

HOW TO GET THE RIGHT MEAL TIME INSULIN DOSE WITH TYPE 1 DIABETES



CHOOSE YOUR DIET - THEN YOUR DOSING STRATEGY

JOHN PEMBERTON | TYPE 1 DIABETES | REGISTERED DIETITIAN

WWW.DIABETICMUSCLEANDFITNESS.COM

ABBREVIATIONS

AA = Amino Acid

ADP = Adenosine Di Phosphate

ATP = Adenosine Tri Phosphate

AUC = Area Under the Curve

BCAA = Branches Chain Amino Acids

Ca = Calcium

CGM = Continuous Glucose Monitoring

FFA = Free Fatty Acid

FPU - Fat and Protein Units

GDH = Glutamate Dehydrogenase

GI = Glycaemic Index

GL = Glycaemic Load

GLP-1 = Glucagon-like peptide-1

GIP = Gastric Inhibitory Polypeptide

GPCR = G-Protein Coupled Receptor

I:G = Insulin to Glucagon ratio

ICR = Insulin to carbohydrate ratio

MDI = Multiple Daily Injections

MUFA = Monounsaturated Fatty Acids

KATP = ATP-regulated potassium channel

mTOR = mammalian target of rapamycin

SFA = Saturated Fatty Acid

TCA = Tri-Carboxyl-Acid cycle

CHANGING THE GAME: CHOOSE YOUR DIET FIRST - THEN CHOOSE YOUR INSULIN DOSING STRATEGY

First ask yourself these questions:

What diet do I currently follow, and what is the macronutrient split?

Do I keep my macronutrient split consistent at meal times, and from day to day?

Do I want to go low carb, medium carb, high carb?

Do I change my nutritional intake depending on the phase of physical training I am in?

Take inventory of what you regularly consume. Then decide what diet approach will suit you best. You can apply the best fit insulin dosing strategy. Don't be afraid to experiment, that's when you learn the most!

We will evaluate the most common dietary approaches, and see which insulin dosing strategy fits best.

GOVERNMENT AND DIABETES ASSOCIATIONS RECOMMENDATIONS

The ADA (14) and ISPAD (15) recommend a nutritional intake of:

- 50% carbohydrate
- 30% fat
- 20% protein
- Low GI
- Starchy wholegrain foods
- At least five fruit& vegetables a day
- Choose MUFA and keep SFA low
- Keep sugar less than 5-10% of total energy

The reason why all the governments and agencies promote this type of intake is because:

The wealth of research evidence resoundingly supports that this type of intake gives the best chance for a healthy disease free life.

If you were to believe the "guru bloggers", you would think all the governments and diabetes associations are conspiring against people with type 1 diabetes. Reality check! This type of intake is based on very sound evidence. It is not a conspiracy, it's sound science.

A diet that is 50% carbohydrate will provide the necessary fast burning fuel to optimally power:

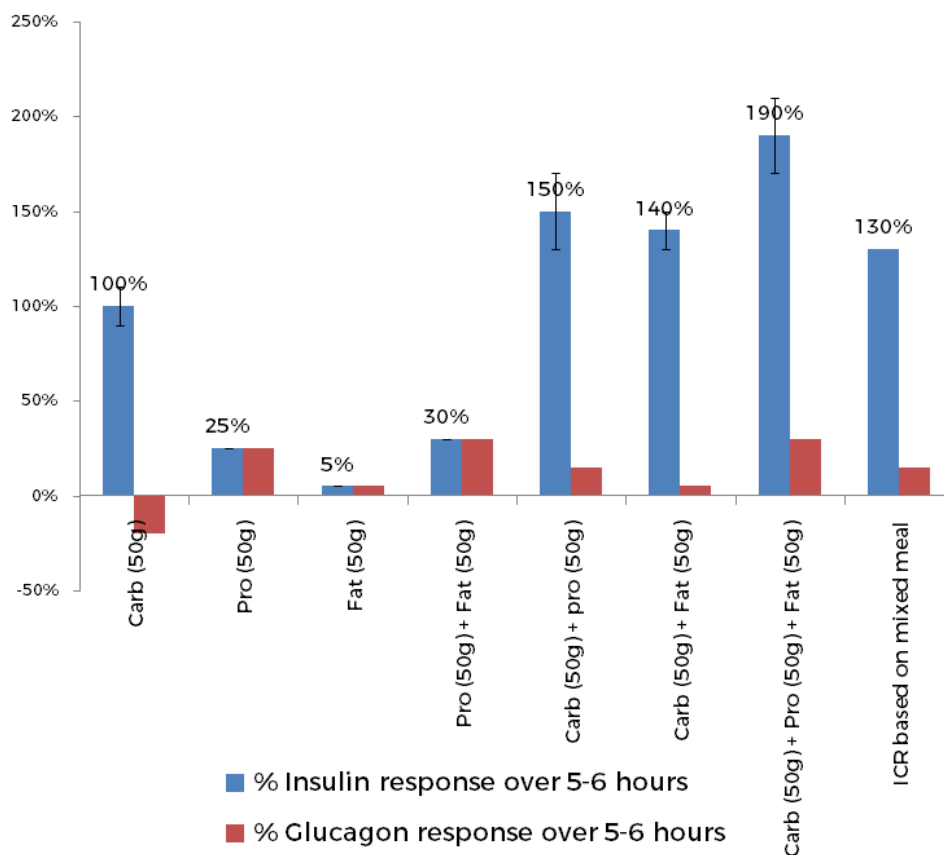
- Fast paced sports activities such as football, basketball, rugby, netball, tennis, rowing.
- Resistance exercise to promote strength and muscle growth.
- Endurance activity where optimal performance is the main goal. Events such as competitive running, triathlon and swimming.
- Recovery from exercise.

That being said, it is challenging to attain a HbA1c of <6.5% (48mmol/l) eating 50% of energy intake from carbohydrate. It can be done if you;

- Choose mainly low GI options.
- Have a good daily level of physical activity.
- Test blood glucose regularly and correct frequently.
- Deliver meal time insulin 15-30minutes before meals.
- Plan exercise effectively and replace carbohydrate when you are most sensitive to insulin.
- Regularly monitor and change your diabetes regime according to your results.

Here are some tips to get your insulin dose as accurate as possible.

Consistency is the key to getting good diabetes control when carbohydrate counting. Keep your macronutrient split and amounts consistent, then just count the carbohydrate and give the insulin based on your ICR. Remember from the graph below that usual mixed meal ICR accounts for about 130% of the effect of carbohydrate.



- Working out your ICR for your usual mixed meals.
 - **Breakfast:** If you calculate your ICR for cereal with milk, which is usually about 50g carb, 15g protein, 10g fat, the ICR will work for breakfasts of that composition. If you change to toast, bacon, sausage and egg, that is 20g carbohydrate 30g protein, 30g fat, you will certainly have a high glucose reading if you only bolus for the carb amount using your ICR!
 - **Lunch:** If you calculate your ICR for sandwich, yoghurt, crisp, which is usually 50g carb, 20g protein, 20g fat. The lunch ICR will work for meals very similar to that. When you change to salad with a lot of protein and fat dressing (Caesar Salad), which is 10g carbohydrate, 30g protein, 20g fat, you have the same problem as breakfast.
 - **Evening meal:** If you calculate your ICR for meat, potatoes and vegetables, which is usually 50g carb, 25g protein, 20g fat. When you change to heavily cheesy pizza, which is 50g carb, 35g protein, 40g fat, you can expect very high reading for a prolonged time. The other way round, what happens if you establish your ICR on consuming high protein and fat foods for evening meal such as Pizza, Lasagne, Cheesy pasta. When you decide to go for the meat, two vegetables and potatoes you go hypo!
 - **Snacks:** If you calculate your ICR for snacks on a breakfast bar or crisps, which is usually 15g carb, 1-5g protein, 10g fat. When you change to fruit only, which is 10-15g carb, 0g protein, 0g fat, you can expect a hypo if you use that ICR.

If you decide to change the fat and protein amounts significantly, you must expect high and low blood glucose levels, unless you make allowances. Below are some simple suggestions on how you can make allowances.

- What do you do when you go outside the norm with high fat and protein, such as a pizza? You can use the latest research review(73) suggestion:
 - If protein is 40g or more and carbs are at least 30g, add an extra 15-20% insulin and give before meal.
 - So a 10 unit bolus would become a 12 unit bolus.
 - Easy equation, insulin dose x 1.20
 - When a meal is more than 35g fat and is at least 30g carbohydrate, add 30-35% extra insulin, and spread the insulin out, 50% upfront, 50% later.
 - So a 10 unit bolus would become a 13.0 unit bolus. If on a pump use a dual/split/combo/multiwave wave bolus. If injections give one injection of 7 units before eating, followed by another of 6.5 unit injection in one hour's time.
 - Easy equation, insulin dose x 1.3 then divide by 2

- When you have a meal that is at least 30g carb, at least 40g protein, and at least 35g fat, you need to add 50% extra insulin and spread the insulin out, 50% upfront, 50% later.
 - So a 10 unit bolus would become a 15unit bolus. If on a pump use a dual/split/combo/multiwave wave bolus. If injections give one injection of 7.5units before eating, followed by another of 7.5unit injection in one hours time.
 - Easy equation, insulin dose x 1.5 then divide 2
- What do you do when you have a carb only meal that is less than 5g protein and fat. You could reduce the insulin dose by 30%, considering the ICR accounts for 130% of the carbohydrate alone.
 - A 10unit bolus would become 7 units
 - Easy equation insulin dose x 0.7
- If you choose lower glycaemic index options, you will get better diabetes control (73), whilst providing your body with the vitamins and minerals it needs. If you switch from high to low GI meals, you may need to reduce your dose by 20% to prevent hypoglycaemia (74,75).
- More MUFA as less insulin resistance (70). So choose olive oil instead butter etc.

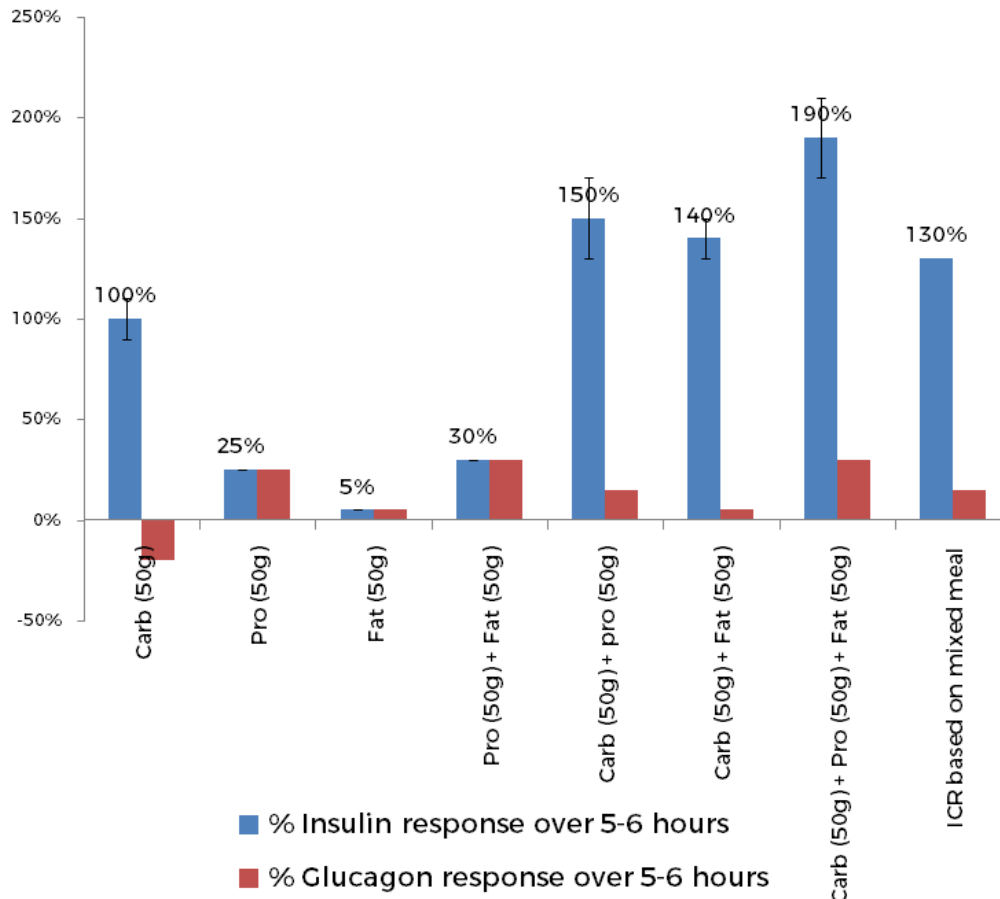
HIGH PROTEIN MODERATE TO LOW CARBOHYDRATE DIETS

The usual make up of this type of diet is protein at 1.5 - 3.0g/kg/day, moderate to low carbohydrate of 50-200g per day, and moderate to high diet. For example, Zone Diet or a physique athlete cutting diet.

There is going to be a significant increase in the insulin requirement from protein with this type of intake. More than can be accounted for by counting carbohydrate alone. Therefore the best approach would be to look at the work of the FII and count the insulin demand as:

- Insulin demand = carbohydrate (g) + (protein (g) x 0.5)

This also mirrors the effect of high protein and moderate carbohydrate meals for the graphical model developed.



You would then need to relax your current ICR to prevent hypos. Relaxing the ratio by 20% would seem like a sensible place to start, considering the ICR is already based on 130% of the effect of glucose.

1. For example, if your ICR is 1unit for 10g carbs, make it 1units for 12g insulin demand.
2. Easy equation; $ICR \times 1.2$

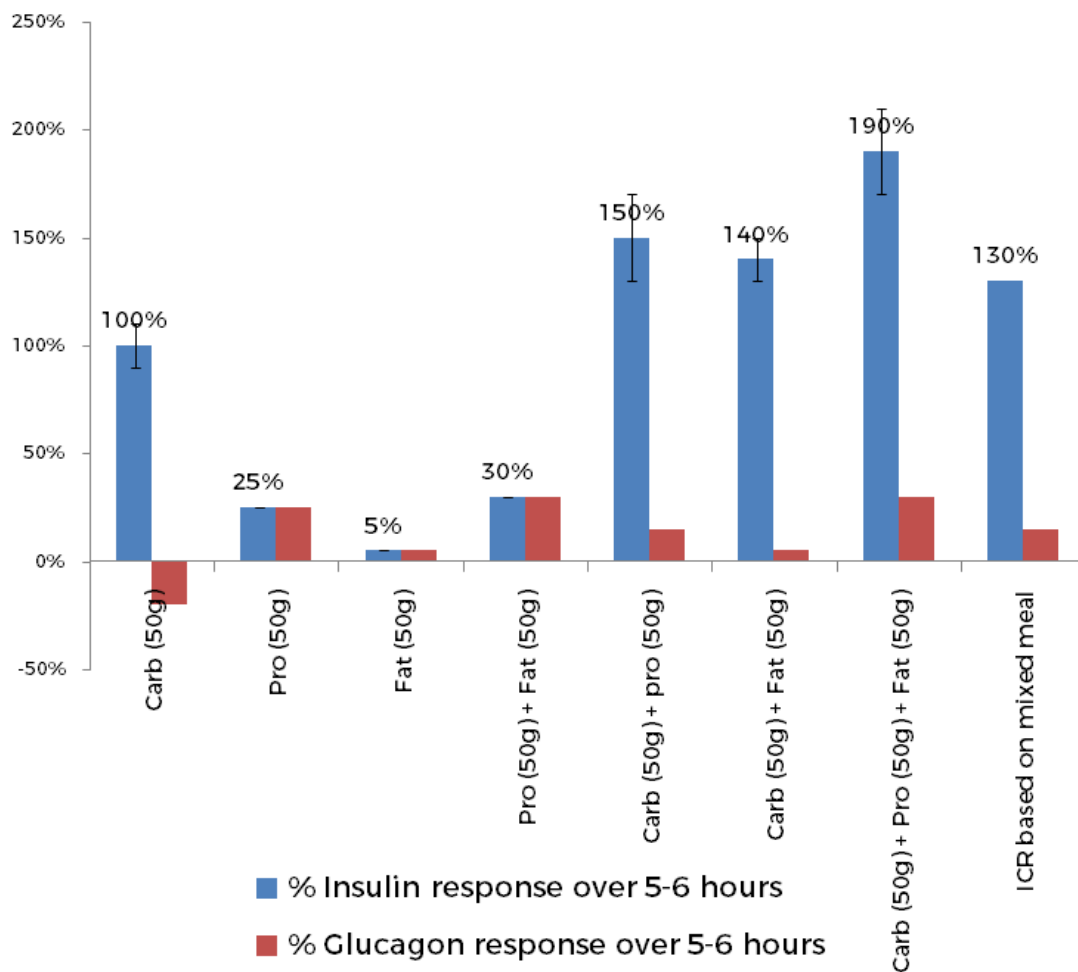
This will prevent too many hypos at the offset. You should adjust your ICR from monitoring.

Some tips that will help if following this approach:

- Consistency rules! Try and keep your protein portions distributed equally from meal to meal. for example 25-40g portions three to four times per day.
- If using Whey Protein you may need more insulin than expected as whey protein is very high in Leucine.
- If you choose lower glycaemic index options, you will get better diabetes control(73), whilst provide your body with the vitamins and minerals it needs.
- More MUFA as less insulin resistance (70). So choose olive oil instead of butter.

VERY LOW CARBOHYDRATE DIETS - LESS THAN 50 GRAMS A DAY

For people choosing to go very low carbohydrate, the insulin requirement for protein and fat is much lower than when they are combined with carbohydrate. Following the research summarised in the graphical model below, only 25% of the protein will need to be considered when insulin dosing, with very little effect from fat, which will most likely be covered by the background/basal insulin.



A formula that may be worth starting with is

Insulin load = carbohydrate (g) + (protein (g) x 0.25)

You could then apply your ICR to get an insulin dose.

People following this type of approach are generally in two camps:

- A Dr Bernstein style approach, which is typically high in protein >2.0g/kg/day, carbs aiming for maximum 24g per day, and the rest made up with fat. You are **UNLIKELY** to get into nutritional ketosis with this approach, because the protein intake, and therefore insulin delivery, is too high.

- A nutritional ketosis approach which is much lower in protein, usually 0.6-1.2g/kg/day, and 70-80% of the total energy coming from fat. Protein is lower is to keep the insulin low. This allows the body to up regulate its metabolic machinery to oxidise FFA and ketones as the major fuel source.

The difference in protein levels between the two approaches is very important. The Dr Bernstein style does not aim to achieve nutritional ketosis. It has a much higher protein intake aiming to stimulate anabolism. Whereas nutritional ketosis has a much lower protein and insulin intake, with the aim of increasing production of ketone bodies by the liver.

WHY IS THIS IMPORTANT?

Nutritional ketosis is not recommended for people aged under 18 years. A recent research review on children in prolonged nutritional ketosis to treat refractory epilepsy reported (72):

- Increase risk of faltering growth, that catches up when nutritional ketosis is stopped.
- Abnormal lipid profiles linked with increased risk of cardiovascular issues.
- Kidney stones.

DOES THIS MEAN LOW CARBOHYDRATE DIETS SHOULD BE AVOIDED FOR CHILDREN WITH TYPE 1 DIABETES?

It is clear if children are constantly in nutritional ketosis, it's not good for health (72). However, the vast majority of children following the Dr Bernstein approach have protein intakes way too high to achieve nutritional ketosis. A big mistake is believing all low carbohydrate approaches are the same. Therefore also believing all low carbohydrate approaches must be detrimental to children with type 1 diabetes.

Is the low carbohydrate approach better for managing diabetes, and is it safe in the long term?

The evidence is sparse to say the least.

Proof of concept that low carbohydrate diets of (<50g) improve blood glucose control was provided recently in a cross over study, Ten adults with type 1 diabetes followed a high carb diet (>250g) for a week, then a low carb diet for week (<50g). Both diets had the same energy intake. They were monitored by CGM which showed for low carb vs. high carb:

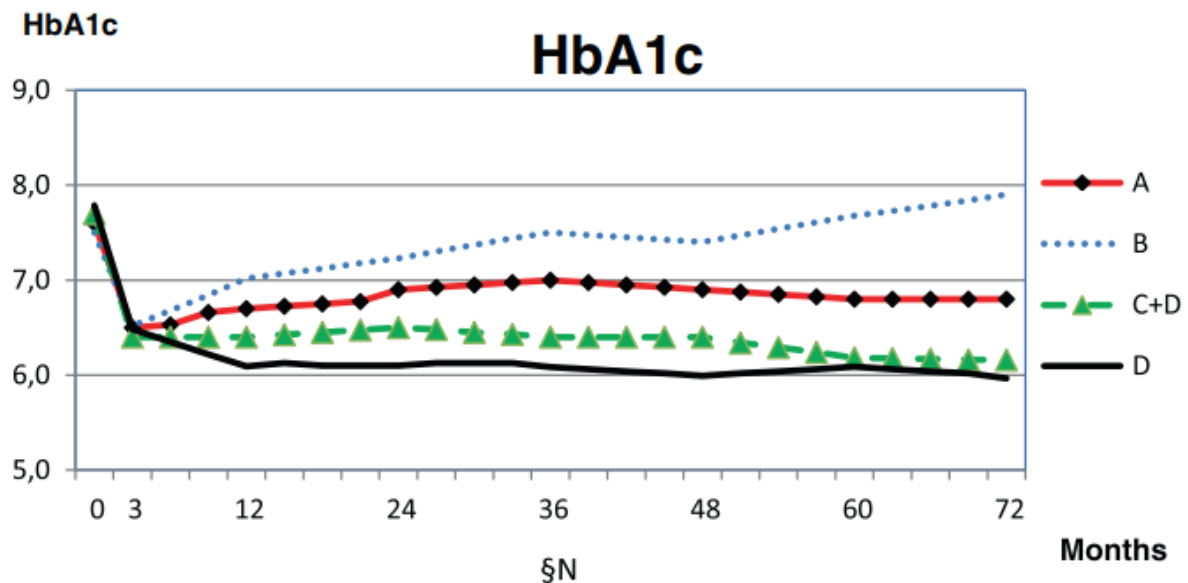
- 3.9mmol/l to 10.0mmol/l: 82% vs. 72%
- <3.9mmol/l: 3% vs. 8%

- Standard deviation: 1.9mmol/l vs. 2.6mmol/l
- No difference in blood lipid levels
- Higher fasting glucagon levels for low carb
- Diet adherence was very high for both diets

These show that in the short term low carb diets improve blood glucose control. But the real question is, what are the long-term effects, and can people stick to a low carb diet for life?

Only one study (81) has any meaningful data on this. A group of 48 adults with type 1 diabetes were educated on how to safely consume a diet of less than 75g of carbohydrate per day. They followed them up at 3 months, 3 years and 4 years. The below graph shows what happened to their HbA1c, depending on their adherence to the diet:

- A = All 48 people
- B = Non-adherent to <75g carbohydrate
- C = Partially adherent to <75g carbohydrate
- D = Adherent to <75g carbohydrate



A	48.....	23	7
B	25	10	3
C+D	23	13.....	4
D	13	8	3

Copied from (81)

The main points to understand from this study are:

- If you fully adhere or partially adhere to a low carbohydrate approach, you will get a sustained drop over four years in HbA1c of 1.8% and 0.7% respectively.

- Only 27% of people can fully adhere to low carb, whilst an additional 21% can partially adhere.
- The 27% who adhered actually improved their lipid profile. A significantly better TC:HDL, with no increase in other complications. The authors used micro vascular and cardiovascular algorithms to predict the low carb adherers reduced their risk of both sets of complications by 20-40%.
- The low carbohydrate adherers reduced their total bolus insulin by 10 units, but background insulin remained the same.

The very limited data suggests a few things. If you are an ADULT and you adhere to a low carb diet, you will very likely improve your HbA1c and complications risk. However, sticking to the diet is going to be a challenge, as only one in four can.

WHAT ABOUT CHILDREN?

A recent report on six children following a low carb diet concluded, children following a low carbohydrate are at increased risk of (84):

- Faltering growth
- Cardiovascular disease
- Social issues

On reading the case reports a few things became evident about the six children.

- They all had inadequate energy intake
- It was not clear if they were in nutritional ketosis
- They were high concern patients across several different centres in Australia

The case reports show clearly that a poorly formulated low carbohydrate diet is a major issue for children. However, the case reports do not make clear if a high protein, adequate energy, and well formulated low carbohydrate diet is detrimental.

The honest answer is nobody knows, because it has not been studied properly! An observational study of the on the TYPE ONE GRIT (Dr Bernstein approach) group has just been completed by Boston Children's Hospital (83). It will be very interesting to read the findings!

There are a few big questions I hope Boston Children's Study will answer:

- Is there faltering growth an issue with adequate energy high protein low carb diets that DO NOT achieve nutritional ketosis?
- Are there detrimental lipid profile changes?
- If the lipid profile is deranged, is that off-set by keeping HbA1c below 6%?
- What is the social impact?
 - Does restricting food choices have a negative impact on social development?

- Does having excellent control with less hypos and more predictability improve confidence in living with diabetes?
- Is there an acceptable off for the above two?

It must be time to research this systematically. This is something Dr Jake Kushner of Texas Children's Hospital is pushing for. He is worth checking out if this topic floats your boat.

I make sure I keep an open mind. It is easy to project our fears, concerns and misconceptions of evidence about low carb diets. It is impossible to be certain that low carb diets are the best or worst for people with type 1 diabetes.

Why?

BECAUSE THE RESEARCH HAS NOT BEEN DONE YET.

A low carbohydrate diet will very likely improve diabetes control for the average person with type 1 diabetes. However, it is important to consider other lifestyle factors when choosing a nutritional strategy. Some very likely situations that a low carb diet will not be optimal for:

- Anyone who plays a sport that requires fast bursts of energy, such as football, basketball, HITT training etc. Notice it says OPTIMAL. You can do these activities on a low carb diet, you just will not be as explosive, and therefore as good.
- Anyone who wants to compete at their best in endurance events such as half marathon, triathlon and cycling races. Again, these activities can be done on a low carbohydrate diet, there is no doubt. A low carbohydrate diet will certainly achieve better blood glucose control during the activity. However, without adequate muscle glycogen stores, the muscles will not be able to create energy at a high enough rate to perform optimally.
- Anyone wanting to gain significant amounts of muscle in a bulking phase. You need the insulin stimulus and glycogen stores for anabolism, and carbohydrate to fuel hard training, and support recovery (25).
- Anyone who likes to eat carbohydrate foods. They would find it very challenging in social situations. The low carb Dr Bernstein group call themselves GRIT for a reason, and that has to be understood and respected.

As an adult if you decide to follow a nutritional ketosis approach, you may want to cycle in and out of nutritional ketosis to prevent hormonal disturbances, such as thyroid issues.

Here are some tips for adults choosing to follow nutritional ketosis.

- Keep protein to 0.6 - 1.2g/kg/day
- Have predominantly MUFA will help against insulin resistance

- Maximise the low carb greens such as spinach, broccoli, sprouts etc..
- Be consistent if you want good control
- Measure your blood ketone levels to see if you are actually in nutritional ketosis.
 - A ketone level of 0.6-3.0mmol/l would indicate you are in nutritional ketosis, as long as your blood glucose is also in target(3.5 - 8.0mmol/l).
 - A ketone level greater than 5mmol/l with blood glucose higher than 10mmol/l indicates you do not have enough insulin on board. You may be on the way to DKA, you need more insulin.
- Above all, do plenty of reading and homework before starting a diet aiming to get into nutritional ketosis. Don't just do it because the in vogue guru thinks it's the best thing since sliced bread. Some key things to read would be:
 - [The Art and science of Low Carbohydrate Living](#)
 - [The Art and Science of Low Carbohydrate Performance](#)

SUMMARY

You can choose any diet type and achieve first class diabetes control, but only if you think like a B-Cell. This document has provided you with that level of thinking.

The contentious issue for most people with type 1 diabetes is;

Should I go low or high carb?

To answer the question you need to ask:

- What are my diabetes management goals?
- How important is OPTIMAL exercise performance?
- How much time am I willing to invest in managing my diabetes?
- How will I cope with being restricted in social situations?

A person who would suit a lower carbohydrate approach would say:

- I want the lowest HbA1c possible, less than 6.0% (42mmol/mol).
- I am happy with average exercise performance. It's a worthwhile trade-off.
- I do not want to spend too much time checking my glucose level after eating.
- I am happy with restricted food options in social situations, because then I do not have to worry about my diabetes control.

A person who would suit a higher carbohydrate approach would say:

- I am satisfied with a HbA1c less than 7.0% (52mmol/mol).
- My focus is on optimal exercise performance. I am happy to trade this for a slightly higher HbA1c.

- I am happy to take more after meal glucose readings, correct with insulin, and spend more time in reviewing and making changes.
- I want the freedom at social situations to eat and drink what I desire, even though I know there will be blood glucose consequences.

Whichever nutritional approach you choose, this article has provided you with necessary skills. It's now time to experiment.

To make your experimentation easy, I have developed an excel calculator that incorporates all of the knowledge and formulas we have worked through. You simply enter your carbs, fat protein, and ICR ,and then voila, the calculator presents you with all of the insulin dosing options.

Visit the Bolus Wizard section on the members site to try the calculator and watch the video of how to use it.

CONCLUSION

It would be nice if all you had to do was count your carbs, use an ICR, and everything will be ok. But the reality is you cannot! Well you can, but just don't expect good diabetes control.

Respect the fact that your current ICR's are set for the insulin requirement for your usual mixed meals. If you keep to consistent amounts of carbs, fat and protein at meal times, your ICR's will work. . When venturing outside your usual meals, increase or decrease the insulin accordingly, and spread the delivery for very high fat meals.

You must change your insulin dosing strategy to include protein counting if you follow a high protein diet this is moderate to low in carbohydrate. If you decide to try the Dr Bernstein or Ketogenic diet, you will need to account for a small amount of protein when insulin dosing.

This document and the calculator offer a great starting point. It's now time to take some action and start experimenting. One tool that will prove invaluable in your experimentation is CGM. CGM will give you immediate feedback on what does and does not work.

If you often say; diabetes is really hard to manage, I never get my meal time doses right, it's like having a crap part time job, my friends don't have to deal with the grind. Consider this:

There has never been a better time to have Type 1 Diabetes. There is quick acting insulin, pumps, CGM, downloads, and an abundance of quality information and research. Sure a fully closed loop system, or stem cell therapy would be great! But that's not available yet. Make the most of what's available, and meet the challenge head on, with a big smile!

