Carbohydrate Counting in Type 1 Diabetes: A case Scenario
A primary goal in the management of diabetes is the regulation of blood glucose to achieve near normal blood glucose using insulin and appropriate diet.

The results of the Diabetes Control and Complications Trial (DCCT)*, published in 1993, proved conclusively what many already knew intuitively: Better blood sugar control reduces the risk of complications from diabetes, including nerve damage, damage to the eyes, and kidney disease.

Blood glucose concentration following a meal is determined by the rate of appearance of glucose into the blood stream (absorption) and its clearance/disappearance from the circulation. The rate of disappearance of glucose is largely influenced by insulin secretion. (Shenk et al, 2003)

Case Scenario

A 10-year-old female patient was transferred from a Siliguri hospital to our institution for tertiary care under our paediatric endocrinologist. She presented to the emergency department with hyperglycaemia, vomiting and abdominal pain. She had a history of polyuria and polydipsia, and weight loss over past two months.

On admission parameters:

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBG</td>
<td>400</td>
<td>mg/dl</td>
</tr>
<tr>
<td>Hb</td>
<td>10.5</td>
<td>%gm</td>
</tr>
<tr>
<td>Urea</td>
<td>36</td>
<td>mg/dl</td>
</tr>
<tr>
<td>Creatinine</td>
<td>0.8</td>
<td>mg/dl</td>
</tr>
<tr>
<td>T3</td>
<td>0.9</td>
<td>mg/ml</td>
</tr>
<tr>
<td>T4</td>
<td>7.6</td>
<td>Ug/dl</td>
</tr>
<tr>
<td>TSH</td>
<td>14.9</td>
<td>uIU/ml</td>
</tr>
<tr>
<td>Potassium</td>
<td>2.0</td>
<td>mEq/L</td>
</tr>
</tbody>
</table>

Urine ketones was positive 2++
Nutritional screening on admission

<table>
<thead>
<tr>
<th>Anthropometric</th>
<th>As per growth chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ht</td>
<td>136cm Just below 25(^{th}) percentile</td>
</tr>
<tr>
<td>Weight</td>
<td>24kgs Below 5(^{th}) percentile</td>
</tr>
</tbody>
</table>

**Impression: Acute Wasting secondary to New onset T1DM in DKA**

Her initial treatment was rehydration, correction of hyperglycaemia and ketosis with insulin, correction of hypokalemia with potassium infusion and 'survival skills education'.

**Diabetes & Diet education:**
Started on 2000 Calorie Diet with 3 meals and 3 snacks
CHO counting and education on insulins and insulin therapy
## CBG and insulin dose during the hospital stay

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>On admission</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>241</td>
<td>16</td>
<td>187</td>
<td>6</td>
<td>140</td>
<td>12</td>
<td>65</td>
<td>Sugar given</td>
<td>50</td>
<td>Sugar given</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>10</td>
<td>269</td>
<td>10</td>
<td>133</td>
<td>8</td>
<td>328</td>
<td>-</td>
<td>372</td>
<td>3 HA</td>
</tr>
<tr>
<td>4</td>
<td>112</td>
<td>12</td>
<td>60</td>
<td>4</td>
<td>316</td>
<td>10</td>
<td>265</td>
<td>-</td>
<td>264</td>
<td>3 HA</td>
</tr>
<tr>
<td>5</td>
<td>101</td>
<td>15</td>
<td>128</td>
<td>8</td>
<td>230</td>
<td>15</td>
<td>264</td>
<td>-</td>
<td>224</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>277</td>
<td>15</td>
<td>213</td>
<td>10</td>
<td>169</td>
<td>15</td>
<td>190</td>
<td>130</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>124</td>
<td>15</td>
<td>156</td>
<td>8</td>
<td>Discharged</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Medications:**
1. Humalog Mix 50 s/c as per CBG
2. HA {Human Atrapid} as per CBG
3. Syrup potklor 7.5ml orally 8th hourly till day 3 to correct hypokalaemia
What happens when carbohydrates is eaten?

The body breaks down or converts most carbs into glucose which is absorbed into the bloodstream. As the glucose level rises in the blood, the pancreas releases the hormone insulin. Insulin is needed to move glucose from the blood into the cells, where it's used as an energy source.
## Insulin

### Main types of insulin preparations

<table>
<thead>
<tr>
<th>Type</th>
<th>Onset</th>
<th>Peak</th>
<th>Duration</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid-acting insulin analogue</td>
<td>5-15 min</td>
<td>30-60 min</td>
<td>2-5 hr</td>
<td>Can be injected at the start of a meal</td>
</tr>
<tr>
<td>Short-acting (soluble/regular insulin)</td>
<td>30 min</td>
<td>1-3 hr</td>
<td>4-8 hr</td>
<td>Usually injected 15-30 minutes before a meal. Clear solution</td>
</tr>
<tr>
<td>Intermediate or long-acting insulin (isophane or zinc insulin)</td>
<td>1-2 hr (NPH, Lente) 2-3 hr (Ultralente)</td>
<td>4-8 hr</td>
<td>8-12 hr (NPH) 8-24 hr (Ultralente)</td>
<td>Used to control glucose levels between meals. May be combined with short-acting insulin</td>
</tr>
<tr>
<td>Long-acting insulin analogue</td>
<td>30-60 min</td>
<td>No peak</td>
<td>16-24 hr</td>
<td>Usually taken once daily</td>
</tr>
</tbody>
</table>
Action of Insulin isomers

- Monomers: Immediate onset
- Hexamers, delayed onset
- Variability, clear peak
- Mild peak
- Peakless
**Hitting The Bull's Eye**

*Once you know where you want to reach, the road becomes clear*

Know your targets:

<table>
<thead>
<tr>
<th>TIME</th>
<th>NORMAL</th>
<th>GOAL</th>
<th>POOR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fasting</strong></td>
<td>70-100</td>
<td>90-130</td>
<td>&gt;150</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;90</td>
</tr>
<tr>
<td><strong>Post-Prandial</strong></td>
<td>&lt;140</td>
<td>140-160</td>
<td>&gt;180</td>
</tr>
<tr>
<td><strong>Avg. Bed time</strong></td>
<td>&lt;120</td>
<td>110-150</td>
<td>&gt;180</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;110</td>
</tr>
</tbody>
</table>
Many people believe that a diabetes meal plan means that you just have to cut back on sugar.

This is not true!

1. Carbohydrates (carbs) have the greatest effect on your blood sugar
2. 90 to 100 percent of the carbs you eat appear in your bloodstream as blood glucose within minutes to hours after you have eaten.

The carbs you will need to count are both:

- starches that break down slowly into sugar
- simple sugars that break down into blood glucose almost right away

Foods Without Carbohydrate:

- Meat, fish, poultry, cheese, eggs, cottage cheese, tofu
- Butter, oils, margarine, mayonnaise, salad dressings

To count carbohydrates, you’ll need to know which foods contain carbohydrates and learn to estimate the number of grams of carbohydrate in the foods you eat.
All of these foods contain starches:

<table>
<thead>
<tr>
<th>Cereals and products made from grains like bread, biscuits, noodles, vermicelli, pasta and pizzas</th>
<th>Legumes Dried beans and peas</th>
<th>Starchy vegetables like potatoes, tapioca, colocasia, yam, corn, and peas</th>
<th>Milk and milk products</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Cereals" /></td>
<td><img src="image2.png" alt="Legumes" /></td>
<td><img src="image3.png" alt="Starchy Vegetables" /></td>
<td><img src="image4.png" alt="Milk" /></td>
</tr>
</tbody>
</table>
All of these foods contain sugars:

<table>
<thead>
<tr>
<th>Fruit and fruit juices jams, jellies, and fruit smoothies</th>
<th>Sweet bakery products like cake with icing, pie, donuts, candy, and cookies</th>
<th>Sugary drinks such as regular soda and fruit drinks</th>
<th>Sweet condiments such as barbeque sauce, relish and ketchup</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Image of fruits and juices]</td>
<td>[Image of cookie]</td>
<td>[Image of sugary drinks]</td>
<td>[Image of ketchup]</td>
</tr>
<tr>
<td>[Image of cake]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CARBOHYDRATES NEEDS

• The total amount of carbohydrate needed daily is based on calorie needs of each person.
• Carbohydrate should comprise around 50-55% of the day’s calorie intake.
• The amount of carbohydrate eaten should be spread throughout the day.
• The total number of meals and snacks can differ based on BMI and nutritional needs, lifestyle, and the action and the timing of medication and insulin.
Estimated total calorie intake from Carbs

Carbohydrate should provide 50-55% of total calories
Complex carbohydrate should account for 2/3 of total Carbs
For a 2000 k calorie diet:
55% of 2000 =1,100 kcals from carbs
At 4 kcals per gram=275 grams of carbs
50% of 2000 =1000 kcals from carbs
At 4 kcals per gram=250 grams of carbs
Definition of Carb Counting

Definition

A method of teaching people how to “eat consistent amounts of carbohydrate at meals and snacks at similar times each day, with the end goal of achieving glycaemic control and other diabetes and metabolic nutrition goals.” It offers a little more freedom than exchange list. The reason why this way of eating is so popular is that it is simple. Have to count carbs per meal or snack.


Advantages:

Effectiveness
Flexibility
Ease of implementation

2,3. Practical Carbohydrate Counting, American Diabetes Association, 2001
Why Count Carbohydrate?

Carbohydrate is the nutrient in food that raises blood glucose the most.
Principles of Carbohydrate Counting

• Carbohydrate counting is a meal planning method for people with diabetes
• It is a way to count carbohydrate (grams or serving) in meals and snacks
• By evenly spacing carbohydrates throughout the day and by eating the same amount at each meal or snack, you get better blood sugar control so you can stay within target blood sugar.
• With carbohydrate counting food choices can vary from day to day as long as the total amount of carbohydrate is the same at each meal or snack. This consistency can help keeping blood sugar in target range

• For diabetic following flexible insulin therapy insulin doses are matches to the amount of carbohydrates they choose to eat to get a better blood glucose control
Carb Counting: A Continuum

• **Basic Carb Counting:**
  Learn the foods that contain carb. Choose and eat these foods in the proper proportions/servings at meals.

• **Intermediate Carb Counting:**
  Actual counting of carbs at meals.
  Example: 45 grams of carbs per meal.

• **Advanced Carb Counting:**
  Coordinating the amount of diabetes medication taken with the amount of carbs consumed.
Basic Carb Counting Using Grams

Your meal plan may call for you to eat a specified amount of carbohydrate at each meal or snack. You do not have to eat the same foods everyday. Your food choices can change from day to day as long as the total carbs specified for each meal and snack stay about the same. Being consistent is the key to successful carb counting. For example, if you need to eat around 55 grams of carb for breakfast, here are three different breakfasts that each total around 55 grams of carb:

<table>
<thead>
<tr>
<th>Breakfast 1# Continental Around 55 grams of carb:</th>
<th>Breakfast 2# Indian Around 55 grams of carb:</th>
<th>Breakfast 3# Chinese Around 55 grams of carb</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 slices of toast 30 gm</td>
<td>2 chapattis (45 gm raw wt) 30 gm</td>
<td>Noodles 45 gms (45 gms) 30 gms</td>
</tr>
<tr>
<td>1 tsp Jam 5 gm</td>
<td>1 cup mixed veg 5 gms</td>
<td>1 cup saute veg 5 gms</td>
</tr>
<tr>
<td>1 orange / 1 med apple 14 gm</td>
<td>1 orange / 1 med apple 14 gm</td>
<td>1 orange / 1 med apple 14 gms</td>
</tr>
<tr>
<td>1 egg / white to order 0 gm</td>
<td>1 egg / white to order 0 gm</td>
<td>1 egg / white to order 0 gms</td>
</tr>
<tr>
<td>1 cup Milk for coffee/tea 7 gm</td>
<td>1 cup Curd (150ml) 7 gm</td>
<td>1 cup Milk for coffee/tea 7 gm</td>
</tr>
</tbody>
</table>
Carbohydrate counting

• Carbohydrate serving/choice:
A carbohydrate serving or choice is a portion of food that has 15 g of carbohydrates.
1 carbohydrate choice = 15 g carbohydrates

• Carbohydrate counting by gram:
Another way is to count carbohydrates by gram in the portion you eat and add those amount for a meal or a snack total
Tools for Carbohydrate Counting

Nutrition Labels

The serving size for the food is 1 cup.

There are 3 servings or 3 cups in this container.

The total carbohydrate tells how many grams of carbohydrate are in 1 serving.

Sugar is already included in the total carbohydrate amount. This value shows the amount of natural or added sugar.

Measuring Tools
Carbohydrate Counting Hand Guide

Fist = 8 fluid oz or 1 cup

Palm = 3 oz.

Handful = 1/2 cup

Thumb = 1 oz.

Thumb tip = 1 tsp.
For carbohydrate counting, you need to:

1. Be motivated and able to take the time required to improve diabetes management
2. Do simple arithmetic (add, subtract, multiply and divide)
3. Understand insulin action
4. Read food labels
5. Count carbohydrates
6. Understand the relationship between carbohydrate and insulin
7. Adjust insulin based on food intake, exercise and blood glucose level
Carb Counting

One serving of carbohydrate is measured as 15 grams. A food that contains 15 grams of carbohydrate is called “one carb serving”.

One slice of bread, a small piece of fruit, or a ear of corn each have around 15 grams of carb.

Each of these equals one carb serving.

Carb Counting
**Grams of Carbohydrate (per food category)**

**Starch and fruit**: 1 serving equals about 15 grams (g) carbohydrate  
**Milk**: 1 serving equals about 12 g carbohydrate  
**Vegetables**: 1 serving equals about 5 g carbohydrate

<table>
<thead>
<tr>
<th>Cereals and starchy veg 15 g Carb</th>
<th>Pulses and Fruit 15 g Carb</th>
<th>Milk and other products 12 g Carb</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 slice bread</td>
<td>½ C lentils cooked</td>
<td>270 ml cows milk</td>
</tr>
<tr>
<td>1 Chapati, thin 6” diameter</td>
<td>½ C toor dal cooked</td>
<td>200 g curd</td>
</tr>
<tr>
<td>½ paneer paratha thin 6” dia</td>
<td>1C thin mixed dal cooked</td>
<td></td>
</tr>
<tr>
<td>1 dosa approx 10” dia</td>
<td>½ C kidney beans cooked</td>
<td></td>
</tr>
<tr>
<td>1 small idli</td>
<td>½ C mung dal cooked</td>
<td>Vegetables 5 g carb</td>
</tr>
<tr>
<td>½ C poha</td>
<td>1 small Apple</td>
<td>Veg A 1 cup cooked</td>
</tr>
<tr>
<td>½ C Dalia(cooked)</td>
<td>1 small banana (4oz) or ½ med</td>
<td>Veg B 1/2 cup cooked</td>
</tr>
<tr>
<td>½ C potato sabji</td>
<td>3 dates</td>
<td></td>
</tr>
<tr>
<td>½ C peas</td>
<td>1 small orange</td>
<td></td>
</tr>
<tr>
<td>1 C aloo gobhi</td>
<td>1 C papaya cubes</td>
<td></td>
</tr>
</tbody>
</table>
All foods once looked like this...
...but now many foods look like this.
Counting carbohydrates from food labels

- Check the product serving size
- See the total amount of carbohydrate/serving
- Find the dietary fiber amount/serving (if the food you are planning to eat has more 5 g of fiber per serving, subtract the grams of fiber from the total carbohydrates grams)
- Compare the serving size listed to your portion
- Calculate the amount of carbohydrate in your portion
“Sugar-free” and “no sugar added” foods may still contain a large amount of carbs.

Sugar-free apple pie has carbohydrates from the apples and the pie crust.

This sugar-free pudding contains 8 grams of carb per ½ cup serving:

Sugar-free pudding has carbohydrates from the milk.

Nutrition Facts

<table>
<thead>
<tr>
<th>Serving Size: 1/2 cup • 11g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount Per Serving</td>
</tr>
<tr>
<td>Calories</td>
</tr>
<tr>
<td>Calories from Fat</td>
</tr>
<tr>
<td>% DV</td>
</tr>
<tr>
<td>Total Fat</td>
</tr>
<tr>
<td>Saturated Fat</td>
</tr>
<tr>
<td>Trans Fat</td>
</tr>
<tr>
<td>Cholesterol</td>
</tr>
<tr>
<td>Sodium</td>
</tr>
<tr>
<td>Total Carbohydrate</td>
</tr>
<tr>
<td>Dietary Fiber</td>
</tr>
<tr>
<td>Sugars</td>
</tr>
<tr>
<td>Protein</td>
</tr>
<tr>
<td>Vitamin A</td>
</tr>
<tr>
<td>Vitamin C</td>
</tr>
<tr>
<td>Calcium</td>
</tr>
<tr>
<td>Iron</td>
</tr>
</tbody>
</table>

Unofficial Pts: 2

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Percent of Calories from:

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>2,000 Calories</th>
<th>2,500 Calories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat</td>
<td>less than 65g</td>
<td>less than 80g</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>less than 23g</td>
<td>less than 25g</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>less than 300mg</td>
<td>less than 300mg</td>
</tr>
<tr>
<td>Sodium</td>
<td>less than 2,400mg</td>
<td>less than 2,400mg</td>
</tr>
<tr>
<td>Total Carbohydrates</td>
<td>303g</td>
<td>375g</td>
</tr>
<tr>
<td>Fiber</td>
<td>25g</td>
<td>30g</td>
</tr>
</tbody>
</table>

1g Fat = 9 calories  
1g Carbohydrate = 4 calories  
1g Protein = 4 calories  
1g Alcohol = 7 calories
Advanced carbohydrate counting

• Diabetic patient treated with insulin should match their insulin (time and dose) with their meal times and carbohydrate amounts

• Patient following a flexible insulin therapy or on insulin pump can make adjustment in their bolus insulin based on the amount carbohydrate and type of food they choose to eat

• To do this, you need to know your carbohydrate-to-insulin ratio.
  – Example: Ratio of 15:1 means that 1 unit of insulin needed for every 15 grams carbohydrate
What Is An Insulin-to-Carb Ratio?

- An insulin-to-carb ratio helps you dose how much rapid-acting insulin you need to “cover” the carbohydrate you will eat at a meal or snack.
- For example, an insulin-to-carb ratio of **1:20 means that 1 unit of rapid-acting insulin “covers” 20 grams of carbohydrate.**
- Estimated amount of carbohydrate in the meal, amount of insulin taken, and what was the blood glucose before and two hours after eating will help to decide if the ratio is correct, or if it should be adjusted.
- Different people have different insulin-to-carb ratios depending upon age, sex, nutritional status and even time of the day
- The insulin-to-carb ratio will depend on the total daily dose of insulin and/or on how much insulin currently take with meals.
The 450/500 Rule

450 Rule for Users of Regular Insulin

Divide 450 by the total daily dose of insulin. The result is the grams of carbohydrate that are approximately covered by 1 unit of insulin.

Example: If 30 units a day of Regular insulin then the carb-to-insulin ratio is 1:15

450 divided by 30 (total dose) = 15 (grams of carb covered by 1 unit of insulin).

500 Rule for Users of Humalog and Novo log

Divide 500 by the total daily dose of insulin. The result is the grams of carbohydrate that are approximately covered by 1 unit of insulin.

Example: If 40 units a day of Humalog then carb-to-insulin ratio is 1:12.5

500 divided by 40 (total dose) = 12.5 (grams of carb covered by 1 unit of insulin).

Generally, one unit of rapid-acting insulin will dispose of 12-15 grams of carbohydrate. This range can vary from 4-30 grams or more of carbohydrate depending on an individual’s sensitivity to insulin. Insulin sensitivity can vary according to the time of day, from person to person, and is affected by physical activity and stress.
How to use the insulin to carb ratio?

**Step 1:** Count up the total amount of carbohydrate in your meal or snack.

**Example using an insulin-to-carb ratio of 1:15:**

- **Step 1:** (count up the total grams of carbohydrate)
  - 11/2 cup rice --------------------------- 32 g carb
  - 1 cup dal------------------------------- 18 g carb
  - 60 gms non veg ------------------------ 0 g carb
  - 1 cup mixed veg------------------------ 5g carb
  - 1 cup curd(150ml)---------------------- 7 g carb
  - = 62 g of total carbohydrate

**Step 2:** Divide the total amount of carbohydrate eaten by your insulin-to-carb ratio to determine your insulin dose (divide by the **insulin-to-carb ratio**)

62 g ÷ 15 = 4.1 units of insulin (those on multiple daily injections can round up to 5 units)
Healthy eating guidelines

• Calories to promote healthy body weight
• Total fat < 35%
• Saturated fat <10% (<7% for some)
• Dietary cholesterol < 300 mg (<200 mg for some)
• Protein 15-20% of total calories
• Fiber 25-30 g /day

• Use fat sparingly in cooking
• Bake, steam, grill food instead of frying
• Choose lean cut of meat
• Choose low fat milk and dairy product
• Allow sweet only occasionally
Take Home Messages

- Recommended caloric intake should be a mixture of Carbohydrates (55%), Fats (30%) and Proteins (15%)
- Carbohydrates – in the form of complex carbs
- Food divided into 3 main meals
  - Breakfast (20%), Lunch (20%), Dinner (30%)
  - and 2-3 snacks (10%) each.
- Carbohydrate Exchanges should be taught to the family
- Maintain normal growth and development
  - Evaluate using growth charts every 3-6 months
- All family members should eat the same meal prepared for the child
- A snack should be taken before any unusual sport activity or physical exercise
So, enjoy the increased variety and flexibility with Carbohydrate Counting...

..but watch the fat and calories! THANX YOU
Acknowledgement

Dr Bhuvaneshwari Shankar
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Dr Subrata Dey
HOD Academics Paediatrics
Senior Consultant Paediatric Endocrinologist
Apollo Gleneagles Hospital

Dietetics team, Apollo Gleneagles Hospital ,Kolkata