Medical Nutrition Therapy (MNT) for Diabetes
Evidence-based Recommendations

Advances in Internal Medicine 2013
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No financial disclosures

Objectives

1. Review evidence supporting the following nutritional practices in relation to glycemic control in diabetes:
   - Carbohydrate counting & consistency
   - Carbohydrate restriction
   - Low glycemic index foods
   - Fiber

ADA. Diabetes Care 2008; 31:S1-S78
Objectives

2. Review evidence supporting the following nutritional practices in relation to cardiovascular outcomes in diabetes:
   - Mediterranean diet
   - Low fat, calorie restricted diet (Look AHEAD)

1. Glycemic Control

   Definitely Beneficial Based on Existing Evidence

   - Limiting sucrose
     - Higher Fiber intake
   - Carbohydrate Counting
   - Carbohydrate Consistency
   - Calorie restricted, low fat
     - Mediterranean diet
   - Low Glycemic Index foods
   - Carbohydrate restriction

Diabetes Control and Complications Trial

   - Landmark trial showing that intensive glycemic control dramatically reduces microvascular complications

   ![Graph showing cumulative incidence of a sustained change in hemoglobin A1c in patients with type 2 diabetes mellitus during intensive or conventional therapy.](image-url)
Diabetes Control and Complications Trial

- DCCT involved extensive nutritional training in the intensive arm:
  - Carbohydrate consistency/counting and healthy food choices
- Greater HbA1c reductions were associated with adherence to:
  - Following overall meal plan
  - Adjusting carbohydrate intake or insulin in response to hyperglycemia
  - Not over treating lows glucoses


Dose Adjustment for Normal Eating (DAFNE study)

- Multicenter randomized control trial examining the benefit of 5-day outpatient intensive diabetes education with emphasis on carb counting and flexible eating
- 164 motivated subjects with T1DM and moderate to poor glycemic control
- Outcomes: Glycemic control, hypoglycemia rate, QOL

Baseline Characteristics N=164

<table>
<thead>
<tr>
<th>Baseline Characteristics</th>
<th>N=164</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr</td>
<td>40 ± 9</td>
</tr>
<tr>
<td>Duration diabetes, yr</td>
<td>16.6 ± 9.6</td>
</tr>
<tr>
<td>HbA1c</td>
<td>9.4%</td>
</tr>
<tr>
<td>Retinopathy</td>
<td>37%</td>
</tr>
<tr>
<td>Neuropathy</td>
<td>17%</td>
</tr>
</tbody>
</table>


Outcomes

- HbA1c, %

<table>
<thead>
<tr>
<th>Time</th>
<th>Immediate DAFNE</th>
<th>Delayed DAFNE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>6 months</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>12 months</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

Fig 2. Glycemic control as measured by glycated haemoglobin (HbA1C)


Outcomes

- Freedom to Eat
- Overall QOL

**DAFNE Expansion**

- 31 centers throughout UK & Ireland, 1163 participants
- Retrospective database analysis of 639 participants

**1 Year Follow Up**

<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>HbA1c, %</td>
<td>8.51</td>
<td>8.24</td>
</tr>
</tbody>
</table>

No changes in weight, lipids or blood pressure


**Carb counting in T2DM**

- 24 week randomized control trial comparing a fixed mealtime insulin dosing vs. carb counting in patients with insulin-requiring type 2 diabetes

<table>
<thead>
<tr>
<th>Study Arms</th>
<th>Insulin Requiring T2DM (N=273)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glargine+ Insulin-to-carb ratios</td>
<td>Glargine + Fixed-dose mealtime insulin</td>
</tr>
</tbody>
</table>

**Severe Hypoglycemia**

- Modest improvements in quality of life, depression and anxiety

*Bergenstal et al. Diabetes Care. 2008;31:1305-1310*
**Intervention**

- Metformin continued if used at baseline.
- Weekly insulin titration by algorithm over the phone

**Outcomes**

<table>
<thead>
<tr>
<th></th>
<th>Simple Algorithm Group</th>
<th>Carbohydrate Count Group</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe Hypoglycemia (BG &lt;36)</td>
<td>0.89 events/patient-years (53 episodes in 19 subjects)</td>
<td>0.67 events/patient-years (37 episodes in 19 subjects)</td>
<td>0.58</td>
</tr>
<tr>
<td>Hypoglycemia (BG &lt;50)</td>
<td>4.9 events/patient-years</td>
<td>8.0 events/patient-years</td>
<td>0.02</td>
</tr>
<tr>
<td>Weight</td>
<td>+3.6 kg (3.4%)</td>
<td>+2.4 kg (2.3%)</td>
<td>0.06</td>
</tr>
<tr>
<td>BMI</td>
<td>+1.28 kg/m²</td>
<td>+0.83 kg/m²</td>
<td>0.037</td>
</tr>
<tr>
<td>Triglycerides</td>
<td>-8.19 mg/dl (p=0.17)</td>
<td>-13.19 (p=0.008)</td>
<td></td>
</tr>
</tbody>
</table>

Bergenstal et al. Diabetes Care. 2008;31:1305-1310
Carbohydrate counting/estimating

- Carbohydrate counting has definite glycemic benefits in type 1 diabetes with added benefits in quality of life
- Carbohydrate counting OR fixed-dose insulin coupled with consistent carbohydrate meals are equally effective in insulin requiring T2DM
VARIOUS DEGREES OF CARB RESTRICTION

**Modest carb restriction (40% total calories from carbs)**

**Severe carb restriction (<20 grams per day → ketosis)**

% Dietary Carbs and Glycemic Control

- Observational data from large studies involving T1DM¹ and T2DM² show a positive association between low fat/high carbohydrate diet with lower HbA1c.
- Interventional studies show conflicting results.


Carbohydrate restricted diets in T2DM

<table>
<thead>
<tr>
<th>Study</th>
<th>N</th>
<th>Intervention</th>
<th>Control</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Samaha et al (6 month study):</td>
<td>51</td>
<td>37% CHO+41% Fat</td>
<td>51% CHO+33% Fat</td>
<td>6 mo</td>
</tr>
<tr>
<td>Samaha et al (6 month study):</td>
<td></td>
<td>Severe obesity American subjects, 51 of whom had diabetes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Randomized to Low Carb (30g CHO per day) vs. Low Fat Diet (&lt;30% fat)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>High attrition rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weight loss and TG levels were better in Low Carb group</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>HbA1c trended down in subjects with diabetes: 7.8% → 7.2% (p=0.06)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wolever et al (1 yr study):</td>
<td>156</td>
<td>40% CHO per day</td>
<td>40% CHO per day</td>
<td>1 yr</td>
</tr>
<tr>
<td>Wolever et al (1 yr study):</td>
<td></td>
<td>Low Carb (40% CHO per day) vs. Low GI or Low Fat</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No significant differences in HbA1c, lipids, weight</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>in Low Carb, HbA1c drop: 7.5 to 7.2% (p=0.07) and BMI, LDL lowered significantly</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Haimoto et al (1 year study):

- 127 Japanese subjects with T2DM
- Randomized to simple carb reducing instructions vs. unrestricted diet
- In Low Carb, HbA1c drop: 7.5 to 7.2% (p<0.001) and BMI, LDL lowered significantly.

Carbohydrate restriction

- Studies of low-carbohydrate show conflicting results
- They are relatively small and difficult to compare due to varying degrees of carbohydrate restriction
- The ADA does not endorse an “ideal” carbohydrate amount for people with diabetes

GLYCEMIC INDEX

High GI (>70)
- White rice
- White bread
- Potato
- Cornflakes
- Pizza
- Carrots

Low GI (<55)
- Brown rice
- Whole grain bread
- Tortilla
- Milk
- Beans
- Spaghetti

GLYCEMIC INDEX

Impact of low GI diet on HbA1c

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Factors low glycemic</th>
<th>Factors control</th>
<th>Mean difference (95% CI)</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brand 1991</td>
<td>16</td>
<td>16</td>
<td>17.9 (95% CI)</td>
<td>89.9</td>
</tr>
<tr>
<td>Glisco 2000</td>
<td>29</td>
<td>25</td>
<td>13.9 (95% CI)</td>
<td>73.6</td>
</tr>
<tr>
<td>Gilbertaine 2001</td>
<td>51</td>
<td>38</td>
<td>16.0 (95% CI)</td>
<td>81.0</td>
</tr>
<tr>
<td>Jimenez-Cruz 2003</td>
<td>14</td>
<td>14</td>
<td>0.0 (95% CI)</td>
<td>72.9</td>
</tr>
<tr>
<td>Konishi 2001</td>
<td>10</td>
<td>10</td>
<td>0.0 (95% CI)</td>
<td>74.5</td>
</tr>
<tr>
<td>Rabadi 2004</td>
<td>12</td>
<td>12</td>
<td>1.7 (95% CI)</td>
<td>73.9</td>
</tr>
</tbody>
</table>

Total (95% CI) 115 (95% CI) 100.0% -0.50 [-0.81 -0.20]

Elliott et al. Cochrane Database Syst Rev. 2009; 21

Impact of low GI diet on HbA1c

Children with T1DM
Low GI vs High-Cereal Fiber Diet

155 subjects with T2DM randomized to Low GI (69.6) or High GI (83.5) diet


Low GI diet in T2DM

Glycemic Index

- Choosing low GI foods probably has a small benefit in glycemic control in diabetes at best

FIBER
Fiber and glycemic control

- Most studies are small and of short duration (not shown)

<table>
<thead>
<tr>
<th>Study</th>
<th>Population</th>
<th>Duration</th>
<th>Intervention</th>
<th>Control</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milne 1994</td>
<td>Type 2 Diabetes</td>
<td>18 month</td>
<td>30g Fiber (21g achieved)</td>
<td>21g Fiber (17g achieved)</td>
<td>No change in A1c, lipids, or weight</td>
</tr>
<tr>
<td>Giacco 2000</td>
<td>Type 1 Diabetes</td>
<td>6 month</td>
<td>50g Fiber (40g achieved)</td>
<td>15g Fiber (15g achieved)</td>
<td>In hi fiber compliant, ↓ 0.2% A1c, ↓ hypos by 0.8 x/mo, no change in lipids</td>
</tr>
</tbody>
</table>


Fiber and T1DM

- Lo Fib: HbA1c 8.6% → 9.1% (p=NS)
- Hi Fib: HbA1c 8.8% → 8.6%, p<0.05


Fiber and glycemic control

- There is insufficient evidence to recommend high fiber diets to improve glycemic control
- Recommend daily intake for all (14g/1000kcal)

MEDITERRANEAN DIET
**Mediterranean diet pyramid: a cultural model for healthy eating**

Walter Willet, MD, MPH

- Diet consumed in Crete and most of Greece and Southern Italy in 1960s
- Long life expectancy
- Low rates of CVD and certain cancer


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**Mediterranean Diet vs. AHA Diet**

- 215 overweight subjects with newly diagnosed T2DM
- All on 1500 or 1800 kcal diet
- 175 min mod-intense exercise per week
- MED: <50% CHO, +Olive Oil
- AHA: <30% Fat
- Follow up of 4 years


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**Mediterranean Diets in T2DM**

<table>
<thead>
<tr>
<th>Variable</th>
<th>MED Diet</th>
<th>Low-Fat Diet</th>
<th>Difference (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total energy, kcal</td>
<td>1200 (120)</td>
<td>1000 (110)</td>
<td>200 (100)</td>
</tr>
<tr>
<td>Carbohydrates, %</td>
<td>50 (2)</td>
<td>50 (1)</td>
<td>0 (2)</td>
</tr>
<tr>
<td>Fat, %</td>
<td>20 (1)</td>
<td>20 (1)</td>
<td>0 (2)</td>
</tr>
<tr>
<td>Saturated</td>
<td>5 (1)</td>
<td>5 (1)</td>
<td>0 (2)</td>
</tr>
<tr>
<td>Monounsaturated</td>
<td>5 (1)</td>
<td>5 (1)</td>
<td>0 (2)</td>
</tr>
<tr>
<td>Polyunsaturated</td>
<td>5 (1)</td>
<td>5 (1)</td>
<td>0 (2)</td>
</tr>
</tbody>
</table>

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Primary Prevention of Cardiovascular Disease with a Mediterranean Diet

- Multicenter randomized trial of 7447 subjects with high risk of CVD, 50% with diabetes
  - Among subjects with diabetes: 30% on oral agent and 5% on insulin
- Randomized to: MED with olive oil, MED with nuts, Low fat diet x 5 yrs
- Quarterly individual or group education sessions, shopping lists, free nuts or oil
- Primary outcome: major cardiovascular event (MI, CVA, CV death)


The Diets

<table>
<thead>
<tr>
<th>Mediterranean</th>
<th>Low Fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olive Oil** ≥ 4 tbsp/day</td>
<td>Low fat dairy products ≥ 3 servings/day</td>
</tr>
<tr>
<td>Tree nuts and peanuts** ≥ 4 servings/week</td>
<td>Bread, potatoes, pasta, rice ≥ 3 servings/day</td>
</tr>
<tr>
<td>Fresh Fruits ≥ 3 servings/day</td>
<td>Fresh fruits ≥ 3 servings/day</td>
</tr>
<tr>
<td>Vegetables ≥ 2 servings/day</td>
<td>Vegetables ≥ 2 servings/day</td>
</tr>
<tr>
<td>Fish (esp fatty*), seafood ≥ 3 servings/week</td>
<td>Lean fish and seafood ≥ 3 servings/week</td>
</tr>
<tr>
<td>Legumes ≥ 3 servings/week</td>
<td></td>
</tr>
<tr>
<td>Sofrito* (tomato sauce) ≥ servings/week</td>
<td></td>
</tr>
<tr>
<td>White meat instead of red meat</td>
<td></td>
</tr>
<tr>
<td>Wine ≥ 7 glasses/week</td>
<td></td>
</tr>
</tbody>
</table>

*sofrito: tomato sauce with onions, spices and olive oil
**discouraged in low fat diet


Dietary Changes

Baseline Dietary Intake

- ~43% CHO
- ~40% Fat
- 20% MUFA
- ~17% Protein

- Adherence to Mediterranean diet score = 8 (out of 14)

Dietary Changes vs. Controls

- ↑0.3 servings legumes/week
- ↑0.4 servings fish/week
- ↑50g/32g olive oil/day
- ↑0.99/6g nuts/week
- Major macronutrient change was increase in fat
- Adherence to Mediterranean diet score = 10.5 (out of 14)

Primary Outcome


Who benefitted?

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>HR Primary endpoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
<td>0.71 (0.53-0.96)</td>
</tr>
<tr>
<td>No Diabetes</td>
<td>0.67 (0.45-1.01)</td>
</tr>
</tbody>
</table>

Who also benefitted:
- Male
- ≥70 yo
- Hypertensive
- Dyslipidemic
- Obese
- Large waist
- More adherent to Mediterranean diet at baseline (score of 9 out of 14)


Look AHEAD

- Randomized control trial comparing a 5 year intensive lifestyle intervention (ILI) vs. diabetes support and education (DSE) for the prevention of major cardiovascular events in T2DM over 11.5 year follow up
- Intervention: Aim for 7% weight loss with a reduced calorie, low fat (<30% fat, <10% saturated fat), 15% protein diet and 175 min of mod-strenuous exercise per week
- Included: BMI≥25, HbA1c <11%
- Participants underwent screening treadmill stress test and excluded if couldn’t complete or abnormal

Look AHEAD

- At 3 yrs, the CV event rate in control arm was only 0.7%.
- What could be the reasons?
  - Better management of CVD risk factors
  - Exclusion of those with abnormalities on stress test
  - Study population different from community cohorts from which risk estimates were derived
- Study stopped for futility

Brancati et al. Clinical Trials 2012:9:113

Look Ahead Results

Moderate gains in diabetes medication discontinuation, blood pressure, TGs in ILI


Diabetes Remission in Look AHEAD

Higher rates of remission in those with:
- Less than 2 yr diabetes duration
- Baseline lower A1c
- Baseline not on insulin
- More weight loss in year 1
- Highest fitness change during study

Gregg et a. JAMA 2012;308:2489-2496
Diet and CVD risk

- Mediterranean diet may reduce CV events in people with diabetes (small absolute risk reduction)
- A low fat weight loss diet combined with exercise (Look AHEAD) improves glycemic control and weight. This diet did not show a reduction in CV events due to study design flaws.

Conclusions

- Fiber intake
  - Carbohydrate restriction
  - Low vs. High GI foods
- Carbohydrate Counting
- Carbohydrate Consistency
- Calorie restricted, low fat
  - Mediterranean diet

Thank you