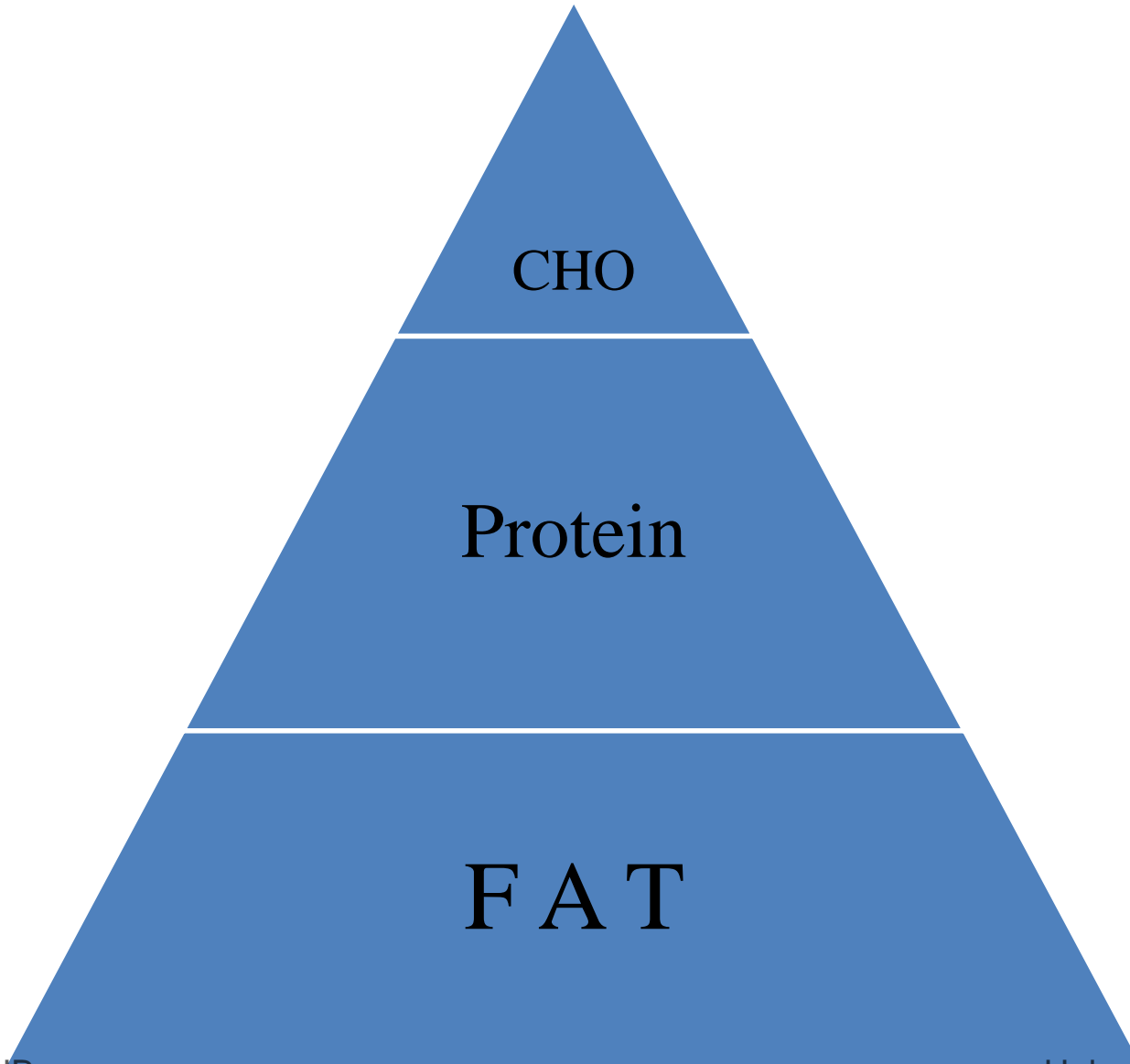


Ketogenic Diet

- The ketogenic diet is a special diet that is:
 - ✓ High-fat,
 - ✓ Low-carbohydrate:
 - That helps to control seizures in some people with epilepsy.

Ketogenic Diet Pyramid



Ketogenic Diet

- It is one of the oldest treatments for epilepsy.
- It is intended to maintain the starvation or fasting metabolism over a long period of time.
- When the body is in a fasting state, it creates ketones: by-products of fat-burning metabolism.
- Seizures often decrease or disappear during periods of fasting in some individuals with epilepsy.
- The ketogenic diet is used as a method of treating seizures when seizures have not been satisfactorily controlled with adequate trials of medications.

What is Epilepsy

■ Epilepsy:

- ✓ Is a brain disorder, neurological condition.
- ✓ Brain sends out abnormal signals:
 - This results in repeated, unpredictable seizures (convulsions).
- ✓ Is a chronic disorder.
- ✓ Is usually only diagnosed after a person has had more than one seizure.
- ✓ If a single seizure that does not happen again is not epilepsy.

Epilepsy Medical Definition

- Epilepsy (seizure disorder):
 - ✓ When nerve cells in the brain fire electrical impulses,
 - ✓ At a rate of up to 4 times higher than normal:
 - This causes a sort of electrical storm in the brain.
 - ✓ The electrical impulses can be transmitted to the muscles:
 - Causing twitches or convulsions known as a seizure.
 - ✓ A pattern of repeated seizures is referred to as epilepsy.

Causes of Epilepsy

- Typically, the known causes of seizure involve some injury to the brain.

But

- In only a minority of the cases there is a clear cause for epilepsy.
- In up to 70% of all cases of epilepsy in adults and children, no cause can ever be discovered.
- The ones most often affected are children and the elderly.
- There are $\approx 180,000$ newly diagnosed cases of epilepsy each year.
 - $\approx 30\%$ of newly diagnosed cases occur in children.

Some of the main causes of epilepsy include:

- Infections (viral, bacterial, fungal) such as meningitis or encephalitis.
- Head injuries that occur during birth or from accidents during youth or adulthood.
- Low oxygen during birth.
- Stroke or any other type of damage to the brain.
- Brain tumors.
- Genetic conditions that result in brain injury, such as: tuberous sclerosis (non-cancerous tumors).

Triggers of Seizures

- Certain factors are known to provoke seizures in people with epilepsy:
 - Missing medication doses,
 - Lack of sleep,
 - Heavy alcohol use,
 - Other drugs that interfere with seizure medications,
 - Cocaine or other drug use, such as ecstasy.
- Avoiding these triggers can help to avoid seizures and live better with epilepsy.
- In $\approx 50\%$ of women with epilepsy, seizures tend to occur more around the time of menstrual periods:
 - Changing or adding certain drugs before menstrual periods can help.

Symptoms of Epilepsy

- Vary from person to person:
 - ✓ Some people may have simple staring spells,
 - ✓ Others have violent shaking and loss of alertness.
- Type of seizure depends on:
 - ✓ Part of the brain that is affected and causes epilepsy.

What is a Ketogenic Diet (KD) ?

- The diet is designed to:
 - ✓ Establish and maintain ketosis: in contrast to a state of glycolysis where blood glucose provides most of the energy.
- Fat is converted in the liver into fatty acids and ketone bodies:
 - ✓ Ketone bodies in the blood (acetone, acetoacetic acid and beta-hydroxybutyric acid),
 - ✓ Ketone bodies become the alternative source of fuel.
- Ketosis is measured in blood and urine.
- Diet order should be specific.

Who is a Candidate for the KD ?

- Ketogenic diet is used for children and adults who:
 - ✓ Are resistant to anticonvulsant medications, or
 - ✓ Experience drug related side effects.

Types of Diet Therapies

1. **Ketogenic Diet (KD) (Classic):**
(very High intake of fats – butter, cream, oil).
2. **Modified Ketogenic Diet:**
High intake of long chain Fats.
3. **MCT oil supplemented (KD):**
(High intake MCT oil medium chain triglycerides).
4. **Modified Atkins Diet (MAD).**
5. **Low-Glycemic Index Treatment (LGIT).**

Classic Ketogenic Diet & Modified KD

- Used for treatment of pediatric epilepsy.
- High fat, low CHO, adequate protein:
 - Ketosis = burn fat for energy instead of carbohydrates, measured in urine/blood.
- A proven therapy for the treatment of pediatric epilepsy.

Ketogenic Diet Ratio

- The ketogenic diet ratio is defined as:
 - ✓ The ratio of gm of fat: gm of CHO & Protein combined.
- Higher ratios result in:
 - Greater degrees of ketosis,
 - Better seizure control, but
 - Poorer tolerability of the diet .

Classic Ketogenic Diet

- The classic ketogenic diet consists of ratios of:
 1. 4:1 ratio: diet contains 4 times as much fat as both CHO & protein:
 - ✓ Which means KD can be about $> 80\%$ of total calories come from fat and about $\approx 10\%$ come from both CHO & Protein.
 2. 3:1 ratio: diet contains 3 times as much fat as both CHOs & proteins.

Modified Ketogenic Diet

- The Modified KD consists of ratios of:
 1. 2:1 ratio: diet contains 2 times as much fat as both CHOs & proteins.
 2. 1:1 ratio: diet contains as much fat as both CHOs & proteins.

Example of the KD 4:1 Ratio

Avocado



Grams per serving = 100 gm,

Grams of fat = 15 gm,

Grams of CHO (-fiber) = 2 gm,

Grams of protein = 2 gm,

Ketogenic Ratio Fat : CHO +
Protein

Avocado Ratio: 15 : 2 + 2

$\approx 4 : 1$

Creating the 4:1 KD ratio

Most foods are not a 4:1 ketogenic ratio, therefore, you have to add foods together to create the correct ratio.



Example: 1000 kcal

Classic & Modified KD

How much CHO is allowed on a 1000 Calorie diet?

KD	8 gm CHO on a	4:1 ratio
KD	16 gm CHO on a	3:1 ratio
MKD	30 gm CHO on a	2:1 ratio
MKD	40-60 gm CHO on a	1:1 ratio

Sample Menu for a Ketogenic Diet with 3½: 1 Ratio Meal Plan

Breakfast	Lunch	Dinner
60 gm Cream 31 gm Strawberries 28 gm Raw Egg 15 gm Butter Make scrambled eggs	60 gm Cream 29 gm Applesauce 15 gm Lettuce 14 gm Tuna 18 gm Mayonnaise Make tuna salad lettuce roll up	60 gm Cream 42 gm Carrots (C) 12 gm Chicken 17 gm Butter

- 2yr 8mo – male: IBW = 13kg, ≈ 1200kcal/day, ketogenic meals.

% Fat Content in Creams

- Half-and-Half: minimum $\approx 12\%$ fat
- Light Cream: minimum $\approx 20\%$ fat
- Light Whipping Cream: minimum $\approx 30\%$ fat
- Whipping Cream: minimum $\approx 35\%$ fat
- Heavy Cream: minimum $\approx 38\%$ fat
- Heavy Whipping Cream: minimum $\approx 38\%$ fat

Classic and Modified Ketogenic Diets

- Achieved by:
 - ✓ Excluding all high CHO foods: starchy foods such as starchy vegetables, bread, pasta, grains and sugar,
 - ✓ Increasing the consumption of foods high in fat such as: nuts, cream, butter, avocado, mayonnaise, oils etc.
- All foods must be carefully prepared and weighed on a gram scale to calculate the exact CHO content.
- Each meal must be eaten in its entirety for the diet to be most effective.

Role of the Dietitian

- Determines energy requirement for each child based on their age and activity level.
- Devises meal plans that complete the required: fat, protein & carbohydrate for each meal.
- Each meal plan indicates the exact gram weight of each food which must be weighed on a gram scale.
- A typical meal includes:
 - ✓ A small amount of fruit or vegetable,
 - ✓ A protein rich food, and a
 - ✓ Source of fat such as: heavy cream, butter or vegetable oil.

How do you begin the diet?

- The diet is started under close medical supervision.
 - During this time blood sugar & ketone levels are monitored.
 - The diet is begun gradually and increased to the full amount over a (3 to 4) day period or longer.
 - A fasting period is not necessary to start the diet according to recent studies.
- ❖ Some hospitals might still do.

Inpatient KD Initiation

- Day #1 KD 1:1 ratio at 1/3 of daily energy requirement.
 - Day #2 KD 2:1 ratio at 2/3 of daily energy requirement.
 - Day #3 KD GOAL 3:1 ratio at full daily energy requirement.
 - Day #4 same 4:1 ratio, discharge from hospital.
- ❖ Can be kept on the 3:1 if his/her “Lab Tests” show good results.

How soon does it take for the diet to reduce or eliminate seizures?

- The diet can become effective immediately or can take several months.
- Each child is unique and has different seizure patterns and frequency.
- There is usually improvement within the first 10 weeks on the ketogenic diet.

What would happen if the child “cheated” on his/her diet?

- If a child ate or drank something that was not part of his/her diet:
 - He/she could experience a seizure within a short period of time.

Why would the KD be stopped? (or maybe just lower the ratio)

The KD diet may be stopped if:

- It's not working,
- There are behavior issues,
- The family requests,
- Other treatment options that don't work with KD,
- There are side effects.

How would you stop the KD?

- If the diet is not helpful,
 - If the KD caused side effects.
-
- ✓ Then the diet will be stopped within a few months.
 - ✓ Usually, the person is gradually taken off the diet over several months or even longer:
 - Because seizures may worsen if the ketogenic diet is stopped all at once.

Is the KD healthy ?

- The diet alone does not contain enough vitamins or minerals:
 - A nutritional deficiency could develop without supplements.
- Special vitamin and mineral supplements are prescribed for each child while on the ketogenic diet.
- ❖ It is also important that the child drink adequate liquids while on the diet.

Are there any Adverse Effects of the KD?

- The most common adverse effect of the diet is constipation.
- There are dietary options to prevent constipation including:
 - ✓ Eating high fiber vegetables that are allowed on the diet, and
 - ✓ Drinking enough water.

Other Possible Side Effects of the KD

- Kidney Stones.
 - ✓ This problem can be prevented by making sure that the child drinks adequate water.
- Hyperlipidemia.
- Metabolic Acidosis.

Can the KD be used for Children with Feeding Tubes?

- The ketogenic diet can be provided to children with feeding tubes.
- Special ketogenic formulas are designed for this purpose.
- These formulas are based on the ratio system of 4:1 and 3:1.
- A dietitian will determine the type and amount of formula for the child.

Medium-Chain Triglyceride (MCT) Oil Supplemented KD (less strict approach)

- MCT oil produces ketones more easily than LCT (long-chain triglyceride) fat:
 - This means that less total fat is needed, thus allowing more carbohydrate and protein to be included in the regimen.
- The MCT diet is more flexible and a larger variety of food can be included due to the higher carbohydrate and protein allowance.
- Experience has shown that better ketone levels are reached and tolerance obtained if the MCT supplement:
 - ✓ Is divided up evenly across the day between both snacks and meals, i.e. all food must be accompanied by a proportion of MCT.

Epilepsy Diet Research

- Some research has shown that:
 - 2 types of ketogenic diet can prevent or decrease seizures in adults who:
 - ✓ Cannot tolerate anti-seizure medication, or
 - ✓ Have inadequate seizure control in spite of taking anti seizure drugs.
- The 2 types of ketogenic diets that were studied are:
 1. The Modified Atkins Diet,
 2. The Low Glycemic Index (GI) Diet.

Differences between Traditional AD Atkins Diet & Modified AD Atkins Diet

Traditional Atkins Diet	Modified Atkins Diet
<ul style="list-style-type: none"> • Prescribed : <ul style="list-style-type: none"> ✓ For weight loss 	<ul style="list-style-type: none"> • Prescribed : <ul style="list-style-type: none"> ✓ For seizures control.
<ul style="list-style-type: none"> • Encourages: <ul style="list-style-type: none"> ✓ High protein ✓ Low CHO intake 	<ul style="list-style-type: none"> • Allows : <ul style="list-style-type: none"> ✓ Even lower CHO foods than the traditional Atkins diet
<ul style="list-style-type: none"> • Less strongly : <ul style="list-style-type: none"> ✓ Encourages high fat intake. 	<ul style="list-style-type: none"> • More strongly : <ul style="list-style-type: none"> ✓ Encourages high fat intake than the traditional Atkins diet.

Differences between Modified Atkins Diet (MAD) and KD

Modified Atkins Diet (MAD)	Ketogenic Diet (KD)
<ul style="list-style-type: none">• No weighing of food quantities• But CHO counts should be monitored either by patients or parents.	<ul style="list-style-type: none">• Weighing of all food on the meal plan is required.
<ul style="list-style-type: none">• Most patients will consume plenty of dairy and oils.	<ul style="list-style-type: none">• Dairy is limited because of its content of CHO.
<ul style="list-style-type: none">• No restrictions on proteins<ul style="list-style-type: none">✓ Typically 35% of calories for a patient on the MAD come from protein.	<ul style="list-style-type: none">• There is some restriction on proteins.

Differences between Modified Atkins Diet (MAD) and KD Cont'd.

Modified Atkins Diet	Ketogenic Diet
<ul style="list-style-type: none">• There is NO Calorie restriction or limitation.	<ul style="list-style-type: none">• Calorie content should be adequate for age and gender and activity level.
<ul style="list-style-type: none">• It is started outside of the hospital.	<ul style="list-style-type: none">• It is started in hospital.
<ul style="list-style-type: none">• Foods can be eaten more freely.	<ul style="list-style-type: none">• Foods are strictly weighed.

Differences between Modified Atkins Diet (MAD) and KD Cont'd.

Modified Atkins Diet	Ketogenic Diet
<ul style="list-style-type: none">▪ Liberal approach therapy.▪ Used as:<ul style="list-style-type: none">– An alternative to the strict ketogenic diet and– As a step-down diet after the traditional ketogenic diet.	<ul style="list-style-type: none">• Strict approach therapy.
<p>❖ No diet for patients with epilepsy should be tried without a neurologist involved.</p>	

How is the Modified Atkins Diet designed?

- The modified Atkins diet plan approximates a 1:1 ratio of fat : carbohydrate & protein.
- This meal plan:
 - Limits total carbohydrate to 15 to 20 grams per day.
 - ❖ CHO intake makes around $\approx 5\%$ of total kcal intake.
 - Does not limit: protein, fats, fluids, or total calories.
- Intake should meet estimated Caloric needs for weight and physical activity.

Modified Atkins Diet

Recommended Foods

Food Group	Foods Recommended
Meats and other protein foods	Fish, poultry (chicken and turkey), other meats — prepared without breading or flour; eggs.
Milk and milk products	Cheeses — limited to 3-4 oz. per day.
Vegetables	Bok choy, cucumber, fennel, lettuce, peppers, radishes, cauliflower, chard, and zucchini — limit to within 15 grams carbohydrate per day.
Fats and oils	Sour cream, cream, butter, mayonnaise, vegetable oils, salad dressings (without added sugar).
Beverages	Club soda/seltzer, coffee, tea, herbal tea, diet soda, water.
❖ No grains or fruit added.	

Sample 1-Day Menu for Modified Atkins Diet

Breakfast	2 eggs scrambled in 1 Tbsp. butter 4 oz. ham Coffee or tea with 1 Tbsp. cream, artificial sweetener if desired
Lunch	8 oz. tuna salad, made with pickle relish and real mayonnaise 6 black olives Sugar-free beverage
Snack	4 chicken wings with 2 Tbsp. blue cheese dressing
Evening Meal	6 oz. roast pork ¼ cup creamed spinach Tossed salad: ½ cup mixed greens with ½ cup avocado slices with 2 Tbsp. vinaigrette dressing Sugar-free beverage

≈ Nutrition Analysis: Calories: 2,010; Protein: 172g (33% of calories); CHO: 24g (5% of calories); Fat: 134g (61% of calories); Cholesterol: 489mg; Sodium: 5,512mg; Fiber: 6g.

Low Glycemic Index Diet

- This meal plan:
 - ✓ Limits total CHO intake to 40 to 60 grams per day,
 - ✓ Allows only CHO foods with a GI of < 50 ,
 - ✓ The digestion of a CHO food is slowed by foods that are eaten at the same time that contain either fat or fiber.
- CHO intake makes $\approx 13\%$ of total kcal intake,
- Does not limit protein, fats, fluids, or total calories.
- Intake should meet estimated caloric needs for weight and physical activity.

Low Glycemic Index Foods

Recommended Foods

- Dried Beans (legumes): chickpeas, kidney beans, lentils, soybeans, hummus.
- Barley, corn tortillas; all-bran, whole wheat pasta, brown rice, whole wheat bread; burghol, in very small amounts.
- Fructose: as sweetener or in fruits.
- Lactose: in milk.
- Many fruits and vegetables e.g.
 - ✓ Cherries, grapefruit, grapes, pears, apples, plums, peaches, oranges.
 - ✓ Carrots, corn, green peas, eggplants, tomatoes, beets, turnips, lettuce, yams, etc.
- Milk (full cream and low fat), yogurt, soymilk.

Sample 1-Day Menu for Low GI Diet

Breakfast	2 eggs scrambled in 1 Tbsp. butter, 2 ounces meat, Coffee or tea with 1 Tbsp. cream, artificial sweetener if desired.
Lunch	1 medium tomato stuffed with 8 ounces tuna salad, made with pickle and real mayonnaise, Sugar-free beverage.
Snack	4 ounces mixed nuts.
Evening Meal	6 ounces baked chicken, 1/4 cup brown rice, Tossed salad: 2 cups mixed greens with 1/2 cup cucumber slices and 1/2 cup avocado slices with 2 Tbsp. vinaigrette dressing, Sugar-free beverage.
Evening Snack	1/4 cup fresh raspberries.

≈ Nutrition Analysis: Calories: 1,750; Protein: 137g (31% of calories); CHO: 58g (13% of calories); Fat: 111g (56% of calories); Cholesterol: 323mg; Sodium: 2,600mg; Fiber: 18g⁴⁵

General Recommendations for Epilepsy and Seizure Control: Foods to Avoid and/or Limit

- Avoid all sweets:
 - Cake, candy, catsup, chewing gum, cookies, honey, ice cream, jam, jelly, molasses, pastries, pies, pudding, sherbet, sugar, sweetened condensed milk, syrup, sugar sweetened carbonated beverages.
- Limit and carefully calculate:
 - CHO foods in order to meet requirements for low CHO diets.
- Carefully calculate:

The whole meal plan which should be:

 - ✓ Strictly supervised by the dietitian.
- A multivitamin, calcium, and iron supplements are ordered since the diet does not meet the RDAs for some nutrients.