



# Ketogenic Diet in Cancer

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## Ketogenic diet

- Ketogenic history
- What is a ketogenic diet?
- Use in patients with cancer



## Ketogenic Diet History

- Fasting as a treatment for epilepsy was first described in the Bible and Text from the Middle Ages
  - Hippocrates, “Sacred Disease”, wrote that modification of diet required to treat epilepsy
  - Based on belief that epileptic patient’s body was “polluted” and modification of diet allows “purification”
- St. Mark; 9:29 (The Bible, King James version)  
An epileptic child was brought to Jesus, who said to disciples,  
“This kind can come forth by nothing but by prayer and fasting”



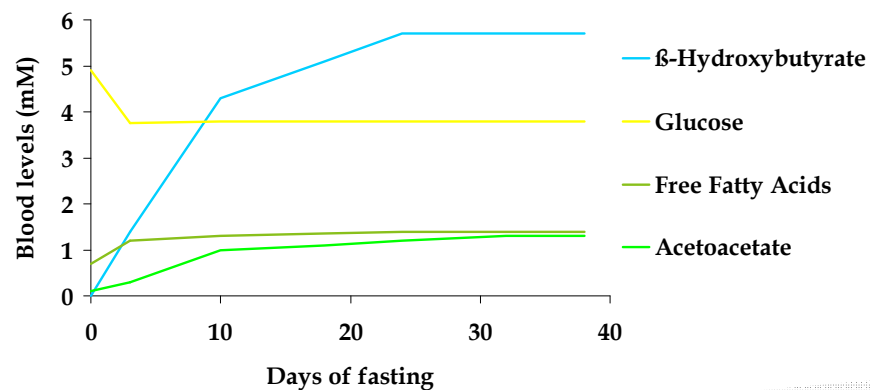
## Ketogenic Diet History

- In 1921, Dr. Rawle Geylin reported to the AMA the successful treatment of epilepsy by fasting, by osteopath Dr. Hugh Conklin.
- Conklin believed epilepsy was caused by intoxication from the Peyer’s patches of the intestine, so he developed program to “put intestines at rest”.
- He would fast patients, with water only, for as long as tolerated, up to 25 days
- “cure” rates of 90% in juvenile patients, 50% in adults

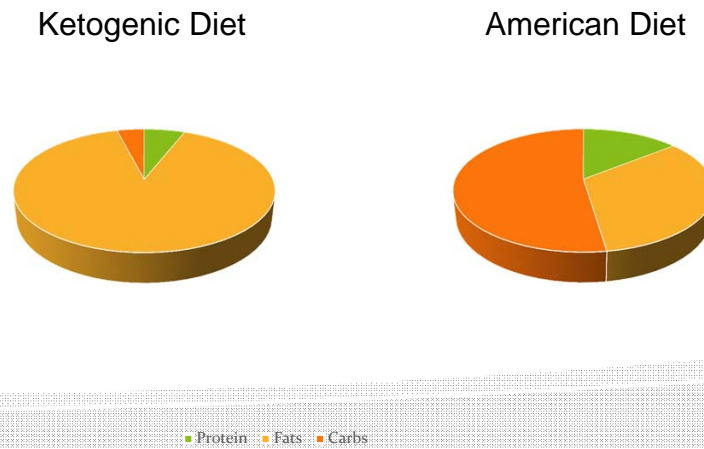
## Ketogenic Diet History

- 1925: The “Ketogenic Diet” was designed to mimic starvation.
  - First described by Peterman at the Mayo Clinic, with 1 g of protein per kilogram of body weight in children, 10-15 g of carbohydrate per day, and the remainder of calories as fat.
  - 19/37 patients became seizure free, seizures in 13 others significant reduced
  - Also noted an “a marked change in character.....decrease in irritability and an increased interest and alertness”

## Metabolism



## Ketogenic Diet vs American Diet



## Contraindications to ketogenic diet therapy

- Fatty acid oxidation defects
- Primary Carnitine deficiencies
- Organic Acidurias
- Pyruvate carboxylase deficiency
- Severe liver disease
- Hypoglycemia



## Types of Ketogenic Therapies

- Classic
- MCT
- Calorie restricted
- Nutritional Ketosis



## Ketogenic diet formulation

### Classic

Calories - Based on individuals calorie needs

- Protein – RDA or above
- Carbohydrates – based on ratio
- Fat – based on ratio

All food is weighed and measured to tenth of a gram on digital gram scale



## Ketogenic Ratio

- Fat: Protein + Carbohydrate

Example: 6 year old active boy, weight 20 kg (50% ile wt/age)

Goal: Calories 1300 per day, 4:1 ratio,

130 grams fat per day (43.33 grams/meal)

22 grams protein per day (7.33 grams/meal)

10.5 grams carbohydrates per day (3.5 grams/meal)

**Options:**

[Return to Main Menu](#)

[Also Back to List](#)

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### KETO CALCULATOR - Meal Edit

Meal for keto kid

**Important Information Regarding Meals:**

1. Be sure to check the verified box when you are satisfied with the meal. Only verified meals can be printed.
2. You must press the 'SAVE' button after changing any field or checking that the meal has been verified.
3. Tabbing to the next field will perform the calculation for fat, protein, carbohydrate and calories.

Meal Created: 4/23/2014 Verified?

Meal Name:

**Save Changes**

Delete?	Food Item	Grams	Fat	Pro	Carb	Calories	Units	Ratio
<input type="checkbox"/>	Cream, 36%	35	12.6	0.7	1.05	120		
<input type="checkbox"/>	Peppers, sweet red - raw	14	0.04	0.14	0.55	3		
<input type="checkbox"/>	Chicken, breast, no skin - cooked	17	0.61	5.27	0	27		
<input type="checkbox"/>	Mayonnaise, Spectrum Organic	29	22.79	0.32	1.01	210		
<input type="checkbox"/>	Avocado, California or Mexico (Hass)	48	7.4	0.94	0.88	74		
<b>Actual</b>			<b>43.44</b>	<b>7.37</b>	<b>3.49</b>	<b>434</b>	<b>10.95</b>	<b>4.1</b>
<b>Recommended</b>			<b>43.33</b>	<b>7.33</b>	<b>3.5</b>	<b>433</b>	<b>10.93</b>	<b>4.1</b>

Suggested accuracy: achieve within 4 calories of recommended calories AND on or slightly above the ratio.

Meal Preparation Instructions



## Ketogenic diet formulation

- Medium Chain Triglyceride diet
  - 60 % fat from MCT oil
  - More ketogenic



## Ketogenic diet formulation

- Calorie Restricted Ketogenic diet
  - “Enhances mitochondrial biogenesis and oxidative phosphorylation”
  - Maintains minerals and nutrients
    - Water only for 3-5 days
    - Goal blood sugar 55-65 mg/dl
    - Goal ketones 4.0 mM
    - Protein 62-92 grams per day



## Ketogenic diet formulation

- Nutritional Ketosis – “Metabolic state that your body must burn ketones”
  - Ketone goal: 0.5 – 5.0 mM
  - Protein intake: 1.5-2.5 grams/kg
  - Carbohydrate intake: < 100 grams/day or lower, many cases 50 grams or less needed
  - Majority of calories from fat



## Formula

- Milk Based - KetoCal
- Soy Based - RCF





## Sugar Substitutes

- Splenda
- Nectresse
- Aspartame
- Stevia



## Alcohol

- Effect on blood glucose levels
- Effect on ketone levels
- Effect on vitamins and mineral deficiencies
- Effect of artificial sweeteners



## Supplements

- Multivitamin with minerals
- Calcium with Vitamin D
  
- Additional as needed
  - Cytra K
  - laxative
  - probiotics
  - digestive enzymes



## Side Effects

- *Elevated serum lipids*
- *Constipation*
- *Deficiencies in water soluble vitamins and calcium*
- *Renal stones (5-8%)*
- *Growth inhibition*
- *Acidosis and excess ketosis during illness.*
- *Increased Bruising*



## What is Ketosis?

- The metabolic state when the liver produces ketones

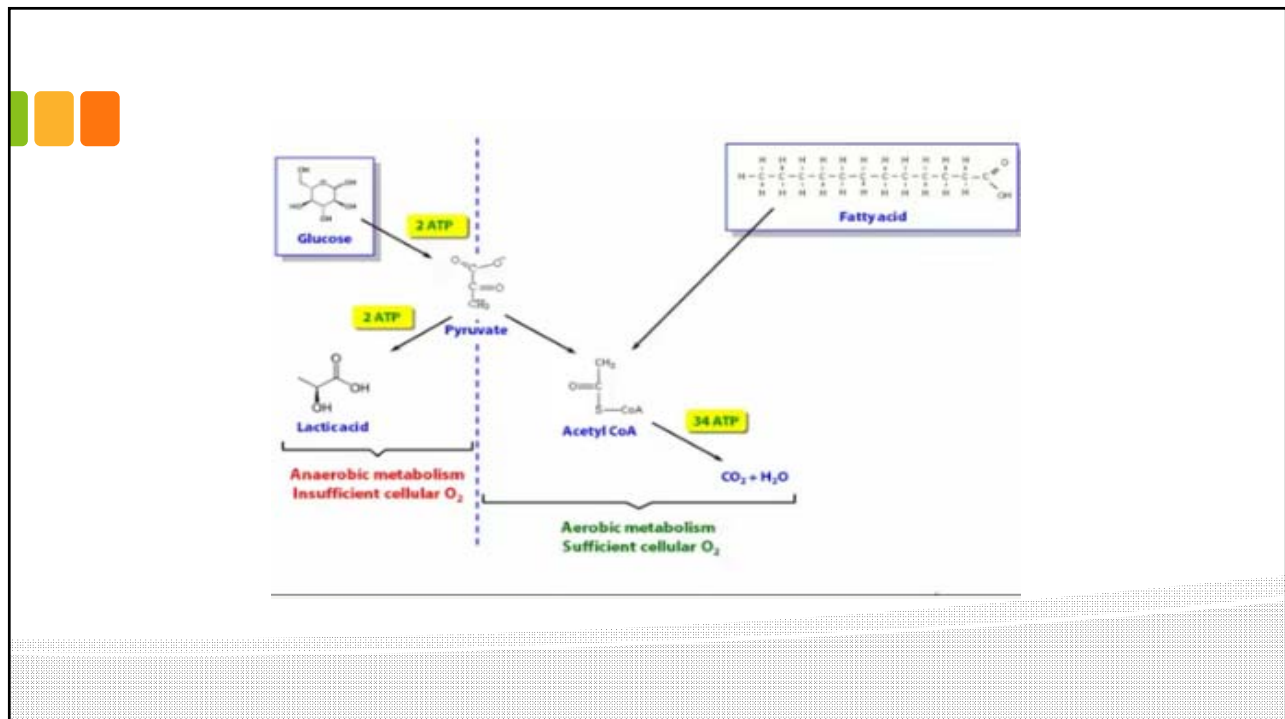


## Ketone bodies

- Acetoacetate – Ketones measured in urine strips
- Acetone – can be smelled on breath when adjusted to ketogenic diet
- Beta-hydroxybutyrate – Serum ketone measured on blood strips.

## Warburg Effect

- In 1924 Otto Warburg discovered that cancer cells are preferential to glucose as their energy source even in presence of sufficient oxygen.





## Normal cells vs Cancer cells

- Normal cells are able to obtain energy from ketone bodies
- Malignant cells depend on glucose metabolism



## Glioblastoma Multiforme

- Standard treatment remains chemotherapy and radiation
- Median Survival 15 months

## Effects of a ketogenic diet on tumor metabolism and nutritional status in pediatric oncology patients: two case reports

L Nebeling, F Miraldi, S Shurin, E Lerner

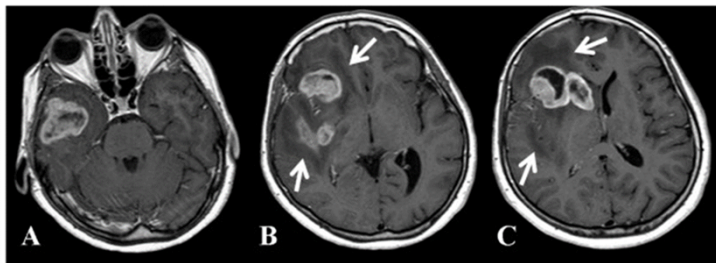
- Two girls diagnosed with non resectable brain tumors (anaplastic astrocytoma stage IV and cerebellar astrocytoma stage III) both had received radiation and chemotherapy
- Goal of the study was to determine if ketosis could decrease availability of glucose to effect tumor metabolism while providing adequate nutrition
- Both children had a reduction in glucose uptake and had long term tumor management.

J Am Coll Nutr 1995; 14: 202-8

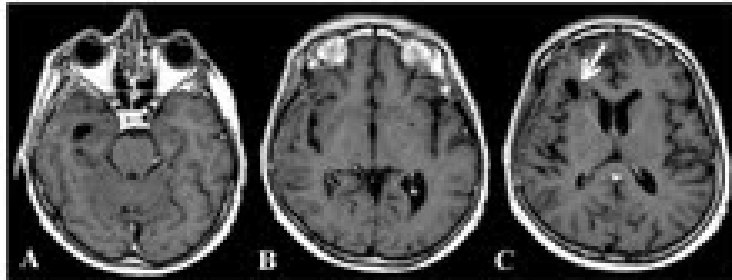
## Metabolic management of glioblastoma multiforme using standard therapy together with a restricted ketogenic diet: Case Report

G Zuccoli, N Marcello, A Pianello, F Servadei, S Vaccaro P Mukherjee

- 65 yo F with GBM
- "Water fast" then 600 calories 4:1 ratio for two months
- Chemo and radiation concurrent with diet



Nutrition and Metabolism 2010; 7:33-53



- No evidence of tumor after 2.5 months of treatment
- Weight reduction of 20%

Ten weeks after stopping diet her tumor recurred and chemotherapy was initiated. She succumbed to her illness less than two years after her diagnosis.

## Effects of ketogenic diet on quality of life in 16 patients with advanced cancer: pilot trial

M Schmidt, N Pfetzer, M Schwab, I Strauss, U Kammerer

- 16 patients on calorie restricted KD for various cancers
- 5 were able to complete 3 months of dietary treatment
- None of these experience tumor progression while on diet
- Of the remaining 11, 2 died at the beginning of the trial, 1 was unable to tolerate diet, 2 dropped out for personal reasons, 1 dropped out to resume chemotherapy, 1 was not able to continue diet for more than one month and 3 had progression of disease less than 2 months after starting diet
- They did not see any severe side effects or changes in cholesterol levels

Nutr Metab 2011; 8(1):54

## Targeting Metabolism with a ketogenic diet during the treatment of glioblastoma multiforme

Cchamp, Jpalmer, J Volek, Mwerner-Wasik, D Andrews, Jevans, J Glass, L Kim, W Shi

- Retrospective review of patients with high grade glioma treated with radiation and chemotherapy
  - 53 patients had enough serum glucose levels to analyze, 6 patients were on a ketogenic diet during treatment
- Glucose levels
  - Patients on standard diet had mean blood glucose level 122
  - Ketogenic diet patients had mean blood glucose of 84 mg/dl
- 4 of 6 alive at median 14 month follow up
- Time to recurrence 6.3 months
- Side Effects
  - Constipation
  - Fatigue (patient reduced calories by 30%)

J Neurooncol 2014; 117: 125-131





## Steroids

- Dexamethasone is commonly used in the treatment swelling around the tumor
- Despite the known side effect of elevation of blood glucose levels some studies have indicated while on dietary therapy levels do not rise above normal ranges.



Monitoring and equipment  
while on dietary treatment



## Monitoring

- Urine for acetone and blood for beta hydroxybutyrate
  - Nova-Beta meter measures blood glucose and ketones
  - Ketostix or Multistix 8 SG by Bayer



## Scales

- Diet Scale -should have ability to weigh to 1000 grams in 0.1 gram increments
- Bathroom Scale - for weekly weight checks



## Blood Sugar Monitoring

- Check blood glucose in the morning, after lunch, and before bedtime
- Goal range during dietary therapy is 55-75
- Record results



## Other Cancers that may benefit from KD treatment

- Prostate
- Breast
- Colon
- Endometrial
- Cervical
- Pancreatic

*SUGAR AND CANCER.*

The theories of Dr. Freund of Vienna concerning the cause of the cancer in the Gorman Crown Prince's throat are generally discredited by New-York medical men. According to recent dispatches Dr. Freund's theory is that the blood of patients suffering from cancer contains an abnormal quantity of sugar, and that cancerous growths may be destroyed by a reduction of the amount of sugar.

Dr. George F. Shrady, editor of the *Medical Record*, was inclined to be conservative on this subject yesterday. He did not care to speak against a new theory just because it was new, for new theories had frequently developed into something practical. In this case, however, it was different. Dr. Freund, who is unknown as an authority, has advanced a theory wholly inconsistent with the results of years of scientific research. In the first place sugar is present normally in the blood in small quantities. Various diseased conditions of the system occasionally produce an excessive quantity of sugar in the blood, the direct cause of diabetes mellitus, which is most difficult to cure. There is no relation whatever between cancer and sugar in the blood as cause and effect, either active or retroactive. A patient may have diabetes and cancer both at the same time, and the treatment of one would have no effect upon the other. Dr. Shrady did not think that Dr. Mackenzie and the other eminent physicians associated with him would experiment upon the Crown Prince with a new theory. They have always been accustomed to using their own opinions, and independent of outside influence.

*The New York Times*

Published: December 24, 1887  
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## How does the ketogenic diet work to treat cancer?

- Insulin like growth factor 1 (IGF-1) are associated with cancer initiation and progression. This is upregulated with consumption of carbohydrates.
- Cancer cells rely on glucose as energy substrate
- Ketogenic Diet decreases glucose availability
- Cancer cells cannot utilize ketones
- Cancer cells starve



What we do know.....

more ketogenic dietitians are needed!



## MGH Center for Dietary Therapy

• Heidi H Pfeifer, RD, LDN	Clinical Nutrition Specialist
• Elizabeth A. Thiele, MD, PhD	Director, Epileptologist
• Ronald Thibert, DO, MSPH	Epileptologist
• Amy Morgan, PhD	Neuropsychologist
• Elahna Paul, MD, PhD	Nephrologist
• Jan Paolini, RN	Nurse coordinator
• Patricia Bruno, RN	Nurse coordinator
• Peter Newberry, MD	Psychiatrist
• Leigh Horne-Mebel	Social Worker
• Ayahna Williams	Administrative Coordinator