other family members. Ask your doctor about a referral to a genetic counselor.

Is genetic testing available?

Genetic testing is available for MMA. Genetic testing, also called DNA testing, looks for changes (variants) in the pair of genes that cause MMA. Talk with your genetic counselor or metabolic doctor if you have questions about DNA testing.

DNA testing is not necessary to diagnose your child. However, if available, it can be helpful for carrier testing or prenatal diagnosis, discussed below.

What other testing is available?

Special tests on blood, urine, or skin samples can be done to help confirm MMA. Talk to your metabolic doctor or genetic counselor if you have questions about testing for MMA.

Can you test during a future pregnancy?

If both gene changes have been found in your child with MMA, DNA testing can be done during future pregnancies. The sample needed for this test is obtained by either CVS or amniocentesis.

If DNA testing would not be helpful, MMA can also be detected by an enzyme test using cells from the fetus. The sample needed for this test is obtained by amniocentesis.

Parents may either choose to have testing during pregnancy or wait until birth to have the baby tested. Parents may also choose to use assisted reproductive techniques to decrease the chance that their future children would have MMA. A genetic counselor can talk to you about your choices and answer questions about prenatal testing or testing your baby after birth.

Can other members of the family have MMA or be carriers?

Having MMA

If they are healthy and growing normally, older brothers and sisters of a baby with MMA are unlikely to have the condition. However, finding out if other children in the family have this condition is important because early treatment can prevent serious health problems. Ask your metabolic doctor whether your other children should be tested to see if they also have MMA.

MMA carriers

Brothers and sisters who do not have MMA still have a chance to be carriers like their parents. Except in special cases, carrier testing should only be done on people over 18 years of age.

If you are a parent of a child with MMA, your brothers and sisters have a 50% chance to be an MMA carrier. It is important for other family members to be told that they could be carriers. There is a small chance they are also at risk to have children with MMA.

All states provide newborn screening for MMA. However, when both parents are MMA carriers, newborn screening results are not sufficient to rule out the condition in a newborn baby. In this case, special diagnostic testing should be done in addition to newborn screening.

Can other family members be tested?

Diagnostic testing

Brothers and sisters of a child with MMA can have special tests on blood, urine, or skin samples to see if they also have MMA. Talk to your doctor or genetic counselor if you have questions about testing for MMA.

Carrier testing

If the gene changes have been identified in your child with MMA, carrier testing can be done for other family members. If you have questions about carrier testing, ask your genetic counselor or metabolic doctor.

How many people have MMA?

About one in 80,000 babies in the United States is born with MMA.

Does MMA happen more often in a certain ethnic group?

MMA occurs in all ethnic groups around the world. It does not occur more often in any specific race, ethnic group, geographical area, or country.

Does MMA go by any other names?

There are a number of different types of MMA. The vitamin B12 non-responsive types are sometimes also called:

- Methylmalonic aciduria due to methylmalonic CoA mutase deficiency
- Complementation group Mut (includes Mut0 and Mut-)
- Methylmalonyl CoA mutase deficiency
- MCM Deficiency

The vitamin B12 responsive types are sometimes also called:

- Methylmalonic aciduria, cblA type
- Methylmalonic aciduria, cblB type
- MMAA/MMAB
- Adenosylcobalamin deficiency

Another type of MMA has additional symptoms of a separate condition called homocystinuria. See the fact sheet [MMA+HCU](#) for more information about this type of MMA.

Where can I find more information?

Organic Acidemia Association

<http://www.oaanews.org>

Metabolic Support UK

<https://www.metabolicsupportuk.org>

Genetic Home Reference

<https://ghr.nlm.nih.gov/condition/methylmalonic-acidemia>

Save Babies Through Screening Foundation

<http://www.savebabies.org/>

Baby's First Test

<http://www.babysfirsttest.org>

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