


# KETOGENIC DIET


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# AGENDA

- ❖ History of the Ketogenic Diet
  - ❖ Diet Pathophysiology
  - ❖ Side Effects
  - ❖ Pros and Cons
  - ❖ How and Why the Diet works
  - ❖ Ketogenic Diet for Type 2 Diabetes
  - ❖ Ketogenic Diet in Cardiovascular Disease
  - ❖ Who is the Diet appropriate for
  - ❖ Conclusions
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# HISTORY OF KETOGENIC DIET

# HISTORY OF THE KETOGENIC DIET

- ❖ Originated in the 1920s after starvation studies discovered that after several days without food seizure activity stopped.
  - ❖ Then discovered that the same results could be produced by introducing an extremely low carbohydrate diet (<20g/day) to induce ketosis.
  - ❖ Was initially used to treat epilepsy.
  - ❖ Diet lost popularity with the discovery of anticonvulsants.
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# TYPES OF KETOGENIC DIETS

❖ The standard Ketogenic diet is traditionally 75-80% Fat, 15-20% Protein and 5% Carbohydrate.

❖ Various adaptations of the ketogenic diet are now used since the Keto Diet became so popular.

- Cyclical (5 days Keto then 2 higher carbohydrate days)
  - Targeted (Standard Keto but with carbohydrates surrounding workouts)\*
  - High Protein Keto (60%fat, 35% protein, 5%carbohydrate)\*
  - Fad Diets ( Atkins, Modified Atkins, Paleo, Dr. Poon , etc)
- **Note:** Targeted and High Protein Keto are designed more for athletes and body builders

# **KETO PATHOPHYSIOLOGY**

# PATHOPHYSIOLOGY (HOW KETO WORKS)

- ❖ Ketosis can be induced either through fasting or drastically reducing ones carbohydrate intake. Ketosis is our bodies survival mechanism during periods of starvation.
- ❖ Lack of Carbohydrate leads to depleted glycogen stores which prevent oxaloacetate (made primarily from glucose) from normal fat oxidation in the Krebs Cycle.

# PATHOPHYSIOLOGY (HOW KETO WORKS)

- ❖ After 3-4 days of fasting or extremely low carbohydrate intake our body enters ketosis and people experience “brain fog” or “keto brain”.
- ❖ The three ketone bodies produced by the liver are:
  - ❖ Acetoacetate (AcAc), Beta-Hydroxybutyric acid (BHB) and Acetone.
  - ❖ The liver is unable to use these Ketone Bodies as energy (BHB → AcAc → Ac-CoA → Krebs Cycle)



# PATHOPHYSIOLOGY (HOW KETO WORKS)

## ❖ 2 Pathways of Gluconeogenesis

- ❖ Breakdown of Protein: Glucogenic Amino Acids (AA), Glutamine and Alanine that are stored in the muscles can be turned into glucose.
- ❖ Breakdown of Lipids: Glycerol -liberated from Triacylglycerols (TAGs)

## ❖ First few days to week of keto is fueled mainly by Glucogenic AAs.

## ❖ Once “Fat Adapted” keto is fueled mainly by Glycerol.

- ❖ Only 16% is fueled by glycerol during the first week of keto
- ❖ 60% once fat adapted, this is why you can preserve lean muscle mass relatively well.

# PROS OF THE KETO DIET

- ❖ Better Blood sugar control and weight loss
- ❖ Better blood profile
- ❖ Reduce blood pressure
- ❖ Increased HDL
- ❖ Can be very effective with proper adherence
- ❖ More flavorful than many traditional diets
- ❖ Increased satiety
- ❖ Increased leptin and insulin sensitivity



**Most of these positive side effects can all be side effects of weight loss in general.**

# CONS OF THE KETO DIET

- ❖ Extremely restrictive
- ❖ Difficult to travel with
- ❖ Possible social isolation
- ❖ Only a temporary solution (not a long term diet)
- ❖ Potential side effects (ie: disordered eating, false food beliefs)
- ❖ Medical complications (re-feeding syndrome)
- ❖ GI issues (constipation/diarrhea)
- ❖ Fatigue
- ❖ Possible Nutrient Deficiencies



**Ketogenic Diet should really be considered a last resort!**

# SIDE EFFECTS OF KETO

## ADAPTATION PERIOD

- ❖ Headache,
- ❖ Decreased Cognitive Function
- ❖ Bad Breath
- ❖ Weakness
- ❖ Fatigue
- ❖ Constipation or Diarrhea
- ❖ Dehydration
- ❖ Vitamin/Mineral Deficiencies

## LONG TERM

- ❖ Bad breath
- ❖ Micronutrient Deficiencies
- ❖ Loss of lean muscle mass



# KETO VS “TYPICAL” WEIGHT LOSS DIETS

Issues	Short Term	Long Term
Fat loss	Same as any other calorie matched diet	Same as any other calorie matched diet
Lean Tissue	More lean tissue loss with Keto	More lean tissue loss with Keto
Anaerobic Performance	Decreased compared to other weight loss diets	Not enough data
Aerobic Performance	Decreased compared to other weight loss diets	Not enough data
Strength Performance	Approximately the same compared to other weight loss diets	Not enough data

# WHY DOES KETO POTENTIALLY WORK



Increased Thermic Effect of Protein



Targeting Satiety Signals/Hormones



Ketone Bodies act as Appetite Suppressants



Long term optimized Fat Oxidation



Reduction in Lipogenesis and increased lipolysis

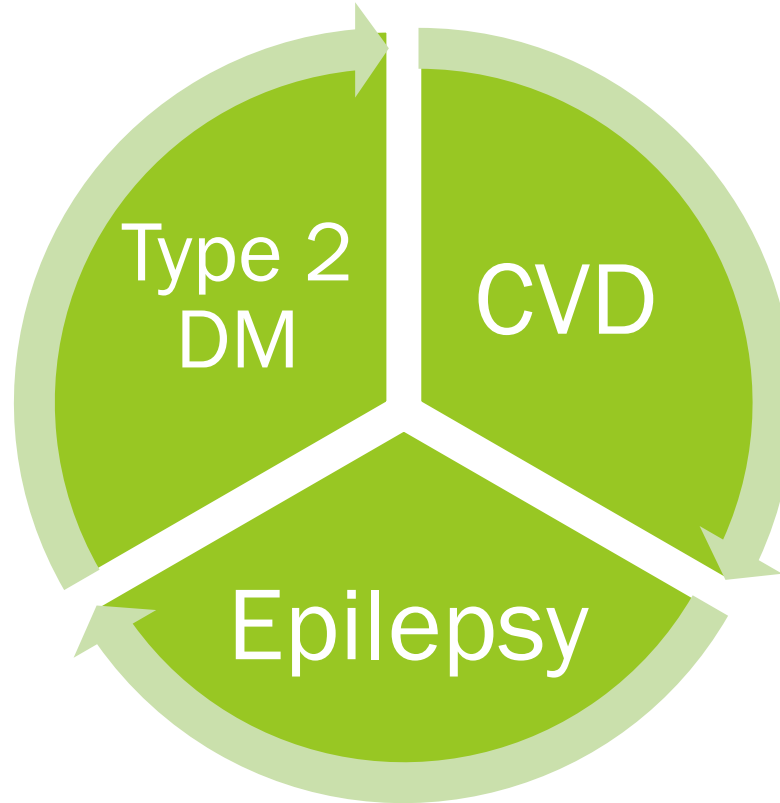


Simplicity in the Guidelines

# MORE ABOUT SATIETY

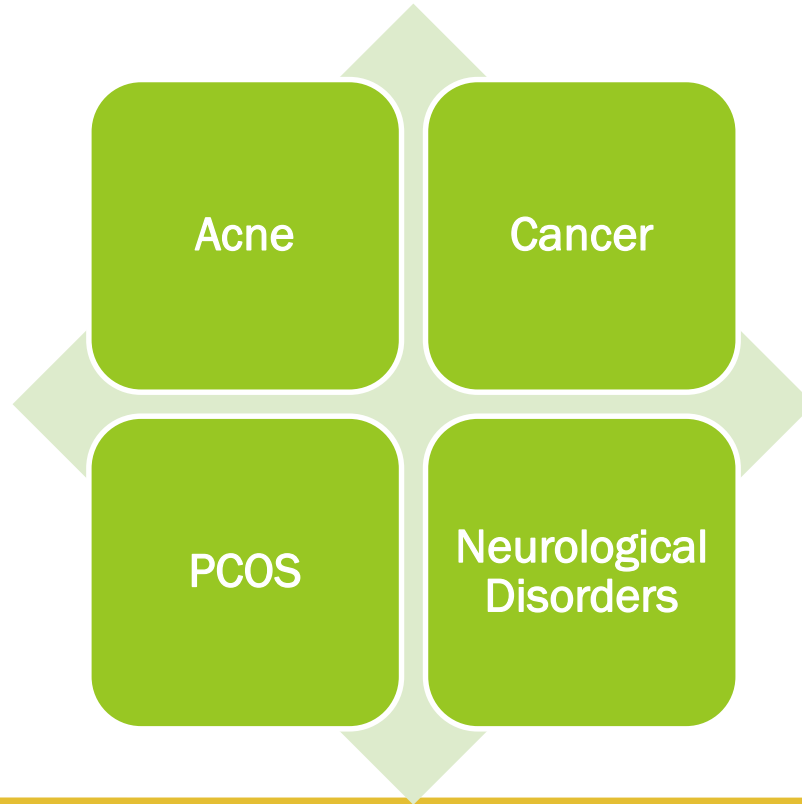
	Short Term	Long Term
Protein	+++	+++
Fat	+	++++
Carbohydrate	+	+
Fiber	++	++

# WHAT IS KETO USE FOR? STRONG EVIDENCE:





# WHAT IS KETO USED FOR? EMERGING EVIDENCE:




# TYPE 2 DIABETES

## Take away message:

- ❖ Not for Type I Diabetes
- ❖ Significant decreases in HbA1C, BG, TAG, LDL & BW
- ❖ Increase in HDL
- ❖ Still need a caloric deficit (>500kcal/day)
- ❖ No standard/Best Practice Guidelines to date
  - ❖ Most studies cut diabetic meds in half (not insulin)
  - ❖ Anywhere between 20-100g CHO per day were used
  - ❖ Still don't know the optimal macro range
  - ❖ How did studies confirm ketosis in subjects?

# CARDIOVASCULAR DISEASE (CVD)

- ❖ Results of a RCT with 120 overweight, hyperlipidemic volunteers over 24 week period
  - ❖ Test Group: <20g CHO, supplements, exercise & group meetings
  - ❖ Control Group: Low Fat Diet (<30% fat, <300mg Cholesterol, 500-1000kcal deficit, exercise & group meetings.
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# RESULTS

	Keto Group	Low Fat Group
Study Completion	76%	57%
% Weight Loss	-12.9%	-6.7%
Fat mass loss	-9.4kg	-4.8kg
Lean mass loss	-3.3kg	-2.4kg
Serum Triglycerides	-0.84mmol/l	-0.31mmol/l
HDL	0.14mmol/l	-0.04mmol/l
LDL	0.04mmol/l	-0.19mmol/l

# CARDIOVASCULAR DISEASE (CVD)

Ketogenic Diet can manipulate the blood lipid profile very well

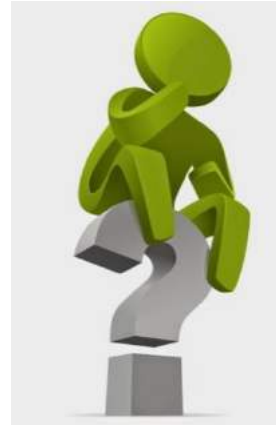
Can result in increased HDL and decrease in Triacylglycerols (TAGs) which is caused by a decrease in HMGCoA reductase (which is insulin activated)

Can increase the size and volume of LDL-C (collects everything and expels it later on)

Does not result in decreased Renal Function with individuals with normal renal function

# LOOKING AT THE RESEARCH!

- ❖ How keto is defined?
- ❖ What amount of carbohydrate induces ketosis?
- ❖ How is ketosis verified?

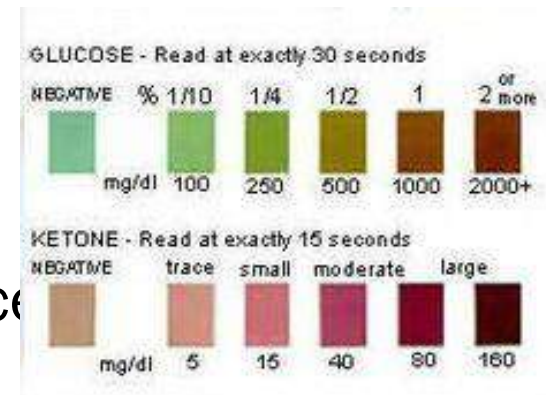


Currently, there is no standard protocol or guidelines for the ketogenic diet, thus each study uses their own definition of the ketogenic diet which makes assessment challenging. Not all studies have patients monitoring ketones or they are not all being monitored in the same way.

# TESTING FOR KETONES

## Urine Strips – Acetoacetate (AcAc)

- ❖ Measures un-used Ketones
- ❖ Measured with Colours
- ❖ Not the most reliable test
- ❖ AcAc can be used very effectively once
- ❖ More reliable in the beginning



## Variables

- ❖ Electrolyte and Hydration levels

# URINE STRIPS

## Pros

- ❖ Cheap and easy to administer

## Cons

- ❖ Not reliable long term, can get messy, decreased accuracy
- ❖ Must be consistent with timing and hydration



# TESTING FOR KETONES

## Blood Tests

Blood Meter – Beta-hydroxybutyrate

- ❖ BHB = Transport Ketone
- ❖ Measured in mmol/L



# BLOOD TESTS

## Pros

- ❖ Most accurate measure
- ❖ Best for long term adaptation

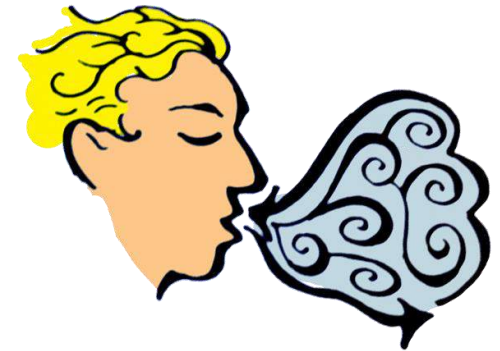
## Cons

- ❖ More expensive/ invasive

# TESTING FOR KETONES

## Breath Test – Acetone

- ❖ Indirect measure (correlates to BHB)
- ❖ Measured in parts per million/ ppm



# BREATH TEST


## Pros

- ❖ Reusable device, non invasive

## Cons


- ❖ Indirect measure, takes longer to get a reading vs blood/ urine

# WHO SHOULD BE CAUTIONED AGAINST KETO?

- ❖ Type I Diabetes
  - ❖ Type II Diabetes on insulin, sulfonylurea's or SGLT2.
  - ❖ History of disordered eating or eating disorder
  - ❖ History of mood disorders
  - ❖ History of GI disturbances
  - ❖ Alcohol abuse
  - ❖ Malnourished or at risk of malnutrition
  - ❖ Children and teens
  - ❖ Pregnant & Breastfeeding mothers
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# WHO SHOULD CONSIDER KETO?

(AS A THERAPEUTIC APPROACH)

- ❖ Newly Diagnosed Type 2 Diabetes (not on insulin)
  - ❖ Overweight and Obesity (no history of disordered eating)
  - ❖ Overweight /Obese with Type II Diabetes or CVD
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# MONITORING CLIENTS ON KETO

- ✓ The decision to try a client on a therapeutic Ketogenic Diet should be made in consultation with the Registered Dietitian and their Primary Care Provider.
- ✓ Care should be shared between the Dietitian and Physician as:
  - ✓ Medications may need to be adjusted by the Primary Care Provider
  - ✓ Blood work needs to be monitored and interpreted correctly

# DIETITIANS ROLE

- ✓ Dietitian will be key to planning a ketogenic Diet that is as nutritionally adequate as possible and to decrease potential for nutrient deficiencies.
- ✓ Dietitian can help client prevent/correct some of the side effects associated with ketogenic Diets
- ✓ Dietitian can help client choose best type of Ketogenic Diet to meet their needs.
- ✓ Dietitian will be key to helping patient's transition out of keto and onto a more sustainable long term diet without rebound weight gain and/or refeeding syndrome.

**Refeeding Syndrome can occur with a rapid increase in carbohydrate intake resulting in cellular uptake of Glucose, K, Mg, Phosphorus and water which can be life threatening.**



# IN CONCLUSION

- ❖ Long term research data is still lacking.
  - ❖ Keto is not a cure all for everyone and everything, should still be considered as a “Last Resort” diet after other less restrictive nutrition interventions have been exhausted.
  - ❖ There can be definite risks associated with ketogenic Diets.
  - ❖ Careful monitoring by a Primary Care Physician and Dietitian is extremely important.
  - ❖ Ketogenic Diets are therapeutic Diets NOT meant to be followed LONG TERM!!!!
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