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Information for the U.S. products. Please refer to the Canadian product label for the list of ingredients and nutritional information for products available in Canada.

A GUIDE FOR FAMILIES WHO HAVE A CHILD WITH

Maple Syrup Urine Disease

CONTENTS

Abbott provides this booklet to health care professionals to help them counsel families, and to families to help them learn about MSUD.

INTRODUCTION TO MAPLE SYRUP URINE DISEASE

Your child has a condition called Maple Syrup Urine Disease, or MSUD for short. Children who have inherited this condition cannot use the essential amino acids isoleucine (i-so-lu-seen) (ILE), leucine (lu-seen) (LEU), and valine (vay-leen) (VAL) in a normal way.

These amino acids are found in all foods that contain protein. You will need to feed your child all the foods necessary for normal growth and development, but only the amount of ILE, LEU, and VAL he can safely use.

Learning some medical terms in nutrition and genetics will help you understand and manage your child's diet better. If you have any questions, write them down and ask the nutritionist (dietitian), nurse, or doctor at the metabolic clinic.

WHAT IS MSUD?

MSUD is an inherited disorder of amino acid metabolism. Proteins, which are made up of amino acids, are found in many parts of the human body, including hair, blood, skin, and muscles. Most foods contain protein. When we eat foods containing protein, this protein is split into amino acids during digestion. The amino acids are later put back together like beads on a necklace to form new protein. These new proteins are used to build and repair the body's tissues.

Twenty amino acids occur commonly in the human body and in the foods we eat. Three of these essential amino acids are ILE, LEU, and VAL. Because of their chemical structure, these amino acids are described as branchedchain. They are frequently grouped together and called branched-chain amino acids (BCAAs).

All foods with protein contain BCAAs. High-protein foods are dairy products, eggs, meat, poultry, nuts, soy products, seafood, seeds, nut butters, beans and peas. Fruits, grains, and vegetables have less protein, and so have less ILE, LEU, and VAL. These are allowed in the diet in measured quantities.

Splitting protein into amino acids requires a special substance that does the actual work. Think of the splitting substance as a pair of scissors snipping beads off a necklace (Figure 1). The "scissors" are called enzymes (n-simes).

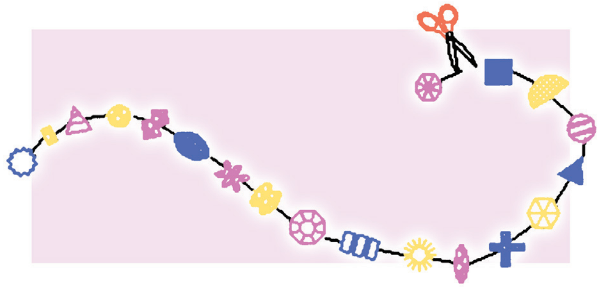

Figure 1. Amino acids are joined together like beads on a necklace to form protein. Enzymes act like scissors to remove amino acids from protein.

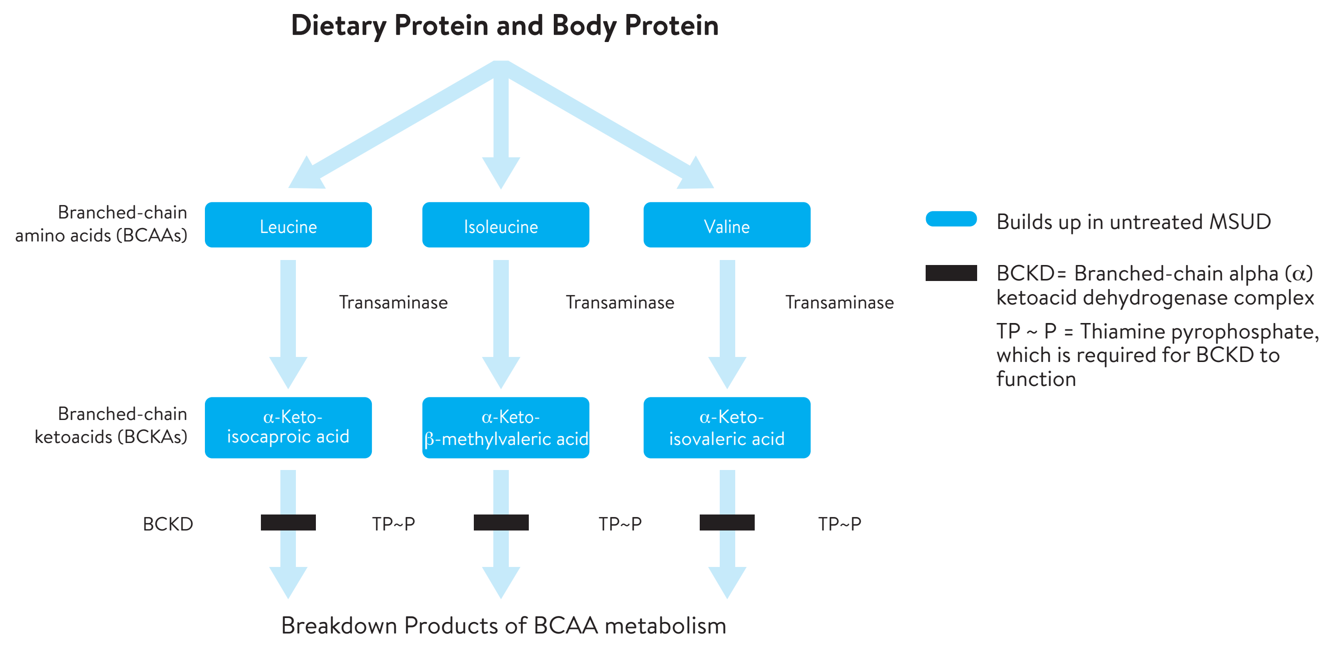

Figure 2. BCAA metabolism in MSUD.

Once ILE, LEU, and VAL are split off food protein, they are absorbed, changed, and used to help form many other useful substances in the body.

In MSUD, the enzymes or group of enzymes called branched-chain alpha (α) ketoacid dehydrogenase (BCKD) are absent or not working properly. Some people, such as your child, do not have any normally working BCKD, or do not have enough to handle all the BCAAs that are in the protein foods they eat. In either case, ILE, LEU, and VAL cannot be used normally and MSUD occurs. Figure 2 shows what happens in MSUD.

Think of the situation as a traffic light (Figure 3). A green traffic light (normal BCKD) allows ILE, LEU, and VAL to be used normally. A red light (no or too little BCKD) keeps ILE, LEU, and VAL from being used. If the light is stuck on red, a traffic jam occurs—BCAAs and ketoacids (BCKAs) increase (Figure 2) and cause the symptoms of MSUD.

If a person is not treated, these products build up in the blood and spill into the urine and perspiration. People who have untreated MSUD have too much ILE, LEU, VAL, and BCKAs in their blood.

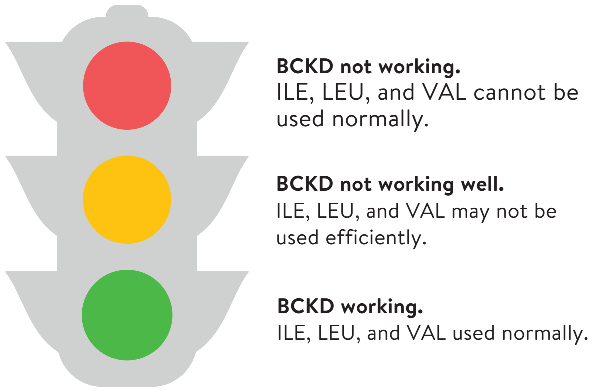

Figure 3. The BCKD traffic light.

MSUD: AN INHERITED DISORDER

MSUD is a genetic disease inherited from both mother and father, just like other features, such as eye and skin color. Genetic information, which determines each person's characteristics, is carried on pairs of genes in every body cell. These genes serve as blueprints, or patterns.

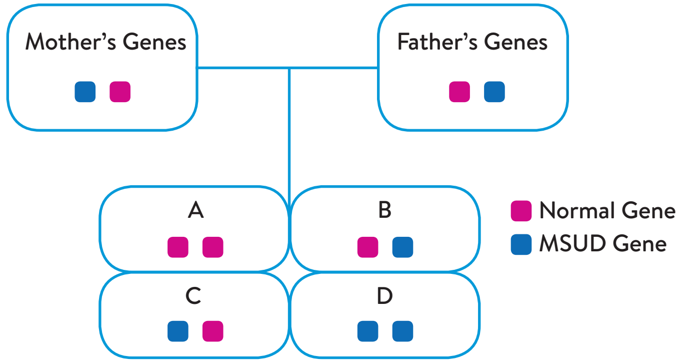

Figure 4. Genetic inheritance of MSUD.

Each parent of a child with MSUD has one normal (🟥) and one altered (MSUD) (🟦) gene. Each one of their offspring will have one gene from each parent and could have one of four gene sets (Figure 4).

A child who receives gene set A inherits two normal genes (🟥🟥). Her body will make enough BCKD to use ILE, LEU, and VAL normally. She will pass a normal gene on to each of her offspring.

A child who receives gene set B or C inherits one normal (🟥) and one MSUD (🟦) gene. His body will make enough BCKD to use ILE, LEU, and VAL normally, but he can pass on the MSUD gene to his offspring. A person with this gene set—one normal and one MSUD—is called a carrier. Being a carrier does not affect the person's health. **You, as parents of a child with MSUD, are carriers.** Brothers and sisters of your child with MSUD may also be carriers.

A child with gene set D has MSUD caused by the two MSUD genes (🟦🟦), one from her mother and one from her father. Her body will not be able to use the ILE, LEU, and VAL in food normally. She will also pass the MSUD gene on to each of her offspring. Your child with MSUD has this gene set.

TYPES OF MSUD

There are several types of MSUD. The type generally refers to the amount of enzyme activity. In the most common type—**classic**—little or no enzyme activity is present. The amount of LEU, ILE, and VAL must be severely restricted in the diet. **Intermediate** MSUD has a higher level of enzyme activity and can handle a greater amount of BCAAs. **Intermittent** MSUD is an even milder form of the disorder and the diet can be more liberal. The final type of MSUD is called **thiamine-responsive** MSUD. Large doses of the vitamin thiamine are given to improve the enzyme activity. The diet may not have to be restricted in protein, or only slightly restricted. Your child's genetic doctor will help you understand the type of MSUD your child has.

DIAGNOSIS OF MSUD

Most states require all babies to be screened for MSUD and other conditions before they are discharged from the hospital. Sometimes the symptoms of MSUD appear quickly, before the newborn screen result is available. In the states that do not include MSUD in their newborn screening, many infants are diagnosed after they start showing symptoms of MSUD.

If the initial screening tests show that a baby may have MSUD, some doctors may hospitalize the infant to confirm diagnosis so that treatment can be started sooner if the baby has MSUD. Additional blood is drawn for precise measurement of ILE, LEU, VAL, and BCKAs, and urine is obtained to determine the amount of BCAAs and BCKAs excreted.

SYMPTOMS OF MSUD

Excessive BCAAs and BCKAs in blood and tissues affect the nervous system. An untreated infant may have some or all of these symptoms:

- Ketoacidosis
- Degenerative or permanent brain injury (encephalopathy)
- Poor feeding
- Poor sucking
- Apnea (transient cessation of breathing)
- Sleepiness (lethargy)
- Vomiting
- Irregular muscle movement
- Seizures

The presence of high levels of ketoacids of ILE gives urine, sweat, and ear wax the odor of maple syrup or burnt caramel, which is how the disorder got its name.

The nervous system symptoms usually appear during the first week of life. Poor control or late diagnosis of MSUD may result in some delay in development.

Table 1. General Guide to Foods on BCAA-Restricted Diets

Foods That Are Not Allowed	Foods That Are Limited	Foods That May Be Eaten Freely
Dairy products (cheese, milk, ice cream, yogurt), soy milk and soy products, beans and peas, eggs, fish and seafood, meat, nuts, nut butters, poultry, seeds, tofu	Breast milk, infant formulas, bread, crackers, fruit, fruit juices, low-protein cereals, popcorn, potato chips, special low-protein foods, vegetables, vegetable juices	Gumdrop candy, hard candy, jelly, Kool-Aid®, lemonade, lollipops, Popsicles ®, pure fat, pure sugar, soda

NUTRITION SUPPORT OF MSUD

A diet that reduces BCAA intake is used to prevent the developmental delay and other problems associated with untreated MSUD. This diet, which is different for each person with MSUD, can lower the blood BCAA to a range that permits normal mental development and growth. The special MSUD diet for your child is very important. To provide enough energy and adequate BCAAs, protein, minerals, and vitamins, a diet restricting BCAAs is designed just for your child to maintain proper BCAA blood levels and growth.

Many foods contain protein. Those foods also contain BCAA. Therefore, the amounts of foods that contain protein must be limited in your child's diet. Table 1 is a general guide to foods that are not allowed, foods that are limited, and foods that may be eaten freely if obesity is not a problem.

Additional Therapies: Your metabolic doctor may recommend certain vitamins, minerals, and medications for your child with MSUD. Common ones include:

- **Thiamine** may help improve enzyme activity.
- **L-ILE** may be supplemented in pure amino acid form if deficiency is noted.
- **L-VAL** may be supplemented in pure amino acid form if deficiency is noted.

Requirements for ILE, LEU, VAL, Protein, and Energy. A child with MSUD who eats enough protein to grow properly gets too many BCAAs. Foods high in protein are cheese, milk, soy milk, eggs, meat, poultry, fish, nuts, tofu, beans and peas, seeds, and nut butters. Foods low in protein include some grains, fruits, fats, vegetables, and sweets. On the other hand, eating these foods in the amounts needed to provide just enough BCAA does not provide enough protein to meet the child's needs for growth. **To get enough protein for growth and not get too much BCAA, a special medical food that is high in protein and free of BCAA is necessary.**

To be sure your child is getting enough energy, protein, and adequate BCAAs for growth and development, the nutritionist carefully calculates the amount of each nutrient needed. Too little BCAAs, protein, or energy can result in growth failure. Frequent diet adjustments are necessary, especially during the first 6 months of life when babies grow rapidly. The nutritionist or metabolic doctor will make these diet changes based on your baby's health, growth, BCAA intakes, and blood levels of BCAAs.

Ketonex®-1 Amino Acid-Modified Medical Food With Iron is a medical food used to provide protein for infants and toddlers. Ketonex-1 does not contain any BCAAs. Similac® Advance® Infant Formula with Iron, breast milk, or other intact protein must also be fed to provide the specific amount of BCAAs a baby needs for growth and development. Breast milk is lower in BCAAs than infant formula or cow's milk and can be used to supply the required BCAAs. The decision to breastfeed should be discussed with your nutritionist and metabolic doctor. The nutritionist or metabolic doctor will tell you the exact amount you will need in addition to your child's medical food. Ketonex-1 is well supplied with fat, carbohydrate, minerals, and vitamins. Supplemental minerals and vitamins are not usually needed when the diet is followed as directed.

Ketonex®-2 Amino Acid-Modified Medical Food is a medical food used in treating children and adults with MSUD. This product contains no BCAAs, so BCAAs must be met by using food sources. Ketonex-2 is also well supplied with fat, carbohydrate, minerals, and vitamins. Your nutritionist will tell you which of the Ketonex products is right for your child.

Ketonex-1 and Ketonex-2 taste different from milk. Most children and adults get accustomed to the flavors of the foods that they eat. They may seem distasteful to you, but it is very important not to show this to your child, either by word or action.

One mother disliked the odor of the medical food so much that she made a face every time she gave it to her son. Because of this, he refused the medical food for several days until she and her family realized what was wrong. She said later, "We changed our attitude to thinking this wonderful diet will make it possible for our child to have a happy life."

Most children taking medical foods for MSUD like them IF they are started early and IF their family has a positive attitude.

Flavorings such as Kool-Aid® Unsweetened Soft Drink Mixes, Wyler's® Unsweetened Soft Drink Mixes, Mio Liquid Water Enhancers, and concentrated fruit juices can be added to Ketonex. Remember to count the added BCAAs if they are present in any of the flavorings.

Ketonex may be made into a paste and combined with some allowed fruits, such as applesauce or other fruit purees, or combined with instant pudding mixes. Check the label and be careful which pudding mixes you buy, as some contain more protein than others.

INTERNATIONAL SYSTEM OF MEASUREMENT (METRIC SYSTEM)

The metric system is the International System of Measurement. It is used for all medical and scientific measures.

In the metric system, solids are weighed in grams (g) or kilograms (kg) and liquids are measured in milliliters (mL) or liters (L). A list of common conversions from the metric system to the English system is given in Table 2. However, the best way to be sure your child is getting the proper amount of BCAA is to weigh food on a scale that reads in grams.

Table 2. Metric to English Conversions

Metric		English
Solids		
1 g (0.001 kg)	=	0.035 oz
28 g	=	1 oz
454 g	=	1 lb
1000 g (1 kg)	=	2.2 lb
Liquids		
5 mL	=	1 tsp
15 mL	=	1 Tbsp
60 mL	=	1/4 cup
240 mL	=	1 cup
1000 mL (1 L)	=	4 1/4 cup (1.06 qt)

Medical Food Preparation. Mix a 24-hour supply of medical food at one time, or as instructed by your nutritionist.

Your nutritionist will tell you exactly how much Ketonex and other formulas or breast milk to use.

Tips for preparing formula for infants:

- **Always follow the instructions on the label and mix the formula according to the recipe provided by your nutritionist or metabolic doctor.**
- Wash your hands and all supplies carefully before preparing formula.
- **Do not** mix longer than indicated on the Ketonex label.
- Always test the temperature of heated formula before feeding by shaking a few drops on your wrist.
- Overmixing causes the fat emulsion to break. Separation of the medical food mixture then occurs. Overmixing may also add air that destroys vitamins A and C.
- Heating above 100° F (37.8° C) or adding hot water may cause loss of vitamins A and C and lead to the Maillard reaction—a reaction in which some amino acids bind with carbohydrate, making them unavailable to the child.

Feeding time should be a pleasant experience for you and your baby.

- Mix in the approved natural protein (breast milk or infant formula) if recommended by your nutritionist or metabolic doctor.
- Refrigerate the medical food after mixing. Discard any unused medical food 24 hours after mixing because of nutrient loss.

Feeding Your Infant. The way you feed your baby with MSUD is the same as for any baby. The Ketonex-1 formula will be supplemented with breast milk or infant formula such as Similac Advance EarlyShield. The nutritionist may have you mix the two formulas together. The Ketonex-1 mixture stored in bottles in the refrigerator may be warmed before feeding.

- Shake the formula mixture and pour into a bottle.
- Set a bottle in a pan of cold water on the stove and gradually warm it or run hot tap water over the bottle.
- Never use a microwave oven to warm formula as this can result in hot spots that can burn your baby.
- Always test the temperature of heated formula before feeding by shaking a few drops on your wrist. The formula should feel lukewarm.
- If the Ketonex-1 mixture drips freely, the nipple holes are the correct size. Shake the bottle well before feeding.

To feed your baby, sit in a comfortable place, hold him in the curve of your arm, and keep the nipple filled with the Ketonex-1 mixture so that air will not be swallowed. You should burp your baby at least once during and again at the end of each feeding. Hold him upright against your shoulder or lay him face down on your lap and gently pat his back.

DO NOT WARM THE BOTTLE IN THE MICROWAVE.
Uneven warming may cause serious burns.

Introduction of Solid Foods. No baby is born with the ability to swallow solid foods. The swallowing reflex develops at 2 to 3 months of age. Before this time, the baby's "tongue thrust" causes the tongue to protrude, making swallowing food difficult. Waiting to feed solid foods until the baby is 4 to 6 months old is best.

Ketonex-1 is similar to infant formula, and the amounts, as well as the kinds of cereals, fruits, and vegetables prescribed, are about the same as for any baby. Your baby's nutritionist or metabolic doctor will advise you about when your baby should start eating infant cereal and strained baby foods, and which foods to introduce. Guidelines for adding various foods to your baby's diet are given in Figure 5. However, your nutritionist or metabolic doctor may suggest different ages. Follow their advice.

At 7 to 8 months of age, your child may begin trying to eat foods such as crackers, low-protein toast, or pieces of fruit without help. At about 9 months of age, your child may begin self-feeding using a spoon.

If your 9- to 12-month-old child has never eaten without help, dip her fingers into the food to give her the idea of finger feeding. Later, you can teach her to pick up a spoon and help guide it to her mouth. Putting your child on your lap to guide her hand may be easier. Start with thick foods, such as mashed potatoes, since they will not slip off the spoon easily.

Do not worry if your child does not eat all of the foods you measure out; just estimate what was not eaten, replace the BCAAs with another food, and write it down.

When your child is older, the differences between the BCAA-restricted diet and the diets of other children will be greater. Your child with MSUD will require Ketonex all her life to provide most of her protein, mineral, and vitamin needs.

Diet Guide and Food Lists. You will be given guidance at each clinic visit that spells out in detail what your child can eat. The amount and how to prepare the medical food mixture, and the types and amounts of food that your child is allowed, will be outlined. The nutritionist will help you work out a plan that meets your child's needs and fits into the family budget and lifestyle.

Lists of foods make meal planning easier and help you be sure your child's nutrient needs are met. You will have time to become familiar with the food lists and their nutrient content, because foods will be added slowly to your child's diet.

When your child is older, you may need to use Free Foods (see Table 1) to meet his energy needs. Free foods, which are high in energy and contain little or no BCAAs, must not replace prescribed foods nor be used in large amounts. If your child eats too many of these free foods, he may become overweight, or the extra sugar may cause tooth decay. Special low-protein foods, including pasta, rice, crackers, cookies, and breads, can be added to the diet. These foods will help to satisfy your child's hunger.

Be sure to check with the nutritionist before using any food that is not on the food lists provided.

If you have any questions about the content of certain foods, the nutritionist can calculate the nutrient composition of the food and help you include it in the diet plan if it is not too high in BCAAs.

CHECKING YOUR CHILD'S PROGRESS

Laboratory Tests. Because your baby grows rapidly during the first year of life, blood is tested frequently for BCAA content. Many doctors will ask for a blood sample once or twice a week during your baby's first 6 months, then once a week until 1 year of age. After 1 year of age, checking blood levels and diet records may be decreased to every 2 to 3 weeks if blood BCAA levels are well controlled.

Various methods are used to monitor the amino acid and ketoacid levels in the blood and urine. Urine may be monitored for the presence of ketoacids. Home monitoring using dinitrophenylhydrazine (DNPH) or Ketostix® strips may be used as a way of detecting ketones in the urine. How often your child is tested will be determined by your baby's metabolic doctor or nutritionist.

Before taking a blood sample, you may be asked to accurately record your child's total food and beverage intake. On a form the clinic will provide, record the name of the food, the exact amount in household measures (cups, teaspoons, or tablespoons) or in grams that your child ate, and the BCAA content based on the food lists or information given to you by the nutritionist.

Blood BCAA Levels. The amount of BCAA in the blood is an indirect measure of how many BCAAs are present in body tissues. Of most concern is the brain, because too much ILE, LEU, VAL, and their ketoacids are harmful to brain

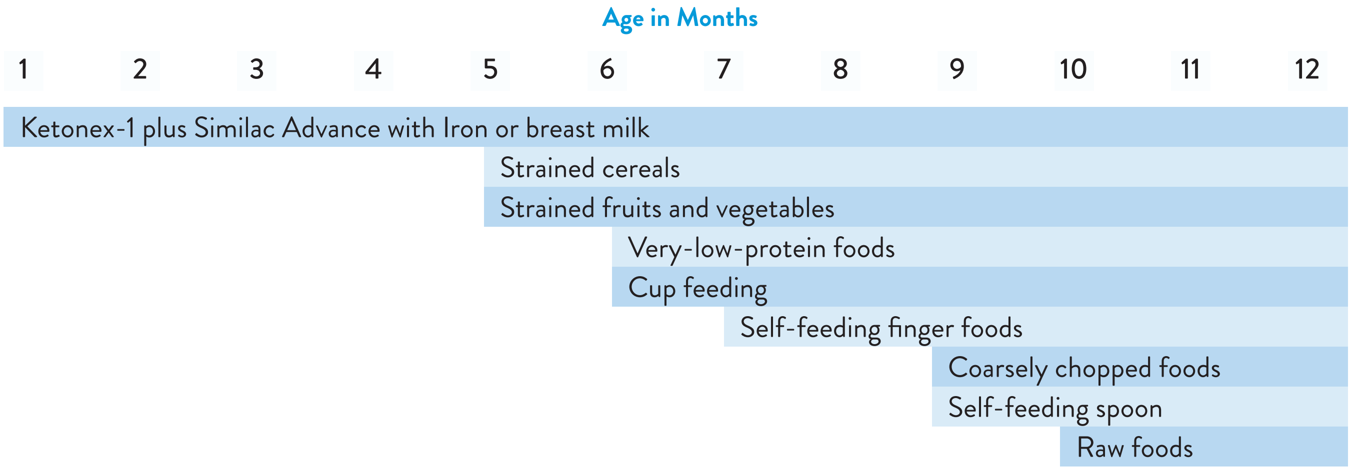

Figure 5. Suggested timetable for beginning solid foods and self-feeding.

development. Because blood transports nutrients to the brain, the concentration of BCAAs in the blood will give the doctor and nutritionist an idea of the amount of ILE, LEU, VAL, and their ketoacids that might be in the brain.

Blood BCAA levels that are **high** may indicate that your child is eating more foods that are high in BCAAs than her body needs for growth. Illness, such as colds and flu, can also cause the body to break down its own protein, releasing BCAAs into the blood. When your child is not getting enough protein, because of rapid growth or inadequate intake of the medical food, the blood BCAA level may also rise. Initially during rapid growth, the blood BCAA level will decrease and then increase as the body breaks down its own protein.

A low BCAA level usually indicates that your child is not getting enough BCAAs in the diet. Sometimes to keep the level of LEU low enough, ILE and VAL drop. The doctor may prescribe ILE and VAL supplements to keep the BCAAs in balance. This will help your child grow properly.

Clinic Visits. Because MSUD is a lifelong condition that could harm growth and development, you will be asked to bring your child to the clinic frequently. If growth and development are normal and blood BCAA concentrations remain within the treatment range, the frequency of clinic visits may be decreased with time.

At clinic visits, your child may be given developmental, physical, and neurological tests. Family interaction, which is important to her development, may also be evaluated. The clinic can address any questions or concerns you may have. Diet changes will be made, if needed, and any questions you may have will be answered.

In addition to the metabolic specialist, you should have a local pediatrician or family doctor to provide required ongoing well-child care. Immunizations should be given at the usual times by this doctor, or you may obtain them from the health department.

YOUR CHILD'S GROWTH AND DEVELOPMENT

By 4 to 6 months of age, your baby's birth weight will double. The child with MSUD who is kept on a controlled intake of BCAAs and whose diet supplies adequate nutrients should grow as well as a child without MSUD.

During the second 6 months of life, the growth rate decreases. Your child may grow 1 inch (~ 2.5 centimeters [cm]) per month during the first 6 months and 4 inches (~ 10 cm) total during the second 6 months of life. This normal decline in the growth rate usually causes a decrease in appetite.

Although the requirement for energy (calories) and protein based on body weight decreases, the total daily requirement for most nutrients increases with age. You will have to adjust food choices accordingly to ensure that your child has an adequate nutrient intake. The nutritionist will help you with food selections that are right for your child.

Weaning from Bottle to Cup. When the time comes to switch from the bottle, your child may need extra attention, as any child would. Weaning takes patience, especially if your child shows no interest in drinking from a cup or a glass.

Begin offering Ketonex-1 from a cup when your child is between 5 and 8 months of age. Some parents find a training cup that has a lid and a spout to be very useful.

During weaning, your child may not want to take all of the prescribed Ketonex in liquid form. You may have to use more of it in instant puddings, cereals, fruits, and soups. Some of the Ketonex can be mixed into a paste with fruits and fed by spoon.

ADDITIONAL WATER MUST BE OFFERED WHEN KETONEX® IS FED AS A PASTE.
Consult your child's nutritionist.

A child of 15 to 18 months may drink more medical food from a cup if he is given a small pitcher of Ketonex and is encouraged to pour it into a small cup without help. Many parents have found using brightly colored straws, special cups, or sports bottles to be good transitional tools to help wean a child from the bottle.

Toddlers. Toddlers, children from 1 to 3 years of age, have a slow growth rate compared with that of infants. Toddlers may gain 4 to 5 pounds (1.8–2.3 kilograms [kg]) a year, compared with the infants' gain of 12 to 22 pounds (5.5–10 kg) per year.

Growth during this period involves changes in body form. Legs lengthen and body fat decreases. Energy needs are decreased because of the slower growth rate. However, mineral and vitamin needs increase.

Toddlers seek independence and are very curious about their environment. Because toddlers want to do things for themselves, encourage your child to feed himself.

Preschoolers. Preschoolers also have a slow weight gain of 4 to 5 pounds (1.8–2.3 kg) per year. On the other hand, their total energy needs are greater than those of toddlers. Because your preschooler's nutrient and energy needs are greater, the nutritionist may tell you to increase foods with a high nutrient content. These foods are packed with vitamins and minerals and are energy dense.

Let your preschooler make some decisions. For example, permit him to choose which cereal, fruit, or vegetable to eat. Be aware that most preschoolers want to do things at their own speed. Be prepared to have your child spend so much time talking that little is eaten. This is normal behavior.

Social Interaction at Mealtime. Mealtime is an important part of every child's social development and, whenever possible, the family should eat together. Younger children can learn how to feed themselves by watching older brothers and sisters.

Make meals for your child with MSUD as similar as possible to the family's meals. Menus for him can be planned from those for the rest of the family. For example, whenever possible, use the same fruits and vegetables for everyone. The family's help and support are very important to maintaining the child's diet.

TEACHING YOUR CHILD DIET MANAGEMENT

Explaining the diet to your child can begin by calling allowed foods "special" or "just for you." From the time she is very young, teach her to ask about unfamiliar foods before eating them. As your child grows older and is able to understand the concept of a missing or nonworking enzyme, explain MSUD.

Some materials that you may find helpful are listed on page 17.

Toddlers and Preschoolers. Permit your preschooler to make food choices such as what fruit to eat for a fruit serving. Plan meals that have variety in color, texture, flavor, and preparation methods. A child who is involved in food selection and preparation will be more interested in trying a new food. Involve your child in planning menus so he can become familiar with foods allowed and excluded. Let him help with grocery shopping, setting the table, and preparing the food.

At about 3 to 4 years of age, children want to serve themselves. Teach your child the proper food portions. Your dietitian may provide you with a technique or way to count protein that you can teach your child.

School Age. When your child reaches school age, she will become more independent in many aspects of her life and eating is one of them. As she begins to develop logic and math skills, it is important she use these skills to understand the diet. Encourage your child to help prepare the medical food and calculate the amount of BCAAs in foods. As your child gets older, she should understand what levels of BCAA are considered normal and the consequences of high BCAA levels.

Adolescence. Adolescence may be a difficult time for both the child and the parents, regardless of MSUD! The influence of friends and the struggle for independence may make dietary compliance a challenge. They may feel that MSUD makes them different from their friends. Eating out with friends is part of growing up. Help your child develop the skills for eating out, traveling, and "sticking" to the diet when not at home. Sometimes teenagers with MSUD would rather tell people they are a vegetarian or vegan than explain about MSUD. Help your teenager deal with her peers and not be self-conscious that she has MSUD. Finding a peer with MSUD through support groups can be a great comfort for a teen. Ask the clinic for resources and suggestions.

FEEDING PROBLEMS

Parents may be tempted to treat their child as a "sick" child and not follow their usual patterns of child rearing. The child with MSUD is a normal child who needs to manage food intake carefully. Ask your child's doctor, nutritionist, public health nurse, or social worker for support and help if any of the following problems should occur.

Loss of Appetite. Loss of appetite can result from a variety of causes, including illness; eating too many sweet foods or desserts that satisfy the appetite and decrease the desire to eat the foods prescribed; getting too much Ketonex, which may depress the appetite for other foods; or having a lower than normal blood BCAA level. Some children have a poor appetite despite adequate treatment and dietary management. In such cases, it may be necessary to use a feeding tube to ensure nutrition needs are met.

Unusual Hunger. This may be an indication that the diet needs to be adjusted. The amount of Ketonex may need to be increased because the table foods prescribed are not satisfying needs. Providing low-protein foods is a great way to manage hunger without increasing protein intake.

Refusing Medical Food. A child may refuse Ketonex because of normal variations in appetite, and this should not be of concern, especially if average intake over a week is adequate. If Ketonex is not offered regularly, a child may decide to refuse it. Improperly mixed Ketonex can also be a cause—too much water makes the volume too great; too little water makes the medical food mixture too thick. A child may refuse Ketonex as an attentiongetting device, especially if he senses that his parents are anxious for him to drink the Ketonex mixture. Remember, Ketonex plays an important role in providing most of your child's nutrition needs. If refusal of the medical food continues to be a problem, the use of a feeding tube may need to be considered.

Refusing Solids. A child may experience normal variations in appetite or taste for certain foods. Or, the prescribed amount of Ketonex may be too high and the energy in it is causing her to lose her appetite.

Toddlers and preschoolers periodically have one of two characteristic feeding behaviors that cause parents concern. They may decide to stop eating—go on a "food strike," or they may go on a "food jag."

During a food strike when your child refuses to eat, offer food at usual mealtimes and if she refuses the food, take it away. Allow only water between meals. She will become hungry and then eat. **Remember that Ketonex supplies most of your child's nutrient needs, so her medical food should never be restricted.**

Do not give in to the food strike and offer free foods or foods that are not on the BCAA-restricted diet. The nutritionist can help you during this trying time, so do not hesitate to call. It is also very important for both parents to support each other in managing a food strike. If a child is allowed to eat foods not on her diet, blood ILE, LEU, and VAL levels will not be controlled.

On a food jag, a child wants to eat the same food or foods for long periods. If the foods are nutritious and are in the diet, there is no reason for concern. Remember that most of your child's nutrient needs are supplied by Ketonex.

Inappropriate Feeding Behavior. Inappropriate behaviors, such as refusing to give up the bottle and/or difficulty in eating solids, chewing, or self-feeding, may result from a variety of causes, including a delay in offering solid foods; delay in teaching the child to drink Ketonex by cup; or not allowing the child to self-feed either with his fingers or a spoon. Always keep a positive attitude and make feeding a pleasurable event.

Try not to feed a child longer than necessary at mealtime to encourage self-feeding. Remember that small amounts of food are usually wasted when a child first learns to selffeed, but this is normal. Keeping food records will help your nutritionist estimate your child's intake.

A child may be using his diet as a way of getting attention or manipulating parents. If your child has any of these problems, call the nutritionist. The nutritionist will give you support and offer suggestions to help solve the problem.

THE ROLE OF THE FAMILY AND OTHER CARE PROVIDERS IN MANAGING MSUD

Parents carry the bulk of the responsibility for the diet. If possible, try to share the responsibility, so both parents can prepare and monitor the diet. Other children in the family, as well as the child with MSUD, should learn about the diet as soon as they are old enough to understand it. Older brothers and sisters should be encouraged to be involved in feeding the child with MSUD so they become familiar with foods allowed and excluded. Make sure they understand the importance of the diet for their brother's or sister's health. Brothers and sisters should not feel sorry for the child with MSUD because she is on a special diet. Treat your child with MSUD as normally as possible.

Grandparents love to spoil their grandchildren! It may be difficult for them as they sometimes feel the child with MSUD is "missing out." It is important that they understand the diet and become actively involved as much as possible. A grandmother may be the ideal person to experiment with low-protein cooking and provide special low-protein treats.

Explain MSUD to relatives, friends, day-care providers, baby-sitters, and all teachers. They should become familiar with foods allowed and excluded and understand the importance of the diet. Give a list of the foods allowed and excluded to anyone who feeds your child and explain the list as well as the exact menu.

Tell everyone who cares for your child that even "just a little bite" of a high-protein food is not allowed. Emphasize what can happen if your child does not stay on the diet.

YOUR CHILD'S DIET DURING ILLNESS

A body temperature greater than 98.6° F (37° C) or a rectal temperature over 100° F (37.8° C) is a fever. During a fever, the body's rate of using food for energy speeds up. If extra energy is not supplied during illness, the body will break down its own muscle and fat stores for energy. Muscle protein breakdown needs to be prevented in children with MSUD, because it will release too much BCAA into the blood. BCAA is then carried to the brain where it may have a harmful effect. Give your child extra low-protein foods, formula or fluids during illness. This extra food energy will decrease the amount of muscle protein broken down for body energy.

Feeding an ill child can be very difficult. Often a child with fever is restless and loses appetite. The illness might also include stomach upset, nausea, or even vomiting. A child may become very dehydrated because of the high body temperature and a lack of adequate fluid intake.

If you suspect a cold or virus, or if your child has a fever, it is important to call your pediatrician or metabolic doctor immediately. Illness in a child with MSUD can be very serious. Your metabolic doctor or nutritionist will help you decide on how to manage it. Ask your nutritionist for a "sick-day plan" to use during illness. A sick-day plan provides adequate calories to meet energy needs and helps keep your child out of the hospital. Ask about beginning medication such as acetaminophen (Tylenol®) to reduce fever and fluids to prevent dehydration.

Here are some suggestions of things to do when your child is ill with fever.

- Do not force-feed food or Ketonex, especially if your child is nauseated or vomiting. Soda crackers may be the only food he will feel like eating. Encourage intake of any allowed foods your child is willing to eat.
- Encourage your child to continue drinking his medical food if he tolerates it.
- Offer Pedialyte® Oral Electrolyte Solution with added carbohydrate, such as dextrose or table sugar (3 Tbsp sugar to 8 fl oz of Pedialyte); Pro-Phree®; non-cola carbonated beverages; sugar-sweetened carbonated beverages; Kool-Aid®; Tang®; tea with sugar; vegetable broth; or fruit juices with some sugar added.
- Dilute the Ketonex mixture, or use liquid Jell-O® if it is tolerated.
- Freeze any of the beverages listed and make into chipped ice. Frequently feed small amounts of this chipped ice to provide energy and prevent dehydration.
- As your child's appetite improves, gradually return to the usual diet plan.

Emergency Letter. Individuals with MSUD should have an emergency letter with them at all times. This letter provides important information such as the name of the condition, explanation of symptoms, the importance of timely treatment and treatment strategies, and your metabolic doctor's contact information. In times of illness or stress that may require hospitalization, this letter can be presented. This letter can be provided by your metabolic team.

A LOOK TO THE FUTURE

Continuing the Diet. MSUD is a serious health concern. Treating a child as early in life as possible helps to prevent developmental delay and neurological damage. Not following the MSUD diet may cause mental and nervous system damage at any age. Lifelong nutrition support must be adapted to each person's needs. Metabolic doctors and nutritionists provide support that will help your child have a normal, productive life.

Current research is looking at alternative treatment options for MSUD, such as enzyme replacement, gene therapy, and liver transplantation. However, until these therapies can be proven effective and safe, dietary treatment for life is essential.

Family Planning. MSUD occurs approximately one time in every 185,000 live births. In the Old Order Mennonite population, MSUD occurs in approximately 1 in 175 newborns.

The chance that two carriers of MSUD will have a child with MSUD is 1 in 4, or 25%, for each pregnancy (Figure 4). The chance that two carriers will have a child who is a carrier is 1 in 2, or 50%, for each pregnancy.

Before a couple who has a child with MSUD has any more children, they should take time to seriously think about the special parenting tasks that parents of a child with MSUD must manage. Genetic counseling is recommended to review the risks and to discuss several reproductive options that are available before and during pregnancy.

While there is no test that can determine if another child will be affected with MSUD before a pregnancy, prenatal testing may be possible during the early part of the pregnancy. A couple may want to discuss and consider all their options with their metabolic doctor and genetic counselor before having another pregnancy.

If you decide to have another child, give yourselves time to adjust to the special needs of the first child. Make sure you have learned diet management for your child with MSUD before having another child.

Offspring of a Person with MSUD. All children born to a person with MSUD will be carriers of the gene. As shown in Figure 6, all offspring of a parent with MSUD (🟦) and a parent who is normal (🟪) inherit one normal (🟪) and one MSUD (🟦) gene. Each one of their offspring will be a carrier.

If a person with MSUD has children with a carrier for MSUD, approximately one-half (50%) of their offspring will have MSUD and one-half (50%) will be carriers (Figure 7).

Childbearing by Women with MSUD. For the woman with MSUD, having children may cause problems. A major concern for women with MSUD is the stress of the pregnancy on her metabolic control. Nutritional requirements can rapidly change during the course of a pregnancy. Pregnant women must be monitored carefully for their own safety, as well as the health of their baby. Successful pregnancies require careful diet monitoring during the prenatal, labor, delivery, and postpartum periods.

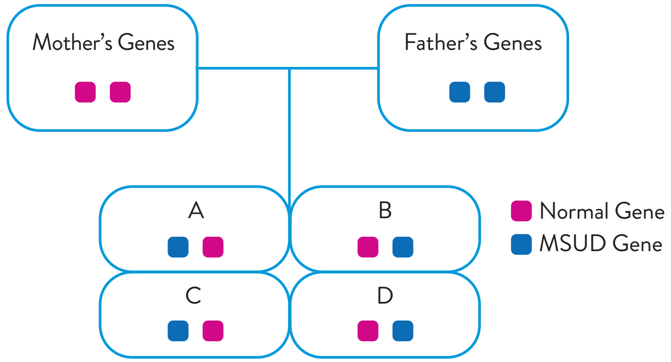

Figure 6. All children of a person with MSUD and a person who doesn't have MSUD will be carriers of MSUD.

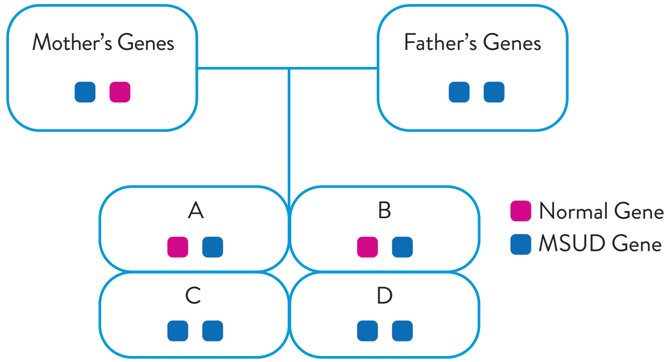

Figure 7. Approximately half of the children of a parent with MSUD who mates with a carrier of MSUD will have MSUD.

RECIPES

Kool-Aid®-Flavored Ketonex™-1

Yield: 8 fl oz

40 g Ketonex-1
3 Tbsp, **level**, sugar[1]
1/4 tsp Kool-Aid or Wyler's® **Unsweetened** Soft Drink Mix

Add water (room temperature) to ingredients to make 8 fl oz. Mix in a blender at lowest speed no more than 4 seconds. Or, shake briskly in a closed container for 10 to 12 seconds. Serve chilled.

Nutrient	*1 fl oz*	*8 fl oz*
Isoleucine, mg	0	0
Leucine, mg	0	0
Valine, mg	0	0
Protein, g	0.75	6
Energy, kcal	42	336

[1] Osmolality (concentration of particles in solution) may be too high if more sugar is added, which may cause bloating and diarrhea.
[2] The amount of drink mix may be varied according to taste preference.

Kool-Aid®-Flavored Ketonex™-2

Yield: 16 fl oz

40 g Ketonex-2
3 Tbsp, level, sugar[1]
1/2 tsp Kool-Aid or Wyler's **Unsweetened** Soft Drink Mix[2]

Add water (room temperature) to ingredients to make 12 fl oz. Mix in a blender at lowest speed no more than 4 seconds. Or, shake briskly in a closed container for 10 to 12 seconds. Serve chilled.

Nutrient	*16 fl oz*
Isoleucine, mg	0
Leucine, mg	0
Valine, mg	0
Protein, g	12
Energy, kcal	308

[1] Osmolality (concentration of particles in solution) may be too high if more sugar is added, which may cause bloating and diarrhea.
[2] The amount of drink mix may be varied according to taste preference.

Fruit Juice-Flavored Ketonex™-2*

Yield: 8 fl oz

20 g Ketonex-2
3 fl oz concentrated apple, grape, or orange juice[1]
Water (room temperature) to make 8 fl oz

Warm juice concentrate to room temperature. Place all ingredients in a blender and mix at lowest speed no more than 4 seconds. Or, shake briskly in a closed container for 10 to 12 seconds. Serve chilled.

Nutrient	*Apple juice*	*Grape juice*	*Orange juice*
Leucine, mg	33	15	48
Isoleucine, mg	0	9	28
Valine, mg	6	13	41
Protein, g	6.5	6.7	8.5
Energy, kcal	257	276	251

*Please check with your dietitian or doctor before using this recipe in infants.

Additional Tips for Flavoring Ketonex Medical Food

- Add chocolate or strawberry syrup.
- Mix Ketonex with fruit to make a “smoothie.”
- Freeze flavored medical food into “slushies” or “popsicles.”
- Add dry Ketonex to pudding (lemon, tapioca, vanilla, etc) mixture. Prepare pudding with non-dairy creamer.

Use low-protein food lists to calculate protein content of flavorings.

Ketostix, Jell-O, Kool-Aid, Popsicles, Tang, Tylenol, and Wyler’s are not registered trademarks of Abbott Laboratories.

RESOURCES

Support Groups/Newsletters

MSUD Family Support Group
Email:secretary@msud-support.org
Website: www.msud-support.org

Low-Protein Food Suppliers

Canbrands Specialty Foods, Inc.
3500 Laird Rd.
Mississauga, Ontario, Canada L5L 5Y4
Phone: (905) 829-6003
Email: helpdesk@canbrands.ca
Web site: www.canbrands.ca

Dietary Specialties
8 S. Commons Rd.
Waterbury, CT 06704
Phone: (888) 640-2800
Web site: www.dietspec.com

Ener-G® Foods, Inc.
5960 First Avenue South
Seattle, WA 98108
Phone: (800) 331-5222; (206) 767-3928
Fax: (206) 764-3398
E-mail: customerservice@ener-g.com
Web site: www.ener-g.com

Med-Diet™ Laboratories, Inc.
3600 Holly Lane, Suite 80
Plymouth, MN 55447
Phone: (800) 633-3438 (MED-DIET);
(763) 550-2020
Fax: (763) 550-2022
E-mail: info@med-diet.com
Web site: www.med-diet.com

PKU Perspectives
PO Box 696
Pleasant Grove, UT 84062
Phone: (866) PKU-FOOD; (801) 785-7722
Fax: (866) 701-3788
Web site: www.pkuperspectives.com

Taste Connections, LLC
Phone/Fax: (310) 371-8861
E-mail: tasteconnect@verizon.net
Web site: www.tasteconnections.com

IMPORTANT PHONE NUMBERS

Nutritionist: ______________________________
Metabolic Doctor: ______________________________
Pediatrician: ______________________________
Police: ______________________________

Fire: ______________________________
Hospital: ______________________________
Other: ______________________________
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Your Path to Insurance Reimbursement Support

pathway plus

Abbott offers a reimbursement support program to help determine your coverage options for Abbott Metabolic products and will connect you with a supplier who can help get it delivered right to you door.

How it works

STEP 1
You Call
with patient's information, insurance and diagnosis

STEP 2
We Help
determine available coverage options

STEP 3
We Connect
your covered patients to a supplier

Call To Get Started: 1-855-217-0698 (M-F, 8:30 a.m. to 5:00 p.m. EST)

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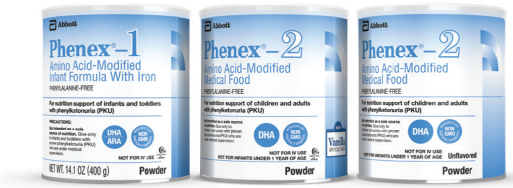
Abbott Metabolic Medical Foods

21 products to meet a wide range of nutrition needs in more than 40 inborn errors of metabolism.



Phenylketonuria (PKU)

Maple Syrup Urine Disease

Urea Cycle Disorders

Propionic and Methylmalonic Acidemia

Glutaric Aciduria Type I

Tyrosinemia

Isovaleric Acidemia and Disorders of Leucine Metabolism

Homocystinuria

Dietary Modification of Protein

Hypercalcemia

Ketogenic Diet Management Carbohydrate Disorders

Dietary Modification of Carbohydrate and Fat

Use under medical supervision.

Abbott Metabolic Medical Foods

Ketonex® is part of an extensive
line of medical foods from
Abbott, makers of Similac®

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