



MSUD (Maple Syrup Urine Disease)

What is it?

MSUD stands for maple syrup urine disease. It is named for the sweet maple syrup smell of the urine in untreated babies. This condition is one type of organic acid disorder. People with MSUD have problems breaking down certain amino acids found in protein.

What causes it?

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.

Classic MSUD, the most common form, is caused by the absence of a group of enzymes called branched-chain ketoacid dehydrogenase (BCKAD). The job of this enzyme group is to break down three different amino acids called leucine, isoleucine and valine. When they cannot be broken down, these amino acids build up in the blood and cause problems.

Leucine, isoleucine and valine are called branched-chain amino acids (BCAAs) because of their tree-like structure. They 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 MSUD is not treated, what problems occur?

There are a number of different forms of MSUD. The most common form, classic MSUD, can be life-threatening and must be

treated promptly to prevent serious health problems. Other forms are less severe. These milder forms are less common. This fact sheet contains information on classic MSUD.

Classic MSUD

Symptoms start as soon as baby is fed protein, usually shortly after birth. Some of the first symptoms are:

- 1) Poor appetite.
- 2) Weak suck.
- 3) Weight loss.
- 4) High-pitched cry.
- 5) Urine that smells like maple syrup or burnt sugar.

Babies with MSUD have episodes of illness called metabolic crises. Some of the first symptoms of a metabolic crisis are:

- 1) Extreme sleepiness.
- 2) Sluggishness.
- 3) Irritable mood.
- 4) Vomiting.

If not treated, other symptoms can follow:

- 1) Episodes where the muscles become tight and rigid and then go limp
- 2) Swelling of the brain
- 3) Seizures
- 4) High levels of acidic substances in the blood, called metabolic acidosis
- 5) Coma, sometimes leading to death

Symptoms of a metabolic crisis often happen:

- 1) After going too long without food.
- 2) During illness or infection.
- 3) During stressful events such as surgery.

Without treatment, brain damage can occur. This can cause mental retardation or spasticity. Some babies become blind. If not treated, most babies die within a few months.

What is the treatment for MSUD?

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

Prompt treatment is needed to prevent mental retardation and serious medical problems. Most children need to eat a very low-protein diet and drink a special medical formula. You should start the treatments as soon as you know your child has MSUD. Your dietician can create a food plan that contains the right amount of protein, nutrients and energy to keep your child healthy.

The following are treatments often recommended for children with MSUD:

Medical Formula

In addition to a low-protein diet, children are often given a special medical formula as a substitute for milk. This formula gives them the nutrients and protein they need while helping keep their BCAA levels in a safe range.

Your metabolic doctor and dietician will tell you what type of formula is best and how much to use.

Diet Low in Branched-Chain Amino Acids

The diet is made up of foods that are very low in BCAAs. This means your child will need to avoid foods such as cow's milk, regular formula, meat, fish, cheese and eggs. Regular flour, dried beans, nuts and peanut butter also have BCAAs and must be avoided or strictly limited.

Many vegetables and fruits have only small amounts of BCAAs and can be eaten in carefully measured amounts.

There are other medical foods such as special low-protein flours, pastas and rice that are made especially for people with MSUD. Some states offer help with payment or require private insurance coverage for medical formula and other special medical foods.

Your metabolic doctor and dietician will decide on the food plan for your child. The exact plan will depend on many things such as your child's age, weight and general health. Your dietician will fine-tune the diet over time. Any diet changes should be made under the guidance of a dietician.

Lifelong treatment with the MSUD diet is necessary. Children are at risk for episodes of metabolic crisis when they don't follow the diet.

Tracking BCAA Levels

Your child will have regular blood tests to measure amino acid levels. The diet and formula may need to be adjusted based on blood test results.

Supplements

Children with a rare form of MSUD called thiamine-responsive MSUD often can be helped by thiamine supplements. Some children with classic MSUD also may benefit from thiamine. Ask your doctor whether your child should take thiamine supplements. Do not use any supplements without checking with your doctor.

Call Your Doctor at the Start of Any Illness

For children with MSUD, even minor illness can cause a metabolic crisis. In order to prevent problems, call your doctor right away when your child has any of the following:

- 1) Poor appetite
- 2) Low energy or extreme sleepiness
- 3) Vomiting
- 4) An infection or illness

- 5) Fever
- 6) Behavior or personality changes
- 7) Difficulty walking or balance problems

Children with MSUD need to eat more carbohydrates and drink more fluids during an illness – even if they’re not hungry – or they could have a metabolic crisis. Children who are sick may not want to eat. If they can’t eat, or if they show signs of a metabolic crisis, they may need to be treated in the hospital.

Ask your metabolic doctor if you should carry a special travel letter with medical instructions for your child’s care.

What happens when MSUD is treated?

With prompt and lifelong treatment, children with MSUD often have healthy lives with typical growth and development. Early treatment can help prevent brain damage and mental retardation.

Even with treatment, some children still develop swelling of the brain or have episodes of metabolic crisis. Children who have repeated metabolic crisis may develop permanent brain damage. This can cause lifelong learning problems, mental retardation or spasticity.

What causes the BCKAD enzymes to be absent or not working correctly?

Genes tell the body to make various enzymes. People with MSUD have a pair of genes that do not work correctly. Because of these gene changes, the BCKAD enzymes do not work properly or are not made at all.

How is MSUD inherited?

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

In children with MSUD, a pair of genes needed to make the BCKAD enzymes is not working correctly. These children inherit one non-working gene for MSUD from each parent.

Parents of children with MSUD rarely have the condition themselves. Instead, each parent has a single nonworking gene for MSUD. They are called carriers. Carriers do not have MSUD because the other gene of this pair is working correctly.

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

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

Having MSUD

If they are healthy and growing normally, older brothers and sisters of a baby with MSUD are unlikely to have the condition. If you have questions about testing your other children, talk with your metabolic doctor or genetic counselor.

MSUD Carriers

Brothers and sisters who do not have MSUD still have a chance to be carriers like their parents. Except in special cases, carrier testing should be done only in people older than 18.

Each of the parents’ brothers and sisters has a 50 percent chance to be a 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 MSUD.

When both parents are 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

If there is concern about whether they have the condition, diagnostic testing can be done on brothers or sisters. Talk to your metabolic doctor if you have questions about testing for MSUD.

Carrier Testing

If both gene changes have been found in your child, other family members can have DNA testing to see if they are carriers.

If DNA testing is not helpful, other methods of carrier testing may be available. If you have questions about carrier testing, ask your genetic counselor or metabolic doctor.

How many people have MSUD?

About one in 200,000 babies in the United States is born with MSUD.

Does MSUD happen more frequently in a certain ethnic group?

MSUD occurs in all ethnic groups. It is more common in Mennonite people in the United States. About 1 in 760 people of Mennonite background have MSUD. It is also more common in people of French-Canadian ancestry.

Does MSUD go by any other names?

MSUD is sometimes also called:

- 1) Branched chain ketoaciduria.
- 2) Branched chain alpha-keto dehydrogenase deficiency.
- 3) BDKD deficiency.

There are a number of other forms of MSUD that are less common than the classic type. These other forms are not discussed in this fact sheet:

- 1) Intermittent branched-chain ketoaciduria
- 2) Intermediate branched-chain ketoaciduria

- 3) Thiamine responsive MSUD
- 4) MSUD type 1B
- 5) MSUD type II

Where can I find more information?

The MSUD Family Support Group
www.msud-support.org

Children Living with Inherited Metabolic Diseases (CLIMB)
www.climb.org.uk

National Coalition for PKU and Allied Disorders
www.pku-allieddisorders.org

Genetic Alliance
www.geneticalliance.org

Children's Special Health Services (CSHS)

State Capitol Judicial Wing
600 E. Boulevard Ave., Department 301
Bismarck, ND 58505-0269
Toll Free: 800.755.2714
701.328.2436
Relay TDD: 701.328.3975
CSHS website: www.ndhealth.gov/CSHS
North Dakota Department of Health website:
www.ndhealth.gov

Family support resources available from CSHS:

- Guidelines of Care Info
- Family Support Packet
- Financial Help Packet
- Insurance Fact Sheet

Family Resources

Family to Family Network
Center for Rural Health
University of North Dakota
School of Medicine and Health Sciences
P.O. Box 9037
Grand Forks, ND 58202-9037
Toll Free: 888.434.7436
701.777.2359
Fax: 701.777.2353
E-mail: NDF2F@medicine.nodak.edu
www.medicine.nodak.edu/crh

Pathfinder Services of ND
Pathfinder Family Center
1600 2nd Ave. SW, Ste. 19
Minot, ND 58701
Toll Free: 800.245.5840
701.837.7500
Relay TDD: 701.837.7501
E-mail: ndpath01@ndak.net
www.pathfinder.minot.com

Family Voices of North Dakota, Inc.
P.O. Box 163
Edgeley, ND 58433
Toll Free: 888.522.9654
701.493.2634
Fax: 701.493.2635
www.geocities.com/ndfy

**This fact sheet has general information.
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
should be followed by a metabolic doctor in
addition to their primary-care provider.

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