GLUTARIC ACIDEMIA TYPE II

A Guide for Parents

Sponsored by the
Pacific Northwest
Regional Genetics Group (PacNoRGG)

This booklet contains general information about glutaric acidemia type-II.

As every child with this disorder is different, the information in this booklet may not apply to your child specifically.

Please share this booklet with anyone who cares for your child, such as health providers, nutritionists, and other health care workers, school professionals, childcare providers, and members of your family.

Feel free to ask your child's health provider any questions you may have about the enclosed information.

For your reference, a glossary of medical terms is included in the back of the booklet.

Glutaric Acidemia Type-II

Glutaric acidemia type-II (pronounced glue-tair-ic a-sid-e-mee-a) is an inherited disorder. Although there is more than one type of glutaric acidemia, your child has been diagnosed with type-II. This disorder is also called multiple acyl-CoA dehydrogenase deficiency.

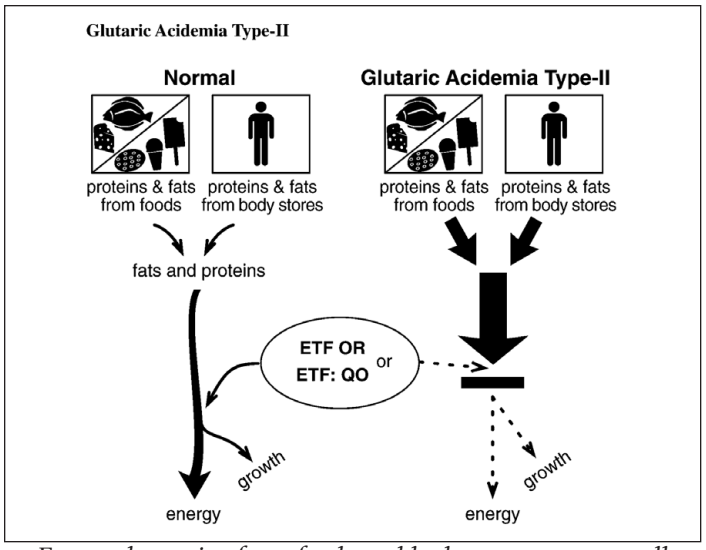
People with glutaric acidemia type-II have an enzyme that does not work properly. Enzymes are substances in the body that enable chemical reactions to occur. Two specific enzymes are associated with glutaric acidemia type-II:

1. electron transfer flavoprotein (ETF)
2. ETF-ubiquinone oxidoreductase (ETF:QO) (pronounced you-bik-win-own ok-sid-o-re-duk-tase)

Both of these enzymes have similar functions in the body, and children with glutaric acidemia type-II may lack one or the other of these enzymes. Both ETF and ETF:QO are found in many cells. They play an important role in breaking down fats and proteins, and help the body produce energy. Because children with this disorder lack one of these enzymes, fats and proteins from food or body stores cannot be completely broken down to be used for energy. Toxic substances build up in body tissues and cause illness. To prevent this, all people with glutaric acidemia type-II need to follow a special food pattern, or diet. (See Diagram 1.)

Some children diagnosed with glutaric acidemia type-II have normal levels of both enzymes. For these children, the actual enzyme that is lacking is unknown at this time.

Diagram 1. **The metabolic defect of glutaric acidemia type-II.**



Fats and proteins from foods and body stores are normally broken down to become a source of energy. Because of the inactivity of enzymes ETF or ETF:QO, this process does not occur.

Symptoms of Glutaric Acidemia Type-II

It is important to remember that all children are unique and will be affected by this disorder to different degrees. Many children with this disorder will not display symptoms until they are several years old, or perhaps not even until they are adults. Symptoms include episodes of nausea, vomiting, and weakness. In addition, after a physical stress of some sort, like extreme physical exercise or play, there may be a period of low blood sugar, called hypoglycemia. This hypoglycemia can be very severe, and your child may feel weak, shaky, or dizzy. His or her skin may also feel wet and cold (clammy) to your touch. Symptoms may be triggered by extreme physical exercise, eating too much protein, going too long without food, or by illness.

Treatment

There are three parts to successful treatment of glutaric acidemia type-II:

1. A high-carbohydrate, low-fat, low-protein, food pattern.

Although children with glutaric acidemia type-II can't turn fats and proteins into energy very well, their bodies can use carbohydrates for energy. This means your child should eat foods with very little fat or protein in them, since he or she lacks one of the enzymes needed to break these foods down. Instead, your child should eat plenty of carbohydrates in order to get enough calories for energy.

It should be noted that this is *not* a fat-free or protein-free food pattern, but simply *low* in fats and proteins. Your child's body needs small amounts of fats and proteins to function properly, so these should never be completely eliminated from the diet. Your health provider and nutritionist can help you create a food pattern that will ensure your child will be well nourished.

2. Supplemental forms of carnitine and/or riboflavin.

Carnitine is essential for muscle energy production, and helps transport fat to cells in the body where it can be converted into energy.

Riboflavin is a very important vitamin that helps

the body carry out many chemical reactions.

Children with glutaric acidemia type-II may be lacking these nutrients. The use of these supplements varies with the needs of each individual child. Contact your health provider to see if these treatments are appropriate for your child.

3. Immediate contact with your child's health provider when illness occurs.

All children become ill at times, whether or not they have glutaric acidemia type-II. Sometimes they catch a cold, the flu, or something more severe. Your child with glutaric acidemia type-II will need to take special precautions during these times. Typical childhood illnesses can cause harmful glutaric acid to build up in the body, because the body is breaking down its own sources of fat and protein as a source of energy. This can create toxic build-up in tissues. During these times, be sure to give your child extra fluids to help the body get rid of excess glutaric acid.

Give your child fluids and foods with extra calories, but no protein. Extra energy foods, such as sugar, will decrease the body's need to break down more protein. Feeding an ill child can sometimes be difficult, as sick children often have very little appetite. Encourage drinking fluids as much as possible. Many children enjoy popsicles or drinks which are frozen, then chipped into ice chunks.

Always call your child's health provider when your child is vomiting, has diarrhea, has an infection, or has a fever of more than 101 degrees Fahrenheit.

Nutrition and Dietary Guidelines

The most effective treatment for glutaric acidemia type-II is a food pattern high in carbohydrates, and low in fats and protein. The table below includes a list of high carbohydrate foods, to be encouraged, and a list of foods high in fat and protein, which should be limited. It also includes a list of high energy foods to be eaten in times of stress. Your health provider and nutritionist can help you create a food pattern appropriate for your child's growth and development, as well as her or his tastes.

It should be noted again that your child needs small amounts of protein and fats for normal growth and development. Proteins and fats should not be completely eliminated from the food pattern.

Foods to be encouraged

A. Foods high in carbohydrates:

Cereals and Grains: (1/2 cup serving has about 2 grams of protein)

cold cereals
hot cereals
bagels
pasta noodles
croutons
breads
rolls
buns
English muffins
wheat germ
pita bread
rice
animal crackers
graham crackers
tortillas
popcorn
breads and pastas
crackers

Vegetables: (1/2 cup serving has about 1 gram protein)

corn
potatoes
asparagus
lettuce
green beans
peas
carrots
broccoli
vegetable juices
onions
cauliflower
cabbage
spinach
yams
sweet potatoes
mushrooms
lettuce
squash
radishes

Fruits: (1/2 cup serving has a trace of protein)

apples
oranges
fruit cocktail
apricots
grapes
berries
cherries
peaches
pears
fruit juices
raisins
pineapples
kiwi
tomatoes
bananas

Foods to be limited:

A. High Fat Foods

butter
margarine
oils
cheeses
whole milk
cream products
ice cream
sour cream
nuts, seeds, and their products
peanut butter
dried peas and beans
fried foods

B. High Protein (1 oz meat, 1 egg, or 8 oz milk has 7-10 grams protein)

meats
poultry
fish
eggs
cheeses
all forms of milk
all dairy products
nuts, seeds, and their products

C. Foods with NO protein which only provide extra energy

gum drops
hard candy
Kool-aid
jams and jellies
pure sugar
popsicles
sodas
margarine
oils
suckers
low protein pastas and breads

You may have questions concerning the amounts of fat or protein in specific foods. The following books are good references. Your nutritionist should be able to tell you how they can be purchased.

Low Protein Food List for PKU
by Virginia Schuett
Dietary Specialties, Inc.
PO 227
Rochester, NY 14601
800/544-0099

Bowes & Church's Food Values of Portions Commonly Used, 17th ed.
by Jean AT Pennington
JB Lippincott

The nutritionist can also recommend a wide variety of special low protein foods which can offer more food choices and add variety to your child's food pattern.

Because your child will be limiting certain foods, the food pattern may not always have enough vitamins or minerals to meet your growing child's needs. A general multivitamin and mineral supplement that includes calcium and iron is essential.

Length of Treatment and Medical Visits

Glutaric acidemia type-II does not go away. The low protein and fat, high-carbohydrate food pattern must be continued throughout life to maintain health. Because glutaric acidemia type-II is a lifelong condition that could at times be severe, your child should be followed closely by your health provider and nutritionist.

Medical visits offer many advantages for children with glutaric acidemia type-II, such as developmental, physical, nutritional and neurological assessments.

The medical team will want to learn how your child is getting along with parents, siblings, and friends, and work with you to solve problems. The goal is to help your child develop the skills needed to take responsibility for managing his or her own condition. The staff knows this will be no easy task, and wants to provide as much support as they can to you and your family. Most importantly, these visits offer you an opportunity to ask questions and get answers.

At a medical visit, you and your child can expect any of the following:

WHAT TO EXPECT:	HOW IT WILL HELP:
Discussion of medical history since last appointment	To determine if treatment is working, and to see if changes are needed; To talk about concerns at home, at school, with friends and/or with caregivers
Physical exam	To look at neurological status and other measures of physical well-being
Record of height, weight, and head size	To monitor child's growth and treatment
Food records	To look at food choices, assess the amounts of fats and proteins eaten, and adjust as needed
Developmental exam	To assess child's learning and development
Blood draw	To measure levels of amino acids and other compounds in the blood

Organizing Your Information

You may want to buy a 3-ring notebook binder with tab dividers to record information, questions, and food patterns. Here you can collect treatment plans, growth and medication records, questions, articles, food lists, recipes, and other information that may be useful to you. One section might hold food records, and another a graph of your child's growth and development. Make a list of questions as you think of them, so you'll remember them at your next medical visit.

Social Concerns

All family members play a very important role in your child's treatment. Other children in your family, as well as the child with glutaric acidemia type-II, should be taught about the special food pattern. Encourage all family members, including brothers and sisters, to help choose and prepare foods that are high in carbohydrates and low in fats and proteins. Explain glutaric acidemia type-II to everyone who will participate in the care of your child (relatives, teachers, day care providers, friends, baby-sitters, and others) and help them become familiar with the foods allowed and not allowed. Be sure to emphasize the importance of the special food pattern for normal growth and development. Also teach siblings and relatives not to feel sorry for the child with this disorder because he or she cannot have certain foods.

Treat your child with glutaric acidemia type-II as normally as possible. Despite efforts to make your affected child feel good about himself or herself, there may be a time when your child becomes aware of her or his uniqueness and simply wants to be like everyone else. Help your child celebrate his or her individuality and realize that every person is different in some way.

Genetics

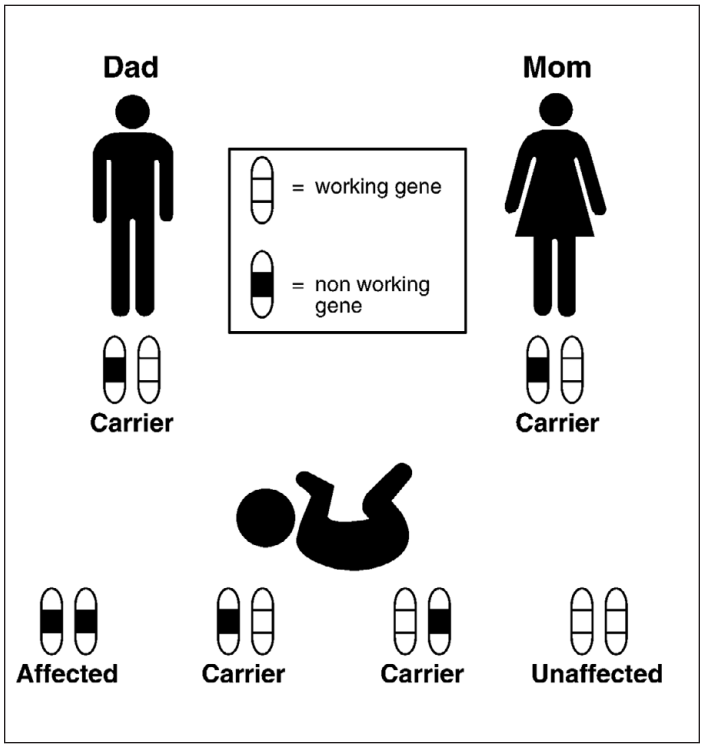
Within each child there are two copies of every gene, one copy from the mother and the other copy from the father. Most often, genes work normally. Sometimes however, a gene is changed from its original form. This is called a mutation. Mutations usually cause genes not to work correctly.

The gene change that causes glutaric acidemia type-II is inherited in what is called an autosomal recessive pattern. This means that one copy of the changed, or non-working, gene must be inherited from each parent for a child to be affected with the disorder. The parents' health is not affected because their other copy of the gene is working correctly. Therefore, each parent is called a gene "carrier." It is important to remember that all people carry several of these "hidden" recessive genes. Also, it is no one's fault that your child was born with glutaric acidemia type-II, and both boys and girls can have the disorder.

The chance that two parents who carry the same changed gene will have a child with the disorder is one in four, or 25% with each pregnancy. The chance these parents will have a child that is healthy, but a carrier, is one in two, or 50% with each pregnancy. There is also a one in four, or 25% chance that these parents will have a child who is neither affected nor a carrier. (See Diagram 2.)

For affected individuals planning to have children, a consultation with a genetic counselor is recommended. The genetic counselor can explain the chances and risks of any future children being affected with the disorder, and can also explain options for testing.

Diagram 2.
Autosomal recessive inheritance



The chance that two parents who carry the same changed gene will have a child with the disorder is one in four, or 25% with each pregnancy.

Resources

Following is a list of agencies that may be helpful to you. Each agency specializes in different areas, such as health care, physical or mental development, support groups, or general information. Since each child is affected differently, not all agencies may be useful to you.

Genetic Alliance, Inc.
4301 Connecticut Ave NW Ste 404
Washington DC 20008
202/966-5557; 800/336-GENE (4363)
info@geneticalliance.org
http://www.geneticalliance.org

Metabolic Information Network
PO Box 670847
Dallas TX 75367-0847
214/696-2188; 800/945-2188
Fax: 214/696-3258
mizesg@ix.netcom.com

MUMS: National Parent-to-Parent Network
150 Custer Court
Green Bay Wisconsin 54301-1243
920/336-5333
Fax: 920/339-0995
mums@netnet.net
http://www.netnet.net/mums

National Center for Learning Disabilities
381 Park Ave S Ste 1401
New York NY 10016
212/545-7510; 888/575-7373
Fax: 212/545-9665
http://www.ncld.org

National Parent Network on Disabilities (NPND)
1130 - 17th Street NW Ste 400
Washington DC 20036
202/463-2299
Fax: 202/463-9405
npnd@mindspring.com
http://www.npnd.org

National Society of Genetic Counselors
233 Canterbury Drive
Wallingford PA 19086-6617
610/872-7608
nsgc@aol.com
http://www.nsgc.org

NORD: National Organization for Rare Disorders
PO Box 8923
New Fairfield CT 06812
203/746-6518; 800/999-6673
Fax: 203/746-6481
orphan@rarediseases.org
http://www.rarediseases.org

Organic Acidemia Association
c/o Kathy Stagni
13210 - 35th Ave N
Plymouth MN 55441
763/559-1797
Fax: 763/694-0017
oaanews@aol.com
http://www.oaanews.org

Washington State Parent-to-Parent Program
4738 - 172nd Court SE
Bellevue WA 98006
425/641-7504; 800/821-5927
statep2p@earthlink.net
http://www.arcwa.org

ALASKA

PARENTS: Parents as Resources Engaged in Networking and Training
4743 Northern Lights
Anchorage AK 99508
907/337-7678
Fax: 907/337-7671
parents@parentsinc.org
http://www.parentsinc.org/

IDAHO

Idaho Parents Unlimited
4696 Overland Road Ste 568
Boise ID 83705
208/342-5884
800/242-4785 (ID only)
Fax: 208/342-1408
ipul@rmci.net
http://home.rmci.net/ipul

MONTANA

PLUK: Parents, Let's Unite for Kids
516 N 32nd Street
Billings MT 59101
406/255-0540; 800/222-7585
Fax: 406/255-0523
plukinfo@pluk.org
http://www.pluk.org

OREGON

Coalition in Oregon for Parent Education (COPE)
999 Locust Street NE
Salem OR 97303
503/581-8156; 888/505-COPE (2673)
Fax: 503/391-0429
orcope@open.org
http://www.open.org/~orcope/index.htm

WASHINGTON

Washington PAVE
6316 S 12th
Tacoma WA 98465
253/565-2266; 800/572-7368 (WA only)
Fax: 253/566-8052
wapave9@washingtonpave.com
http://www.washingtonpave.org

Treatment Plan

Prescribed food pattern:

Vitamin and/or mineral supplement: _____

Specific foods to be avoided:

Medication _____ Dose _____ Schedule _____

_____ _____ _____

Important names and phone numbers:

Health Care Provider:

Nutritionist:

Hospital:

Genetic Counselor:

To Schedule Clinic Appointments:

Public Health Nurse:

Remember

Raising a child with a rare metabolic disorder can be challenging and often confusing. Your health care providers are there to help you, and can answer the questions you will have along the way. Please do not hesitate to call upon them as you make the many changes necessary for successful treatment of your child's disorder.

Glossary

Autosomal recessive inheritance - one copy of the changed gene must be inherited from each parent.

Carbohydrate - the primary fuel for the body.

Carrier - a person who carries one non-working (mutated) gene in a pair of genes. Carriers do not have the disorder, they simply carry one gene mutation for it.

Carnitine - a non-toxic, natural chemical which helps transport fat to cells in the body where it can be converted into energy.

Enzyme - a substance in the body that enables chemical reactions; ETF and ETF:QO.

Food pattern - another term for diet. A food pattern consists of foods and beverages to be included or avoided on a daily basis.

Gene - the smallest unit of hereditary material.

Genetics - the study of heredity.

Hypoglycemia - low blood sugar.

Mutation - occurs when a gene is changed from its original form.

Protein - the building blocks of body tissues.

Riboflavin - a vitamin which helps the body perform many of its chemical reactions.

Scientific References:

1. Frerman FE and Goodman SI, "Nuclear-encoded defects of the mitochondrial respiratory chain, including glutaric acidemia type-II." In: Scriver CR, Beaudet AL, Sly WS, and Valle D, eds. The Metabolic and Molecular Basis of Inherited Disease, 7th ed. New York, McGraw Hill, 1995.

2. Goodman SI, Stene D, McCade E, Norenberg M, Shikes R, Stumpf D, and Blackburn G, "Glutaric Acidemia Type-II: Clinical, Biochemical, and Morphologic Considerations," The Journal of Pediatrics, Vol. 100 (6), June, 1982, pp. 946-950.

3. Mandel H, Africk D, Blitzer M, and Shapira E, "The Importance of Recognizing Secondary Carnitine Deficiency in Organic Acidaemias: Case Report in Glutaric Acidaemia Type-II," Journal of Inherited Metabolic Disease, Vol. 11, 1988, pp. 397-402.

4. Dusheiko G, Kew M, Joffe B, Lewin J, Path F, Mantagos S, and Tanaka K, "Recurrent Hypoglycemia associated with Glutaric Aciduria Type-II in an adult," The New England Journal of Medicine, Vol. 301 (26), 1979, pp. 1405-1409.

5. Loehr JP, Goodman S, and Frerman F, "Glutaric Acidemia Type-II: Heterogeneity of Clinical and Biochemical Phenotypes," Pediatric Research, Vol. 27 (3), 1990, pp. 311-315.

Christine Cavanaugh, MS, RD

Cristine M Trahms, MS, RD, FADA Department of Genetics and Development and Center on Human Development and Disabilities University of Washington, Seattle

Robin Bennett, MS, CGC, Department of Genetics University of Washington, Seattle

And the PacNoRGG Education Committee, with special thanks, to Johanneke Smith, MS, CGC; Susie Ball, MS, CGC; Rebecca Zacharias, MS, CGC; and Diane Plumridge, MSW.

Reviewed 2002

Project Administrator: Kerry Silvey, MA, CGC

This project was partially funded by project #6 H46 MC 00091-15 SI of the Maternal and Child Health Bureau, Department of Health and Human Services. An equal opportunity affirmative action institution.

Project Administrator and Regional Coordinator:
Kerry Silvey, MA, CGC
Project Director: Jonathan Zonana, MD
Administrative Assistant: Denise Whitworth

Copies of this booklet available on the PacNoRGG web site:
http://mchneighborhood.ichp.edu/pacnorgg

Design & Production: Northwest Media Inc.