

Aunt Cathy's Guide to:

Thinking About OTHER Nutrition Issues in Diabetes



AUNT CATHY

Cathy Breedon PhD, RD, CSP, FADA
Prenatal/Pediatric Nutrition Specialist
Clinical and Metabolic Nutrition Specialist
Sanford Health (formerly MeritCare)
and UND School of Medicine
Fargo, North Dakota

Introduction:

Blood sugar control is the key focus of nutrition and diet planning for people with diabetes. Historically the most attention has been paid to adjusting the intake of the types and amounts of carbohydrate throughout the day, including the newer concepts of “carbohydrate counting” and the “glycemic index.” Additional attention has been paid to total calories and total fat content, plus the content of saturated fat and “trans” fat because of the importance of weight control in diabetes, and the increased risk of cardiovascular disease. **These remain the basis of diet and nutrition interventions for diabetes.**

However, information is becoming available about the special roles of **certain vitamins, minerals, phytochemicals, and some forms of dietary fat** that appear to be useful in various ways in fighting diabetes and its consequences. The nutrition tools described here do not “cure” diabetes – but in many cases they have been shown to have the capacity to **decrease the risk of diabetes developing**. Others have demonstrated that they can be useful for people who already have it by **helping with diabetic control**, or by **making diabetes hurt them less**. This includes reduction in complications like blindness, kidney failure, neuropathy, impaired circulation, and even birth defects.

Some have been shown to be helpful in at least one of seven ways:

- 1) **Enhancing insulin sensitivity.**
- 2) **Using antioxidants to minimize secondary damage from poor diabetes control caused by higher than normal production of free radicals.**
- 3) **Reducing the severity of inflammation that has been shown to be associated with diabetes in order to decrease risk of developing diabetes complications (including Type I, Type II and gestational forms.)**
- 4) **Helping stabilize/improve excessive fluctuations of blood sugar that can sometimes be a problem in spite of following the diet very carefully (e.g. what some people used to refer to as “brittle” diabetes.)**

5) Minimizing risk of developing other threats to health and well-being, including conditions that are known to be exacerbated by diabetes.

6) Minimizing the risk of developing diabetes.

7) Discovering the emerging miscellaneous effects of a variety of phytochemicals (plant substances) on the diabetic state.

Happily, all of the diet or nutrient ideas suggested here are also reported to be beneficial for most folks in terms of decreasing risks associated with one or more of a variety of chronic illnesses, including cardiovascular disease, cancer, MS, arthritis (both rheumatoid and osteo,) alzheimers, parkinsonism, depression and osteoporosis. In other words, **the suggestions are all health-promoting for the whole family, whether one has diabetes or not ... they are just even more important if you DO have diabetes.**

It is also extremely important to note that all of the suggestions are based on research reported in the legitimate peer-reviewed scientific literature. None are based on wild claims made on the internet (or elsewhere.) There is no law against fiction in America, and therefore there are quite a lot of false claims made for diet and nutrition in particular, often in the interest of selling products.

Many of the “dietary supplements” sold are in fact not related to nutrition at all. Many are actually pharmaceutical products, but a loop-hole in the FDA laws allows the marketing of substances in the “dietary supplement” category without having to show “safety and effectiveness” as they would if marketed as pharmaceutical products.

Understandably, the existence of so much nutritional quackery in the world has made health professionals hesitant to consider nutrition manipulations to be legitimate adjuncts to management of complex diseases like diabetes. There is a tendency to just “throw the baby out with the bathwater.” The purpose of this paper is simply to highlight areas of research that are identifying the real “babies” to watch out for.

All the suggestions included here are generally regarded as safe at this time (I never recommend anything that comes anywhere near to “scary,”) and they are often easy to do and inexpensive. In two cases, the amount of the substance that has been shown to be beneficial is somewhat impractical to attempt when using the currently available over-the-counter products. In these cases, a prescription for the appropriate higher dosage product makes it much simpler. Although these two products and one other are also among the more expensive interventions discussed, the prescription form may be covered by insurance even though the over-the-counter form is not.

As always, the information provided here is simply my best interpretation of the research currently available. No claims are made that any of the large official health organizations have approved this message. It is all subject to change, which is why my papers are

clearly marked with a date. And as is always the case for everything in the world “more research is ALWAYS needed,” but now there is actually quite a lot of research out there, and certainly for some things there is clearly enough evidence to initiate some safe and cheap changes. It’s at the “**won’t hurt / really might help**” level.

I am not selling anything – no supplements, no diet plan, no books. My only goal is to try to do some good for people. However, also as always, not all the suggestions are appropriate for every individual, so be sure to **discuss things with your personal health care provider**. **Feel free to share these materials with him/her.**

References for the research cited in this paper are included at the end, divided into subtopics. In the interests of brevity and saving trees, I will sometimes refer you to another of my papers for more complete information about a particular topic. In addition, papers with more details on this topic and others available for free on the Sanford Health website.

Part One: Enhancing insulin sensitivity and decreasing incidence of diabetes.

Magnesium and chromium are two minerals which have specific roles in carbohydrate metabolism. **Both are frequently suboptimal in the diets of the majority of Americans** (based on data from the National Health and Examination Survey – NHANES) for a variety of reasons and **assuring adequacy** has been shown to be critical for insulin sensitivity. For more details, references, and specific recommendations, please see “Aunt Cathy’s Guide to Nutrition: Magnesium” and “Aunt Cathy’s Guide to Nutrition: Chromium.”

Chromium

Chromium is a component of “Glucose Tolerance Factor.” It has roles in the metabolism of carbohydrate, protein and fat. Supplementation of chromium picolinate (a well-absorbed form) has been shown to be helpful in blood sugar control and weight loss among people with Type II diabetes on sulfonylurea medication. However, at least in the amounts studied, it may not show all the same benefits among obese people on insulin whose type 2 diabetes is poorly controlled. But just supplementing at the Advisable Intake levels has also been shown to have a role in managing dyslipidemias like high triglycerides and high LDL cholesterol.

As expected, additional supplementation is unlikely to add further benefit if one's needs are already met. However, the assumption of chromium adequacy is clearly erroneous for most Americans and standard care typically does not include asking questions about intake of chromium-rich foods or chromium supplements. In fact, many folks, including many health professionals, are not familiar with which foods are the richest sources. It has been generally “not in our radar.” This continues to be a problem when interpreting studies providing supplemental chromium are conducted showing no apparent benefit with outcomes like “developing diabetes” or changes in “insulin resistance,” but actual chromium status at the onset is not evaluated.

Chromium is not the only player on the team, but it is definitely one of them. It also has roles in cholesterol and triglyceride metabolism, heart disease and possibly atypical depression. Improved cognitive-cerebral function has been demonstrated in older adults with chromium supplementation. Inadequacy is common and definitely not benign. References follow at the end of this paper.

For more information please see my handout:
“Aunt Cathy’s Guide to Nutrition: Chromium.”

Magnesium

Magnesium has many roles in metabolizing carbohydrate, protein and fat, including being an essential cofactor in the production of ATP via the TCA Cycle. [ATP is a major form of energy used by the cells ... we make by burning carbohydrate, fat or protein fuel.] In fact, **magnesium is known to play a role in over 300 chemical reactions in our bodies** including nerve activity and managing heartbeat, so it is not a surprise that it is a very important nutrient, and that inadequacy can be an issue in a broad range of health conditions.

Magnesium is specifically important for the functioning of the insulin receptors on cells, so magnesium inadequacy is a known contributor to **insulin resistance**, a key feature of Type-2 diabetes. In a very large prospective study from Harvard University it was found that **women with the poorest magnesium intake from food compared with the highest were 25% less likely to have developed diabetes over a 16 year period.**

In a Framingham study, magnesium intake was associated with insulin sensitivity in a threshold fashion, with a threshold seen at 325 mg magnesium daily.

An important finding in the National Nutrition and Health Examination Survey (NHANES) from the Center for Disease Control was that the majority of Americans take in less than 2/3 of the normally recommended amount of magnesium.

The magnesium RDA for women is 320 mg and 420 mg for men, and as the RDAs are based on the needs of people who do not have diabetes or other health problems. People with diabetes, however, often need magnesium intake levels above the RDA for reasons explained later.

A low magnesium level in the blood (hypomagnesemia) is highly prevalent in outpatients with diabetes. High plasma triglycerides, waist circumference and albuminuria (all of importance in diabetes) are also independent correlates of hypomagnesemia.

The amount of magnesium in the blood is extremely important for heartbeat and other critical functions so the body works very hard to keep the amount in the blood in the normal range. The blood magnesium level is controlled by hormones and not by daily intake, so a low level of magnesium in the blood can be a marker of serious problems. It also means that a normal blood magnesium level does not assure adequate magnesium levels in other parts of the body or in the diet.

People with poorly controlled diabetes are at particular risk of actually losing magnesium. That is because when blood sugars are high enough that **sugar spills over into the urine**, it takes magnesium with it, resulting in an **additional loss of magnesium**.

This also occurs when one uses certain blood pressure medications like **thiazide diuretics**, like furosemide (Lasix.) Any diuretics that are known to result in potassium loss will also result in a magnesium loss, but often this is not recognized and corrected. More will be said about magnesium later, and I also have a separate handout available on line with much more detail on this critical nutrient.

Magnesium Summary

Magnesium insufficiency in the general public is quite common

Magnesium insufficiency is even more common among people with diabetes.

Magnesium intake from foods or supplements is rarely evaluated by health care professionals.

Improving poor magnesium intake has the potential to help reduce the incidence of both obesity and type 2 diabetes.

Improving poor magnesium intake has the potential to help decrease insulin resistance among people who already have diabetes. (At the very least, it gives us all a more level playing field.)

Rule of Thumb: Terrific magnesium sources are the parts of plants that will become “baby plants” ... nuts, seeds, legumes and the germ of grains. Including any kind of nuts, whole grains and wheat germ, any seeds (e.g. sunflower, flax), and legumes (peanuts, dried beans, peas and lentils) is the best way to provide generous dietary magnesium

For more information on magnesium, please see: “Aunt Cathy’s Guide to Nutrition: Magnesium” and “Aunt Cathy’s Guide to Nutrition: My Current Top Five Easy Ways to Improve Your Family’s Nutrition”

Vitamin K

Vitamin K adequacy is now recognized as important in diabetes because it has a role in both body fat and diabetes/glucose metabolism. Researchers have described a potential beneficial role for phyloquinone (vitamin K in the form found in plants) in glucose homeostasis. Higher phyloquinone intake was associated with greater insulin sensitivity and glycemic status. (Phylloquinone intake, insulin sensitivity, and glycemic status in men and women. Am J Clin Nutr. 2008 Jul;88(1):210-5.) Other forms of vitamin K (e.g. menaquinone and menatretinone) are also being studied with success in correcting complications of deficiency.

As **vitamin K inadequacy is now known to be much more common than was previously believed**, the role of vitamin K in diabetes and obesity will likely begin to be evaluated even more closely in the scientific community.

Assuring vitamin K adequacy has also been found to be of great importance for prevention of certain contributors to **cardiovascular disease**, such as calcification of the arteries, increased arterial inflammation and high blood pressure. Calcification of the **kidneys** is another consequence of vitamin K deficiency of particular importance in diabetes, as is **osteoporosis**, a condition known to be more prevalent among people with diabetes. **The role of vitamin K in these many conditions has only been identified in the years since 2005, so it is not yet well known, but the research is exploding on this topic.**

Other general health problems related to vitamin K deficiency include pre-eclampsia, varicose veins and cancer of the stomach and colon. **Clearly assuring adequacy is a very good idea for everyone, but it is especially important for people with diabetes.** Vitamin K is fat soluble and this gives some folks the impression that it is therefore potentially quite toxic. **However, vitamin K has been shown to be very safe. In fact, there is no upper level of safety established for this vitamin because no one has ever been found to be harmed by it.**

Re: Vitamin K interactions with the drug Coumadin

The exception to the general non-toxicity of vitamin K is an interaction with a specific medication. Coumadin is an anticoagulant that works by interacting with vitamin K. For this reason, **consistency and adequacy of vitamin K are very important for the safety of using the drug.** People can use the drug Coumadin more safely when an adequate blood level of vitamin K is maintained because it prevents the extreme volatility that can be dangerous with this medication.

At present many people taking Coumadin are in fact deficient in vitamin K because of frequent misunderstandings and also due to the fact that the recognition of the body's many other roles for vitamin K is quite new. **Correcting the problem of actual vitamin K deficiency among users of this medication must be managed by the patient's health care provider.** (My paper just for health care providers on this specific topic is available as an email attachment but not on-line.) Note that many other anticoagulants do not operate via interaction with vitamin K, so assuring vitamin K adequacy is very easy and safe to achieve.

Seven factors are contributing to the high prevalence of unrecognized vitamin K inadequacy:

1. Vitamin K is not included in many vitamin supplements because it was assumed that we could rely on intestinal bacteria to provide a substantial amount.
2. Our ability to rely on **intestinal bacteria** for vitamin K has been found to be overly optimistic, and we are more reliant on an outside source than we thought.
3. The best sources are **dark leafy green vegetables** and many folks rarely eat them.
4. Vitamin K status is **rarely evaluated** because it has always been assumed to be just fine based on the assumption that the intestinal bacteria made enough. At the moment, a blood test for vitamin K adequacy is not included in any of the major blood-test “panels” commonly obtained during a health evaluation. This situation may change as the problem of vitamin K inadequacy becomes better recognized, but for now it is very unlikely to be measured in anyone ... even in people on the medication Coumadin, who are at great risk of vitamin K deficiency because of misunderstandings about the need for consistent vitamin K intake ... not inadequate vitamin K intake. Inducing a vitamin deficiency is never in the best interests of anyone.
5. Currently established RDA-type **recommended levels of vitamin K intake have been shown to be insufficient** to maintain older individuals in the normal range of blood vitamin K. This has not yet been evaluated in other age groups, but it seems likely that a similar result will be found.
6. People often **incorrectly believe that vitamin K is likely to be very toxic** because it is “fat soluble.” It is actually extremely safe and no upper end of a safe intake has ever been established.
7. People using the **medication Coumadin** are the only people for whom vitamin K must be provided in a consistent and adequate amount. Many of them are actually vitamin K deficient and the deficiency interferes with the safe use of the drug. At this time, because these issues are so new, the safe use of vitamin K with the drug Coumadin is very often poorly understood by the public and by many health care professionals.

For more information and details on the roles of vitamin K and ways to assure adequacy, please see my handout on line: “Aunt Cathy’s Guide to Nutrition: Vitamin K -- New Issues in Cardiovascular Health, Osteoporosis, Cancer of the Liver and Colon, Diabetes and Varicose Veins.” As noted earlier, I also have a separate paper available as an email attachment for health care professionals focusing on managing vitamin K issues for their patients on Coumadin

Vitamin D

Vitamin D inadequacy is now known to be very common throughout the USA and around the world. The World Health Organization estimates that 40-50% of the world's population is vitamin D inadequate or insufficient. It is frequently unrecognized but it is now beginning to be checked much more often, and today a vitamin D assay is actually the most requested laboratory value in clinics and hospitals.

Over 200 tissues have receptors for vitamin D hormone, so inadequacy compromises a number of functions and increases risk of many health problems, including cardiovascular disease, cancer, autoimmune diseases and compromised immune function. New roles in diabetes are also being identified. Here are some highlights:

Type I Diabetes:

There is a growing body of good evidence that **inadequacy of vitamin D in early life may be one of the triggers that brings on Type I diabetes among genetically susceptible children.** For example, in a study in Finland, children who had experienced vitamin D – deficiency rickets as infants were four times more likely to develop Type I (insulin dependent) diabetes. The data is accumulating all around the globe, and it is consistent with the well known observation that **the northern tier of the US (and places of similar latitude around the world) is known as the “Rickets Belt”, the “MS Belt” and the “Type I Diabetes Belt.”**

Latitude is the most obvious factor in vitamin D inadequacy, but many other people are at risk because of skin color, clothing that covers a person up, diet, and several other important factors. **For many reasons, vitamin D inadequacy is a very large public health problem that has not yet captured the attention of most health professionals. [I hope to be able to edit this last statement out in the near future.]**

In terms of Type I diabetes in particular, the current state of the art is to recognize that **assuring adequacy of vitamin D can be protective against Type I diabetes** to at least some degree. There appear to be several polymorphisms of vitamin D receptors that can affect the relationship, and a variety of other factors. In any case, the documented high prevalence of vitamin D insufficiency in Americans and others, and in children with Type I diabetes in particular make it very reasonable to monitor vitamin D status in everyone and supplement if necessary to ASSURE adequacy instead of simply assuming adequacy.

Here are just three examples of the many references on this topic found at the end of this paper:

Vitamin D and increasing incidence of type 1 diabetes-evidence for an association?

Diabetes Obes Metab. 2010 Sep;12(9):737-43.

Significant vitamin D deficiency in youth with type 1 diabetes mellitus.

J Pediatr. 2009 Jan;154(1):132-4.

Vitamin D in diabetes mellitus-a new field of knowledge poised for D-velopment.

Diabetes Metab Res Rev. 2009 Jul;25(5):417-9.

Type II Diabetes:

Other studies suggest that inadequacy of **vitamin D** may contribute to Type II Diabetes as well as Type I, with additional roles in a wide variety of health problems. These include death from all causes, heart failure, cardiac arrest, cancer of the colon, prostate, pancreas and breast, MS, muscle/nerve pain that is often missed and diagnosed as fibromyalgia, rheumatoid and osteo arthritis, muscle weakness and falling (sarcopenia), fractures, osteoporosis, poor prenatal outcome, and much more.

Assuring adequacy is easy, cheap and crucial to good health, and it is now recognized that **vitamin D inadequacy is very widespread in the US and around the world**. The World Health Organization (WHO) estimates that 40-50% of the world's population is at risk of inadequate vitamin D for a variety of reasons.

It is very clear that many people require levels of vitamin D intake well above the 200-400 iu RDA-ish recommendations. **As a rule-of-thumb, an intake of 2000 iu is a safe and reasonable maintenance dose**. Many people have been found in research studies to require that much to maintain healthy blood levels of this critical vitamin. (Note that 2000 iu is not a therapeutic dose for rapidly correcting a very low blood level. the "Top Five Recommendations" paper discusses these issues in greater detail.]

As diabetes increases risk of cardiovascular disease, as does vitamin D deficiency, it would be prudent to take the extra step to ASSURE that one's vitamin D level is adequate by getting an annual check of vitamin D stores especially during the winter. Also as discussed in the "Top Five Recommendations" paper, the blood level associated with the best health is 35-40 ng/dL or higher, and not the 25 ng/dL that had earlier thought to reflect a health level. An important note: Some lab report print-outs do not yet reflect this changing interpretation of "adequacy"; they still say that 25 is "normal." So when your lab comes back, be sure to ask what your actual number of ng/dL is, and not be satisfied with a description that says "normal."

And, as discussed earlier, one's intake of **fruits and vegetables**, intake of **vitamin K**, **magnesium** and **chromium**, and one's serum **vitamin C** level also appear to be factors in the likelihood of developing Type II diabetes.

Gestational Diabetes:

"Gestational diabetes" ("pregnancy diabetes") develops in mid-pregnancy in some women. It appears to develop less often among women with more vitamin D and vitamin C in their blood. A recent study showed a positive correlation of 25(OH) vitamin D concentrations (the measurement of vitamin D stores) with insulin sensitivity; they suggested that "vitamin D deficiency could be a confirmative sign of insulin resistance." In another study maternal 25OHD concentrations were found to be inversely related to fasting glucose in another study.

Women identified in a clinic as having gestational diabetes may actually have had unrecognized Type II diabetes all along. Additionally, people who are significantly overweight need higher intakes than others to maintain a normal blood level of vitamin D. A side note: with so many young women being overweight now, and because some will actually have unrecognized Type II diabetes, it will be important to begin checking for diabetes much earlier in pregnancy (preferably before conception) in order to minimize the birth defects that are associated with poorly controlled diabetes in very early pregnancy.

For much more on this issue, please see
“Aunt Cathy’s Guide to Nutrition: Top 10 Issues in Nutrition for Pregnancy”

Adequacy of Iodine and Selenium is important for normal metabolism. The mineral selenium also appears to assist with moving glucose into the cells. Both selenium and iodine are centrally involved in the production of the hormone thyroxine by the thyroid gland. Thyroxine is responsible for setting one’s basal metabolic rate (BMR) ... the amount of calories used to run one’s body in a resting state. Poor production of thyroxine contributes to weight gain and fatigue. Selenium is also a part of a very important antioxidant in the body called glutathione peroxidase. More will be said about selenium later. Risk of selenium and/or iodine inadequacy depends on the soil upon which one’s food was grown. Recently, a resurgence of inadequacy of iodine has been documented in America and around the world because of changes in food patterns. **It is likely that the documented increase in iodine inadequacy is also contributing to weight problems.**

For more information on the return of iodine deficiency as a public health problem, please see: “Aunt Cathy’s Guide to Nutrition: My Current Top Five Easy Ways to Improve Your Family’s Nutrition”

Exercise is not a nutrient, but it does play important roles in metabolism. Besides affecting lean body mass (and so BMR,) and the calories burned from activity itself, it also has the capacity of helping to move glucose into the cells, so it is a cornerstone of prevention and also of treatment of Type II diabetes. Exploring this topic further is outside of the scope of this nutrient-focused paper, however.

Part Two: Minimizing secondary damage from poor diabetes control caused by higher than normal production of free radicals

“Free radicals” are normal waste products of metabolism. They can injure cell membranes all over the body if they are not “quenched.” “Antioxidants” are the substances that quench free radicals. **A much greater production of free radicals than usual is well known and documented among people with diabetes.** This is also true in many other diseases with disturbed metabolism, such as inflammatory diseases like MS or arthritis, or conditions with irregular fuel metabolism, such as obtaining a high proportion of calories from alcohol.

In diabetes, the greatest production of free radicals occurs in the people with the least well-controlled blood sugar levels. Such excessive production of free radicals causes serious injury to cells and tissues and it is **an important contributor to the development of diabetes-related complications** like heart disease, blindness, poor wound healing, kidney injury and nerve damage.

The many references on this topic are at the end of the paper, but here is just one as a sample:

Dietary antioxidant capacity is inversely associated with diabetes biomarkers: The ATTICA study. Nutr Metab Cardiovasc Dis. 2010 Feb 18.

“CONCLUSIONS: Although more prospective studies are required, the data presented support the view that dietary modification towards higher consumption of antioxidants should be implemented in public health strategies, in order to better control glycemic markers in individuals, and prevent the development of diabetes at the population level”

Here are some important points from a number of different studies:

- **There is evidence of significant slowing of the development of diabetes complications by assuring a generous intake of antioxidants.** “Generous” in this context usually means substantially more than the usual RDA-type levels (i.e. RDA, RDI, AI, etc.). As noted earlier, the RDA-type guidelines (by definition) are designed to meet the needs of the “healthy” population, so also by definition, they have little to say about the specific needs of people with serious metabolic diseases.
- **Vitamin and minerals with roles as antioxidants that have been studied quite a lot have included vitamins C and E, and the minerals selenium** (part of the important antioxidant “glutathione peroxidase”) **and zinc** (as part of “Zn-Cu superoxide dismutase.”)
- The ideal level of antioxidant vitamins is unlikely to be around the RDA-type levels. As just one example, the author of a recent study concluded that:

“The results suggest that megadose **vitamin C** supplementation [1-3 grams/day] may have a beneficial effect in diabetes mellitus patients on both glycemic control and antioxidant status. Thus dietary measures to increase plasma vitamin C may be an important health strategy for reducing the complications of diabetes for patients.”

- Higher vitamin C levels in the blood, and higher fruit and vegetable consumption were recently reported to be related to decreased incidence of type II diabetes in a 12 year study of over 20,000 people. They found a strong inverse association between plasma vitamin C level and diabetes risk.
- The “odds ratio” of developing diabetes in the top quintile of plasma vitamin C was 0.38 in a model adjusted for demographic, lifestyle, and anthropometric variables. That means that they divided folks up into 5 groups based on their blood vitamin C level, and the

group with the highest level was less likely to have developed diabetes. **For every 100 who developed it in the group with the lowest vitamin C level, there were only 38 who developed diabetes in the highest vitamin C group.**

- In a similarly adjusted model, the **odds ratio of diabetes in the top quintile of fruit and vegetable consumption** was 0.78. (That is, people in the top fourth of intake were found to be about ¼ less likely to have developed diabetes.) They concluded that higher plasma vitamin C level and, to a lesser degree, fruit and vegetable intake were associated with a substantially decreased risk of diabetes.
- Our old friend **vitamin E** (alpha-tocopherol and its cousins like gamma-tocopherol) are back in the news with a lot of new research into its potential to protect against a variety of diabetes related complications.
- It is also being shown that **combinations of antioxidants** may provide more benefit than a generous intake of any one antioxidant alone. As an example, in a study with rats with diabetes, the treatment with a combination of generous vitamins C and E had a significant positive effect on decreasing diabetic damage to learning and memory.
- Another unique antioxidant that has been studied extensively in diabetes is **alpha lipoic acid, (also called thioctic acid,)** a B-vitamin-like substance made in the body from the essential fatty acid linoleic acid. It also has a role in energy production, as it is required in two places in the TCA cycle involved in making ATP energy. It is very safe, and the level that is generally agreed as being **most likely to bring about positive effects in diabetes research has been 600 mg/day.** A randomized, double-blind, placebo-controlled, multi-center trial showed that alpha lipoic acid at an oral dosage of 800 mg/day for 4 months significantly improved cardiac autonomic neuropathy in patients with type 2 diabetes. (Treat Endocrinol. 2004;3(1):41-52.)

This is one of the three supplement substances that were described earlier as being more expensive, and it is sometimes available on line or over the counter in pills of 50 mg or more. A prescription for a higher dose pill would facilitate things. One area in which alpha lipoic acid has been most effective (and most studied) is in peripheral neuropathy (nerve pain) research, but it now looks very promising in several areas of diabetes complication research.

- Another potent antioxidant with other roles in energy metabolism is “**ubiquinone**” – **Coenzyme Q-10.** It is very safe and helpful in a number of applications, but it is also more expensive and a prescription might be helpful for this reason. CoQ10 treatment significantly improved deranged carbohydrate and lipid metabolism of experimental chemically induced diabetes in rats. The mechanism of its beneficial effect appears to be its antioxidant property. It has shown benefit in a variety of conditions involving altered metabolism (like diabetes but others as well) and specifically useful in eye health and muscle health.

- **A generous intake of a variety of plant pigments (natural coloring agents) such as carotene in carrots, lycopene in tomatoes, lutein in spinach and anthocyanin, the blue/red color in blueberries are being shown to be terrifically beneficial in decreasing the complications rate in people who have diabetes.** They have been found to be VERY potent antioxidants – some (like Lycopene) have shown antioxidant protection at 200 times the antioxidant potential of vitamin E!

Research into the control of free radical production (or “quenching” them after they are formed,) has shown antioxidants to have promising roles in kidney health, eye circulation, lens and retinal health, circulation of blood to the extremities, wound healing, peripheral neuropathy, erectile dysfunction, the development of gestational diabetes, and birth defects.

It’s time to seriously consider adding antioxidant protection to our standard protocols

For a review and recommendations for these vitamins, minerals and the plant pigment antioxidants, please see “Aunt Cathy’s Guide to Nutrition: Eye Health.”

Part Three: Reducing the severity of inflammation that has been shown to be associated with diabetes

Inflammation is now being recognized as a significant contributor to heart disease and to tissue damage in general. For example, inflammation inside the blood vessels is an important reason why cholesterol sticks to the arteries and builds up to block circulation. **Poor control of diabetes especially results in an increase in inflammation.**

Besides being a special problem in diabetes, this has been found to be true for many conditions that have an inflammatory component, such as rheumatoid arthritis, MS and inflammatory bowel disease. Inflammation is a normal part of the immune system, but excessive inflammation is injurious. Sometimes inappropriate messages can be sent to cause tissues to be inflamed more than they should. The inflammation results from any chronic disturbances in normal fuel metabolism, such as that seen with diabetes, autoimmune diseases and excessive alcohol consumption.

Two particular families of fats (called the omega-3 family and the omega-6 family) are used to make the inflammatory agents that are part of our immune system. The inflammatory agents are called prostaglandins. When prostaglandins are made from an omega-6 fat they are way more inflammatory than when they are made from an omega-3 fat.

Altering the ratio of omega-6 to omega-3 polyunsaturated fats has been shown to be an important step in achieving health for most Americans, and especially so in diabetes. Americans tend to eat about 10 grams of omega-6 fat for every gram of omega-3 fat. That is, we have about a 10-to-1 ratio of „sixes-to-threes.”

The demonstrably heart-healthy “Mediterranean diet” provides about a 4-to-1 ratio, and most healthy people would clearly benefit from change in this direction. For people with diabetes, MS, and other hyper-inflammatory conditions, it has been suggested that a ratio of two-to-one may provide additional benefit.

One reason why our intake of omega-6 fats is so high is because many of the vegetable oils that we use a lot, like **corn oil, are almost all omega-6**. Soy oil has a little omega-3, canola has a bit more, and flax oil has even more. However, the vast majority of our foods are not made with canola oil, much less flax oil.

What vegetable oils do they use in the Mediterranean Region? They use a lot of **olive oil and peanut oil** instead of other vegetable oils. Olive and peanut oils both are high in MONOunsaturated fat ... a type that is neither omega-3 nor omega-6 and not involved in making inflammatory prostaglandins. **If we were to replace a significant amount of our usual omega-6 dietary fat (like corn oil) with monounsaturated olive or peanut oil, though, it would make a very substantial change in the omega-6 to omega-3 ratio.**

These “heart healthy” monounsaturated and omega-3 fats are also the kind that are well represented in **nuts and peanuts**. This another good reason to eat these foods which are also such excellent sources of magnesium and chromium. **Nuts and peanuts are real winners for people with diabetes.**

The omega-3 and omega-6 vegetable oils are converted in our bodies to the forms of fat used to make prostaglandins. These are the fats called EPA (the omega-3 one) and ARA (the omega-6 one.) We have always thought that if people ate the vegetable forms they could easily convert them to the EPA and ARA forms. **However, another important new discovery is that many people are unable to efficiently convert vegetable essential fats to these critical EPA and ARA fats that are used to make a variety of important substances.**

We can eat ARA omega-6 fat “ready-made” in meats, and “ready-made” EPA omega-3 fat in fish. However, if people who are unable to efficiently make these fats from vegetable oils eat meat and little fish, then ALL the fats they have available to make prostaglandins are the really inflammatory omega-6 type.

Additionally, we are supposed to make an important fat called DHA out of EPA. DHA is a primary fat of a healthy functional brain. Adequate DHA appears to be important in maintaining cognition, in retina health in the eye, and in mood. **This means that some folks are much more dependent on their diet to assure adequacy of both of these key substances.** This defect in producing EPA, ARA and DHA fats from the forms in plants may be a significant contributor to inappropriate hyperinflammation and so it is very important in diabetes especially.

This discovery is behind recommendations that **“ready-to-go” sources of these fats, like fish or fish oil supplements** have important health benefits for minimizing complications of diabetes, risk of cancer and heart disease, and in promoting a healthy outcome of a pregnancy. **The American Heart Association recommends eating fatty fish twice a week or taking a 1000 mg daily of fish oil (which contains ready-made EPA and DHA.)** Some folks are advised to take more ... for example some people who have high triglycerides in their blood

respond well to 2-4 times that amount. [Check with your doctor before using the higher doses, especially if you are taking aspirin or a medication to block blood clots.]

For more information and specific recommendations, please see:
“Aunt Cathy’s Guide to Nutrition: Omega-3 Fats and Other Lipids.”

Part Four: Helping to stabilize excessive fluctuations of blood sugar

Some individuals have a problem with widely fluctuating glucose levels in spite of following the diet, exercise and medication program very carefully. This used to be called “**brittle**” diabetes. In the past, these people were sometimes suspected of “cheating” on the diet, since health care professionals could not explain the phenomenon. Unfortunately, this accusatory response is still common in some settings.

Increasing knowledge of the effects of other **differences in types of carbohydrates consumed and factors affecting absorption** have led to some changes in our globally accepted recommendations. For example, the carbohydrate called sucrose (regular table sugar) is not looking automatically bad, and the carbohydrate in the form of high fructose corn syrup is looking a bit worse. The high-fructose corn syrup issue is a matter of considerable discussion just now and the jury is still out.

But clearly, some of the issues are related to whether one is taking in these forms of carbohydrate alone (as “empty calories” like in soft drinks) or whether they are eaten as a part of a meal that provides key nutrients involved in metabolizing the carbohydrate taken in.

The popular movement toward **whole grains/whole foods** has improved the **nutrient-to-carbohydrate ratio**, resulting in an improved magnesium and chromium intake, as described above. Increasing the intake of **soluble and insoluble fiber** in foods has positive effects, although we are quick to assume that it is the **fiber** in a “high fiber diet” that does all the good, when a high fiber diet clearly alters many other nutrition parameters as well. (If it were just the fiber providing the benefits, just taking some fiber supplements would do the job; but we only see the great results when people eat nutrient-dense foods that are naturally high in fiber.)

In the not too distant past, the prescribed diet for diabetes was pretty strict about whether the carbohydrate in a food was sucrose or glucose or lactose or fructose or starch, so people were advised to eat very specific amounts of very specific food groups at each meal. Swapping foods between different food groups was discouraged because it was thought that the carbohydrate would probably be used very differently in the body.

However, because we can now easily check people's blood sugar, we have learned that this distinction of carbohydrate type is much less important. We now commonly use a system of **counting grams of carbohydrate in a meal or snack** instead of the more rigid (and much less effective) "exchange system" for meal planning. This has been shown to make managing diabetes much simpler and people are much more successful using this approach than the older version.

But now we also no longer perceive **apple juice** and an **intact apple** to be nutritionally identical in regard to the diet for diabetes, even if the number of grams of carbohydrate are identical and they are both from the old "fruit group." Other substances in the apple, like pectin (a type of fiber) for example, make a difference in how it affects our blood sugar. The same is true of white bread and whole grain bread. Whole grain offers those important nutrients magnesium, chromium, fiber and vitamin E that are not provided in white bread. That means that compared with nutrient-dense whole grain bread, white bread is more of an "empty calorie" food, and therefore less helpful in managing diabetes.

Improved understanding of the fate of specific carbohydrate-containing foods as described above is lending some light to this puzzle, resulting in exploration of concepts such as **genetic differences** in people's metabolism, and the "**glycemic index**" of foods and meals. A quick definition: The Glycemic Index is a comparison of the effect on blood sugar from eating 50 grams of carbohydrate from a food compared with eating 50 grams of carbohydrate as plain glucose. ("Glyc- = glucose or sugar; "-emic" = in the blood.)

A food that is described as having a "**low glycemic index**" is one that will cause a smaller rise in blood sugar in response to eating it than would be produced by plain glucose. The lower blood sugar response can help decrease injury to the circulatory system caused by frequent high peaks of blood sugar. In general, and for several reasons, more complex "nutritionally-dense" foods will usually have a lower glycemic index than "empty calorie" foods like regular soda. However, the glycemic index is just one more tool to use to manage blood sugar in diabetes. A complete evaluation of this research is too large to include here.

One other important piece of the puzzle of large fluctuations in blood sugar is less well known among health professionals, so I will address it here in some detail. It has been found that **relative inadequacy of a substance called "carnitine" exists in some people with diabetes and in others.**

Additionally, there is increasing evidence that supplemental carnitine can be of significant help in prevention or improvement of a number of complications of diabetes. For example, in a recent study **the average serum free-L-carnitine levels in patients with diabetes who had complications was almost 25% lower than in the patients with no diabetes-related complications.** On the basis of the study results, the researchers suggested that "carnitine supplementation in diabetic patients, especially in patients with diabetes complications, might be useful."

Relative carnitine inadequacy has also been found to be a factor in a number of other health conditions, with special importance in kidney disease, high triglycerides, obesity, poor wound-healing and poor eye health ... all of which are risk factors related to diabetes.

Normally, one makes an adequate amount of carnitine in the liver and kidney from methionine and lysine (two essential amino acids,) and additionally carnitine may be obtained from meat. (That's why it is called carnitine – it comes from “carne” which means meat in Latin and Spanish. Memory device: think of “chili-con-carnitine.”) Individual differences in requirements, diet, genetic carnitine production, and the use of certain medications (like valproic acid for seizure control) can result in a relative inadequacy.

Carnitine is a key component of a cellular transporter called “carnitine palmitoyl transferase” which allows fatty acids to cross the mitochondrial membrane to be used as fuel to make ATP. Because inadequate carnitine impairs one's ability to move fatty acids into the mitochondrial membrane, symptoms can include lethargy, significant weight gain and obesity, poor exercise endurance, poor muscle tone, heart muscle damage (cardiomyopathy,) greatly fluctuating blood sugar, excessive appetite, elevated triglyceride levels in the blood, and if applicable, “breakthrough seizures.” and increased risk of liver toxicity from use of certain medications.

The key feature that affects blood sugar is the fact that there are times when we normally switch to burning primarily fat as a fuel source in order to spare glucose for the brain – sort of like having “dual heat” in your home: gas and wood. The brain does not burn long chains of fat like other tissues can do. It can use only tiny bits of fuel like glucose molecules. **But if fat is unable to be burned by other tissues because of carnitine inadequacy, a person will have to burn glucose that he/she really can't afford to burn.** [It is like living in North Dakota in the winter and running out of fuel. You have to burn something to stay alive so you start burning the furniture!]

This unusual need to burn carbohydrate because fat cannot be used can result in an extremely low blood sugar. This, in turn, can trigger release of glucose as glycogen from the liver, causing blood sugar to rebound up high. At night when we are fasting, we usually switch over to burning mostly fat. But poor carnitine status can make that effort fail. As a result, people can experience a low blood sugar in the night and it may not even wake them up. While they sleep, a rush of “rescue” glucose from the glycogen stores in the liver will result in people waking up with surprisingly high blood sugars.

Even more seriously, if no glycogen is available to provide the glucose to correct it, the low blood sugar can be injurious, and even life-threatening. This very serious kind of low blood sugar is especially a problem in people who use insulin as part of their diabetes management.

People using insulin who experience unexpected low blood sugars or unstable blood sugars should be sure to check out the possibility that inadequate carnitine is contributing to the problem. In some studies people with Type-1 diabetes have been found to have low carnitine levels in spite of our usual ability to simply make enough ourselves. It is a bit like

insulin in that way ... people usually simply make enough ourselves and don't need to take insulin. But as you are aware, some folks DO need to take it even if others do not. It may be the same with carnitine.

Bottom line: if a person experiences this kind of yo-yo blood sugar with no identifiable cause, a trial on carnitine would be a good idea. Getting a blood level is not necessarily helpful, because if it is low, then one would prescribe some carnitine. However, if it is "normal," the blood levels do not necessarily reflect adequacy in the other tissues like the heart muscle. So, if there are suggestive symptoms, one would want to do a trial anyway. The usual dose is 50-100 mg/kg/day divided into 3 doses (just because of the high osmolality,) with a maximum usually 3000 mg/day.

For health professionals who want to do a trial for a patient who has symptoms as described, there is no reason not to start at the 100 mg/kg level, as the working presumption of the trial is that tissues may be depleted. Starting too low and stopping too soon may mask a true effect. When I do a trial, we monitor selected symptoms for change, and usually the trial would be continued for at least a month even in the absence of symptom relief, in order to be sure that any deficiency would have been corrected to the point of detection of symptom change.

Carnitine is the other supplemental substance that requires a prescription for a trial and which can be expensive. Over-the-counter products are available, but their actual carnitine content is not assured, so at least for the trial, I would prefer to use the guaranteed product. However, more carnitine supplements are becoming available over-the-counter for lower prices, especially on-line. It is also useful to consider the cost of carnitine supplementation against the cost of damage from blood sugar vacillation, and the impairment of energy production, endurance, and heart function etc., if the problem is not identified and corrected.

Please see my more detailed paper on this topic:
"Aunt Cathy's Guide to Nutrition: A Short Carnitine Discussion That Might Be Helpful."

Part Five: Minimizing risk of developing other threats to health and well-being, including some conditions that are known to be exacerbated by diabetes.

There are a number of conditions for which people with diabetes are at increased risk. These include **elevated homocysteine levels, depression, cardiovascular disease (including stroke), leg cramps, and general neuropathy.** Some are related to **medications**, such as the effect of metformin (Glucophage) on vitamin B12 level. Other common problems that can cause trouble for people with diabetes (or anyone) are these: Proton pump inhibitors for **GERD** may also contribute to poor absorption of vitamin B12 from food, and seriously obese people with diabetes may have had (or plan to have) **gastric bypass (bariatric) surgery**, which can also compromise vitamin B12 absorption and absorption of many nutrients. These situations will need a closer look than usual among people with diabetes.

At present, follow-up of micronutrient status in people who have had bariatric surgery has not been consistent or studied adequately. Often the only outcomes evaluated are losing weight and keeping it off, and any benefits seen in terms of cholesterol, blood pressure and diabetes. For many patients, risks associated with potential multiple micronutrient deficiencies are not assessed or followed at all. An additional concern is a lack of long term monitoring of these issues for bariatric surgery patients. **Many studies have shown that the population undergoing bariatric surgery are often in very poor micronutrient status even before the surgery is performed, so impaired absorption of nutrients after surgery is even more serious.**

High triglycerides are known to be a risk factor for **stroke** in people with diabetes especially. Three of the nutrition factors described above are associated with correcting high triglycerides: inadequate chromium intake, a high ratio of omega-6 to omega-3 fatty acids, and a relative carnitine inadequacy are all potential contributors.

Inadequate vitamin B6 and magnesium appear to be involved in diabetic neuropathy, and also in heart disease and leg cramps. Vitamins B1, B6, B12 and folic acid are critical for preventing elevated homocysteine, a major contributor to stroke (or at least a marker for increased risk of stroke,) and possibly to alzheimers. Folic acid inadequacy is associated with cancer of the breast, prostate and colon. It is also a contributor to depression and inadequacy also makes therapeutic interventions for depression (such as SSRIs) work much less well. Chronic antibiotic use and alcohol abuse both impair folic acid absorption.

Certain groups of people have a genetic problem that requires special attention to folic acid. For example, among some people of Irish heritage, the MTHFR gene has been discovered that contributes to higher rates of certain birth defects, depression and alcoholism related to problems associated with folic acid metabolism. (Please see “Aunt Cathy’s Guide to Nutrition: Folic Acid” and “Aunt Cathy’s Guide to Nutrition: Vitamin B12” for details, references and recommendations.)

Some studies with vitamin B6 have used levels of 50 to 100 mg to achieve a desired effect in people with diabetic neuropathy. This is much higher than the RDA-type level of about 2 mg, but not anywhere near a level that might be a problem. This is especially true if one is hypothesizing that their vitamin B6 requirements are in fact higher than the requirements of other people.

Niacin (vitamin B3), riboflavin (vitamin B2) and thiamine (vitamin B1) and biotin are all being studied. B vitamins are generally among the least toxic vitamins – B6 is the only one documented to cause problems with high amounts, and that was only in the most sensitive people, and never at levels below 200 mg/day. Most people who experienced any tingling in the forearms (the symptom in question) were taking over 500 mg chronically. Some people find it safe, cheaper and convenient to take a “B-100 Complex” tablet along with their general multivitamin with minerals, instead of trying to tinker with a lot of individual B vitamins.

As always, check with your physician about applying any of these ideas to your own health circumstances. But it may be helpful to share this handout with him/her with the section marked that you are asking about. Providing it before your visit to discuss it will give your physician a chance to review the research studies I have listed. Much of this is quite new, and there is a lot of research out there to try to keep up with. Additionally, there is a lot of wacky stuff out there that health professionals are aware of. It can be overwhelming, so there can be a tendency to “Throw the Baby out with the Bathwater.” The purpose of this review is to help sort out the real “babies” in that bathwater that can be very helpful for improving the health of patients.

It has recently been found that serious chronic conditions like **celiac disease, hemochromatosis and certain thyroid problems are much more prevalent in the general population** than has been previously thought. Health professionals would do well to keep these conditions in mind especially among their patients with diabetes. **There are some links between hemochromatosis and diabetes, between hemochromatosis and celiac disease, and between diabetes and celiac disease.** For example, according to a recent report, “higher iron stores (reflected by a significantly elevated ferritin concentration and a lower ratio of transferrin receptors to ferritin) are associated with an increased risk of type 2 diabetes in healthy women independent of known diabetes risk factors.”

Thyroid health problems may be related to **diabetes**, but there is also a newly recognized recurrence of **iodine deficiency** in the US resulting in goiter (enlarged thyroid), weight gain and loss of energy. Additionally, the American Medical Association recommends that all women over 40 have their thyroid function checked annually. There are **age-related changes** that can make women’s (especially) thyroid hormone gradually become inadequate.

Celiac disease, an autoimmune disease that is triggered by exposure to gluten in wheat, rye and barley is genetically more common among people with Type I diabetes. At our clinic, we screen children with Type I diabetes for hidden celiac disease with a blood test. (We also check children with Down syndrome, as they have an increased risk of both celiac disease and Type I diabetes. They have also been found to produce more free radicals than other people, and to sometimes benefit from carnitine supplementation.)

In addition to the gastrointestinal problems that are the most commonly recognized symptoms of celiac disease (which can certainly affect absorption of many nutrients,) it is now recognized that there are other less well recognized neurologic and dermatologic manifestations of celiac disease, and they could be complicating the recognition and treatment of neurologic and skin disorders thought to be primarily related to diabetes. Celiac is also by nature inflammatory and it also contributes to increased production of free radicals.

The increased risk of **developing “pernicious anemia” (an auto-immune type of very injurious kind of anemia) is also a threat in people with Type I diabetes.** It may fail to be recognized because the neurologic symptoms of B-12 deficiency are often mistakenly attributed to diabetes-related neurologic complications. As noted earlier, other factors can interfere with vitamin B12 deficiency as well.

As noted above, both hemochromatosis and celiac disease are decidedly not rare as had been thought and both are very detrimental, so health professionals caring for people with diabetes should be alert for these problems. Hemochromatosis causes an increased risk of damage to organs like the liver, pancreas and heart, and it also is known to contribute significantly to inflammation and production of free radicals. A **dietary protocol in support of the primary treatment of hemochromatosis regular phlebotomy** (giving blood) can be very helpful, but I have found that many health professionals are not familiar with the many nutrition adjustments that can be of great benefit. The diet does not control hemochromatosis, but it allows the therapeutic phlebotomy to be done as often as needed by providing the other (non-iron) requirements for making red blood cells.

If interested in this, please see “Aunt Cathy’s Guide to Nutrition: Hemochromatosis.”

7. Discovering the emerging miscellaneous effects of a variety of phytochemicals on the diabetic state.

Around the world and in the US quite a number of plants and their various “phytochemicals” (“plant chemicals”) are being investigated for their ability to influence health in diabetes and in general. This is outside of the scope of this paper, as in general the properties being looked at are more of a pharmaceutical nature than a nutrition nature. But if you would like to get a taste of the kinds of studies being undertaken, simply log on to Public Medline (www.pubmed.gov) and pick the box at the right that says “for health professionals.” Then check the “Medline” box.

You will see a box at the top of the screen in which you should enter search terms such as: diabetes plant or diabetes herb or diabetes phytochemical. You will find reports like this: “Coffee consumption and risk of type 2 diabetes mellitus: an 11-year prospective study of 28,812 postmenopausal women” in the journal Arch Intern Med. 2006 Jun 26;166(12): 1311-6. The conclusion of this study was that “Coffee intake, especially decaffeinated coffee, was inversely associated with risk of type 2 diabetes mellitus in this cohort of postmenopausal women.” That is, the coffee-drinkers had LOWER risk. More recent studies have supported this finding.

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