Therapy Services

Department of Nutrition & Dietetics

A Guide to the Principles of

Carbohydrate Counting

for the Pen Therapy Management of Type 1 Diabetes

Imperial Centre for Endocrinology

Carbohydrate Counting
As easy as 1, 2, 3

A guide to the principles and practicalities of carbohydrate counting.

Introduction

For people with Type 1 diabetes, the adjustment of insulin doses in relation to carbohydrate intake is essential for the effective management of blood sugar levels.

Modern insulins provide a response to the rise in blood glucose more similar to physiological insulin production. By counting carbohydrate, the patient is able to 'think' for their pancreas. They learn to predict the rise in blood glucose after the consumption of specific types and amounts of carbohydrate (as well as taking into account activity levels, etc.) and give appropriate insulin doses.

This booklet aims to give you a practical guide through the process of Carbohydrate Counting and insulin dose adjustment for patients using pen therapy.

Carbohydrate counting

90-100% of digestible carbohydrates (sugars & starches) are released into the blood, causing a rise in blood glucose within 15 minutes to 2 hours. We need to match this rise with the right amount of insulin.

The aim of **carbohydrate counting** is to allow patients to enjoy more "**dietary freedom**" to choose, within a normal balanced diet, whatever type or amount of carbohydrate they wish to eat and vary the timing of meals and snacks, but be able to adjust insulin doses accordingly so that blood glucose levels are kept within target.

This can be achieved once the background insulin is appropriately determined and is providing 24-hour cover. **Humalog and Novorapid** are usually the most appropriate for covering the glycaemic load from carbohydrate due to their quick and short duration of action.

This approach requires the patient to take more time to learn about the foods they eat; where carbohydrate comes from, and how much carbohydrate there is in different foods. They will also need to look at the doses of insulin taken and the blood glucose responses to meals.

There are specific ways to calculate the **RATIO** of insulin per carbohydrate serving required on an individual basis. Patients need to test this by monitoring blood glucose responses. With time they can become very familiar with their carbohydrate intake so that the process of adjusting insulin doses becomes second nature.

Advantages of carbohydrate counting are:

No need to :

- ✗ Eat strict amounts
- ✗ Eat at set times
- ✗ Avoid 'sugary' foods
- ✗ Snack to avoid hypoglycaemia

It is possible to:

- ✓ Vary meal times & skip meals/ snacks
- ✓ Enjoy restaurant meals/takeways
- ✓ Predict blood glucose responses to different foods
- ✓ Enjoy a wider variety of foods
- ✓ Avoid feelings of guilt when eating 'forbidden' 'sweet' foods

Gaining weight

Some people are anxious that the concept of 'Food freedom' will encourage an unhealthy diet and excessive weight gain. Achieving good blood glucose control is the key to being healthy with diabetes and the process of carbohydrate counting can help this to be achieved.

You may also want to consider the fat, fibre and overall nutrient content of your patient's diet.

Weight gain or loss is determined by balancing food & exercise.

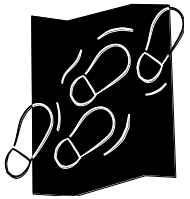
Potential Reasons for Weight Gain

- Eating more/larger servings
- Eating higher calorie foods (chocolate, biscuits, etc.)
- Forgetting about healthy eating
- Feel better - more exercise - muscle vs fat
- Efficient glucose storing
- Underlying medical problem

Potential Reasons for Weight Loss

- Less insulin
- Fewer snacks - less insulin
- Skipping meals/smaller servings
- Eating to hunger rather than to treat hypos
- Feel well - more exercise

1) Steps to successful carbohydrate counting



2) Identify foods containing carbohydrate
3) Calculate TOTAL carbohydrate content of meal/snack and convert into number of CPs
4) Consider factors that may influence blood glucose response (e.g. fat, glycaemic index)
5) Calculate insulin required
6) Consider pre-meal blood glucose (is a correction required?) and consider planned exercise/activity.
7) Give insulin bolus
8) Record blood *glucose response*

Where do you find carbohydrate?

Carbohydrate is found in two main forms: **sugars** and **starch**.

Sugars

Granulated sugar (raw, invert, cane, brown and white) contains ***Sucrose***, which is quick acting. Foods that have this as 'added sugar' like cakes, biscuits, chocolate & other confectionary, jams & preserves, sweet puddings, jelly & soft drinks will increase blood glucose levels. These foods often contain little fibre and lots of fat so they are not recommended as every meal foods.

Fruit (fresh, dried, tinned & juice) contains sugar called ***Fructose***, which will affect blood glucose levels, however, it also contains fibre to help slow digestion and vitamins for health. Milk and diary foods like yoghurt, fromage frais & ice cream also contain a sugar called ***Lactose***, which has to be taken into account. Dairy foods are also important providers of protein and calcium.

Starch

Complex or starchy carbohydrates are made up of glucose units but they are held in a complex structure. They also generally contain more fibre, vitamins and minerals which means they are more nutritious than carbohydrates containing 'added sugar' (sucrose).

They include potato, rice, pasta, noodles, bread, breakfast cereal, oats, couscous, corn, lentils & legumes and anything made with flour such as pizza, pastry, biscuits & buns, crackers and thickened sauces and soups.

Starchy foods are excellent choices but the effect on blood glucose levels will depend on the quantity eaten and the carbohydrate load (grammes per serving). A pound of grapes or a loaf of bread the effect might be similar to having eaten a chocolate bar – the effect on blood glucose is amplified by increasing the quantity.

A Summary of Carbohydrate Sources:

- **Cereal derived starch products:** breakfast cereals, grains, bread, rice, pasta, couscous, flour based products [pastry, biscuits, cakes], thickening agents [eg. cornflour]
- **Vegetable starch:** potato, legumes [lentils, beans, peas]
- **Fructose:** fruit, fruit juice
- **Lactose foods:** milk, yoghurt, ice cream, custard
- **Sucrose (added sugar):** table sugar, syrup, chocolate & other confectionary, ordinary soft drinks.

And Alcohol?

Alcohol is made by fermenting either sugar or starch. Pure alcohol alone does not raise the blood glucose; it is the remaining starch or sugar, fruit and addition of sugar-based flavours that increase the carbohydrate content of the drink. The carbohydrate content of different drinks is found in separate tables accompanying this booklet. Giving a normal insulin dose for this carbohydrate is not usually recommended because of the risk of hypoglycaemia.

If a consistent problem of hyperglycaemia is observed after drinking then the patient may benefit from giving **half** the usual units per CP.

For example:

4 pints of beer contain 40g carbohydrate (4CPs) so give 2 units if on 1 unit per CP ratio. The blood glucose responses need to be carefully monitored, particularly before bed and the next morning. Because there is a risk of hypoglycaemia during the next morning the breakfast insulin may need to be reduced by as much as 50%.

Remember!

Alcohol can affect the ability to recognise a hypo and can impair reasoning. Care needs to be taken when calculating insulin doses when drinking.

Skipping meals

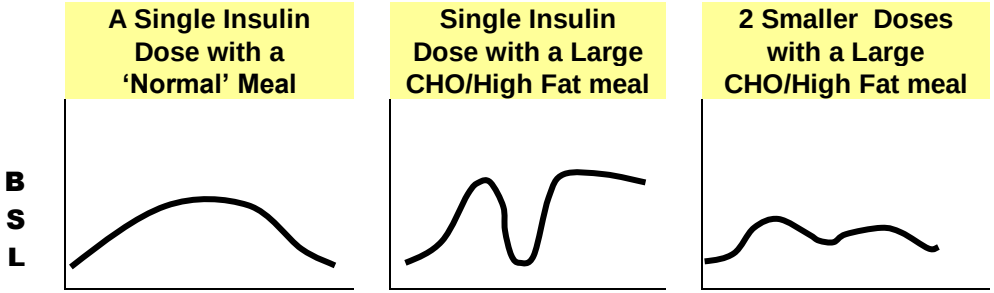
It is possible to do this when the background insulin is correctly determined. Fast-acting insulin is then only given when carbohydrate is eaten/drunk. It is not healthy to skip meals too often. Remember to encourage an overall well balanced diet.

What about high fat foods?

As a general rule, high fat foods should be limited or recipes modified as they are high in calories and can contribute to weight gain and heart disease.

Fat can slow digestion of a meal and make blood sugar levels rise more gradually over the few hours following it. High fat foods could include fish & chips, hamburger & fries, oily Chinese, Indian or Italian pasta meals.

A single dose of insulin may reduce the blood sugar level too quickly, risking hypoglycaemia followed later by a high reading. This is because the rest of the meal is being digested and glucose continues to be released into the blood stream. It may be best to split the dose into two injections with a high fat meal and with a very large carbohydrate intake as described before.

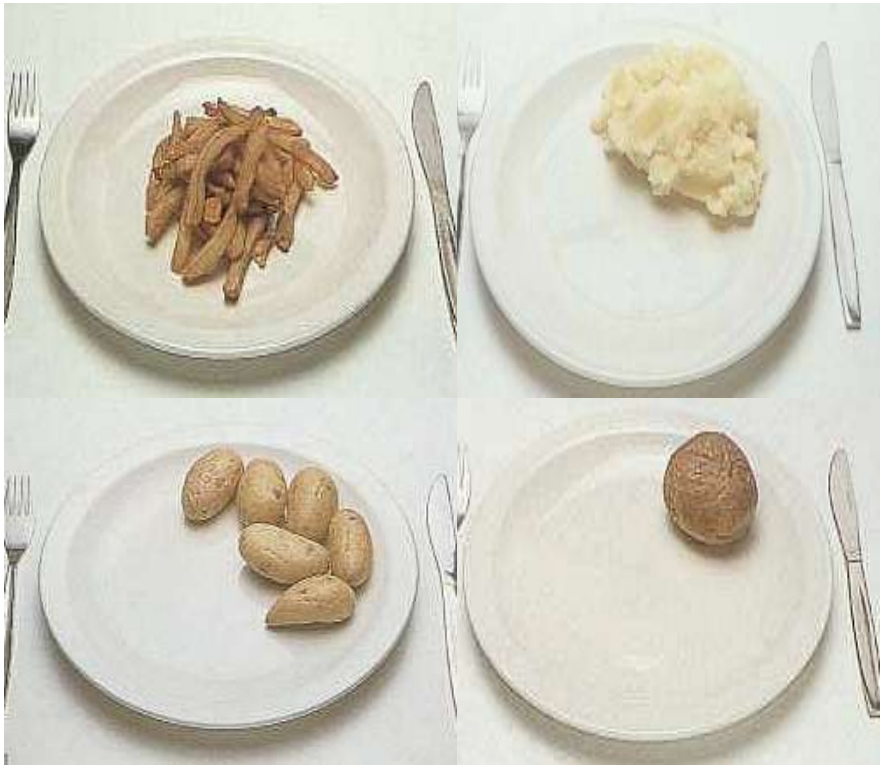


Food contains different amounts of carbohydrate

Carbohydrate varies according to cooking method and other aspects of food composition and preparation. For example, fruit contains 10-20%carbohydrate, while breakfast cereals range from 50-95% carbohydrate.

It is important for patients to understand that the weight of food does not = carbohydrate value.

Potato is another example. Each of the pictures below show 40g of carbohydrate in 4 potato dishes – note how the size of the serving varies according to the different way the potato is prepared.



Working out the carbohydrate of meals

Tools for Counting Carbohydrate

- Scales, cups, spoons
- Food tables
- Food labels
- Food photographs

The CP (Carbohydrate Portion) System

A CP = 10g of carbohydrate

A **CP** contains approximately 10g carbohydrate (similar to 'exchanges' or 'lines' used in the past). Add up the CP portions in a meal or snack using the CP list or by adding up the total grammes of carbohydrate and dividing by 10.

The insulin needed per CP is determined in conjunction with the health care professional by using the **'500 rule'** and by monitoring blood sugars responses.

On average 1 CP (10g carbohydrate) can raise blood sugars by 2-3mmol/l but the effect is individual.

Food tables

Patients should be provided with carbohydrate reference tables. These list types of carbohydrate foods with a typical serving size and how many CPs in that serving. Eg:

FOOD ITEM	TYPICAL PORTION	CPs	CHO PER 100G*
Apple Juice	80ml	1	12.5
Eating Apple	Medium (120g)	1 ½	12
Stewed Apple – No sugar	6 Tablespoons	1	8

**It also lists the reference value. This is the amount of carbohydrate per 100g. This can be used to calculate the carbohydrate value in weighed portions. The values are based on average calculated values and can vary between individual products so it is important to also to refer to product specific food labels.*

Corrective doses

Extra insulin can be given to correct high blood glucose levels above target in addition to that needed for the carbohydrate eaten. The corrective dose is worked out individually using the ***100 Rule.***

Divide 100 by the Total Daily Insulin Dose

For Example:

As before TDD is calculated as 26 units. 100 ÷ 26 = 3.8 mmol/l

We would say that this person can expect a unit of insulin (fast acting) to reduce their blood sugars by 4mmol/l.

This is useful if the patient misjudges the amount of carbohydrate in a meal, they can correct at the next one. If frequent corrective doses are given, there may need to be a change to the insulin: CP ratio or background insulin.

Giving the insulin bolus

The insulin dose should usually be given as one dose at the beginning of a meal/snack. Some people prefer to wait until the end of their meal to be sure of the amount they are eating.

In some circumstances two smaller doses can be given, one at the beginning and the second during or at the end of the meal. Whether to give one dose or two is determined by a number of factors: meal size (large CP value), composition and timing of courses.

For example, when eating out meals come in different courses, with differing amounts of carbohydrate. Some people take insulin with the main course once they can see how much carbohydrate it (& the starter) contains and again at dessert. This ensures they give the correct dose for what they have eaten.

Calculating the insulin doses

The amount of insulin required for carbohydrate is described as units per CP. **Typical range is ½ -3 units per CP.**

This is worked out on an individual basis and takes into account insulin sensitivity. It is usual for most patients to start on a 1 unit per CP ratio and then adjust according to blood sugar responses.

Another way of determining the ratio or for circumstances where it seems that a different ratio is needed is the ***50 Rule.***

50 Rule

Divide Average Total Daily Insulin Dosage (meal & background insulin) **by** 50 to give units of insulin per CP

Example:

If a persons total daily insulin dose = 26 units

26 ÷ 50 = 0.52 say 0.5 or ½ (round down insulin doses to begin with). So this person could try a **½ unit per CP**

To test the bolus ratio it is useful to check the blood glucose responses before the next meal.

When testing responses, it is important that the carbohydrate is calculated correctly and that the patient hasn't exercised or experienced a hypo on that day

Weighing foods

It is useful for patients to weigh portion sizes to start with to get an accurate assessment of the carbohydrate content of foods with varying portions sizes such as potato, rice and pasta. They can then use "handy" measures such as scoops or cups to estimate the content of future meals.

It is important to use the right value e.g. for either cooked or dry weight foods. Remember rice & pasta absorb water when cooked and the portion weighs more while a baked potato loses water and shrinks in size after cooking.

Example:

A portion of cooked rice weighs 200g

In the reference tables 100g cooked rice has 30g carbohydrate

This portion has: **2 x 30g = 60g Carbohydrate or 6 CPs.**

It is now possible to count how many cups or spoons this portion contains in order to work out the carbohydrate content of each cup or spoon.

Example:

This 60g portion of rice fills 4 cups.

Each cup of cooked rice provides **15g carbohydrate** (60 ÷4) **or 1½ CPs**

This exercise can be repeated next time rice is eaten. If the result is the same, you can be confident that by using cups you can count the carbohydrate as 1½ CPs per cup (no need to weigh!).

Food labels

It is important to also look at food labels to determine the quantity found in different products. When read correctly, this information gives a precise figure for the carbohydrate value. It is the TOTAL CARBOHYDRATE you need to count, not the "of which sugars" value. Look for the value given for a 'serving' but check how big a serving size is, it may be different to the portion eaten.

If the values listed are for cooked products, such as pasta, cook the product according to instructions on the packet, e.g. check the recommended time. Food composition will change; it is important to keep updated.

To calculate number of CPs you will need to divide the total carbohydrate grammes by 10.

Food labels can be used for information about dishes where there is no labelling such as a packaged Chinese meal from the supermarket to help you assess a takeaway meal.

Reading labels: some examples

Example1: **Pepperoni Pizza (300g**

	Per 100g	Per 150g Serving
Energy	275 kcal	412 kcal
Carbohydrate	**25.3g**	**38g**
(of which sugars)	3.4g	5.1g
Fat	12.4g	18.6g

If you ate the whole pizza, you would have consumed 2 servings:
2 x 38g = 76g
total carbohydrate
(or 7 ½ CPs)

Example 2: **Pasta Shapes**

90g of dry pasta will typically produce 180g of cooked product *

Typical values (dry weight)	Per 90g	Per 100g
Energy	312 kcal	357 kcal
Carbohydrate	**65.8g**	**73.1g**
(of which sugars)	3.2g	3.5g
(of which starch)	62.6g	69.6g
Fat	1.5g	1.7g

* This information tells you that the pasta doubles in weight when cooked according to their instructions. It is usually more practical to weigh food like pasta & rice after cooking but the values above are for dry weight pasta.

If you weigh this product once cooked, you could halve the amount and then compare with the values shown but it is important to follow the cooking instructions! So if the cooked serving weighs 200g, assume that this was produced from 100g of dry weight pasta, therefore giving **73.1g carbohydrate or 7CPs.**

Tips for Patients

- Handy things to have in kitchen; scales, calculator, measuring cups
- Serve food in kitchen
- Serve rice/pasta etc, separate to sauce
- Become familiar with personal portions using favourite plates & bowls, cups, etc
- Create own lists of the foods commonly eaten
- Practice makes perfect!