

The V Phenomenon:
Vanadium's Role in Diabetes

By Dr. Donna Schwontkowski
(Ret. D.C., M.S. Nutrition, Master's in Herbology)

The V Phenomenon: Vanadium's Role in Diabetes

Copyright 2009 Dr. Donna Schwontkowski

All rights reserved under all Copyright Conventions

Publisher's Note;

Neither the author or experts quoted or the publisher assume any responsibility for the use or misuse of information contained in this book.

No part of this publication may be reproduced, stored in or introduced into a retrieval system, or transmitted in any form – by any means (electronic, mechanical, photocopying, recording or otherwise), without the prior written permission of both the copyright owner and the publisher of this book.

This book and any part of it may not be used in any way, shape or form as a manuscript for rewriting articles, blog postings, newsletters, books, audio scripts, podcasts or video scripts.

The scanning, uploading, copying and pasting, and/or distribution of this book or part of this book via the internet or via any other means without the prior written permission of the author are illegal and punishable by law.

Published in the United States by
Million Dollar Memory Publications
www.milliondollarmemory.net
1-877-747-5677

First printing March 2009

Table of Contents

About the Author	6
Introduction	7
Vanadium is good, right?	
Benefits of Reading This Book	
Chapter 1. How Dan Helped Uncover the V Phenomenon	10
Hair Analysis Reports Can Predict Health Problems	
A Supplement History Can Determine Why Health Issues Arise	
Testing for Vanadium	
We Know that Detoxification Helps	
The 9-11 First Responders Needed to Use Detoxification	
Chapter 2. Why You Should Know about Vanadium	14
Teenage Girl in Medical Crisis	
The V Phenomenon	
Foods that Contain Vanadium	
What Exactly is Vanadium?	
Chapter 3. Sources of Vanadium	16
Where is Vanadium Found in Nature?	
Vanadium Used in Batteries	
Locations Found High in Vanadium	
Seaweeds Concentrate Vanadium	
Vanadium Manufacturers and Processors	
Polluted Dairy Farms	
Other Sources of Vanadium	
Unexpected Sources of Vanadium: Orthopedics	
Unexpected Source of Vanadium: Nanotechnology	
How Nanotechnology Makes Vanadium	
Chapter 4. Animal Studies	21
Health Club Owner Confused about Diabetes	
Vanadium Not Yet Considered Essential to Human Health	
Good Element... or Bad?	
Effect on the Heart	
Effect on Reproduction	
Effect on the Adrenals	

Chapter 4. Animal Studies (continued)

Effect on Liver Enzymes and Lipid Peroxidation
Effect on the Brain and Nervous System: Spatial Ability and Attention
Effect on the Brain and Nervous System: Aging
Effect on the Brain and Nervous System: Free Radicals in the Brain
Effect on the Brain and Nervous System: Myelin Sheath Targeted
Effect on Other Dietary Nutrients
Effect on Lung Tissue
Could There Be Another Reason Why Vanadium Hurts Lung Cells?
Memory Loss Lately?
Breathe It In, Get Lung Tumors ... If You're a Rat
Factor in Pulmonary Fibrosis?
Vanadium Accumulates in Liver and Kidney

Chapter 5. Human Studies Prove Toxicological Effects 26

Vanadium Named as a Top Pollutant
Vanadium Causes Free Radical Production
Vanadium Warning to Boiler Makers
A Component of Orthopedic Devices and Implants
Causes Oxidative Stress, Aging and Cancer
Oxidative Stress and Diabetes
Vanadium Creates Free Radicals
A Potential Cause of Head and Neck Cancers
One Way Vanadium Causes Cancer
Scientists Report Three Ways Metals Cause Cancer
How Does Vanadium Get Into the Cell?
Vanadium Promotes Red Blood Cell Suicide

Chapter 6. Should I Consider Supplementation? 32

Vanadium Imitates Insulin
Vanadium Found to Affect Diabetes Positively
Diarrhea: A Common Side Effect
How Researchers Test Rats with Diabetes
Lowers Insulin Requirement

Chapter 7. Additional Effects of Vanadium 35

Vanadium Comparable to Standard Diabetic Drugs?
What Type of Vanadium Works Best?
Brain Injury Patients May Benefit
Does Vanadium Have a Role in Cancer?
Arrested Mammary Cancer in Rats
Arrested Liver Cancer in Rats
Stopped Cancer in Rats
Conclusion by Some Researchers

Chapter 8. Safety	38
Effective Dose Borders on Toxic Dose	
Do We Really Want to Mimic Insulin?	
Chapter 9. Where to Go from Here	40
How To Find Out Your Levels of Vanadium	
Start Monitoring Your Health with a Simple Non-Invasive Test	
A Hair Analysis Needs Explanation and Guidance	
Where to Find Someone to Read the Hair Analysis	
Chapter 10. How To Decrease High Vanadium Levels	42
The Supplement N-Acetyl-Cysteine (NAC) Decreases Toxicity	
Vitamin E Acetate Completely Reversed Vanadium's Detrimental Effects on the Testes	
Antioxidants Come to the Rescue	
What Happens to Toxicity When You Add Selenium to Vitamin E?	
Chelating Agents are Often Used to Lower High Levels of Heavy Metals	
Is Decreasing Inflammation Advantageous?	
What Chinese Herbs Have Been Tested?	
Other Nutrients That Can Impact Vanadium Toxicity	
Beta-Cell Destruction by Vanadium: Remedies	
Don't Settle for a Partial Plan	

The V Phenomenon: Vanadium's Role in Diabetes

By Dr. Donna Schwontkowski
(Ret. D.C., M.S. Nutrition, Master's in Herbology)

About the Author

Before you learn more about this very disturbing trend and how it affects you, let me introduce myself. I'm Dr. Donna Schwontkowski, a retired chiropractic physician. You can call me Dr. Donna for short.

My background includes a master's degree and bachelor's degree in nutrition and a master's in herbology. My nutrition career has taken me in several interesting directions, starting out as a dietitian and food service director for a 194-bed nursing home where I eliminated all the processed foods from the menu and demanded that the cooks bake and prepare everything from scratch. The benefits the residents received in the areas of health, alertness, and death rate were amazing.

I'm a big believer of getting good solid experience and was also the dietitian/food service director for a 96-bed home for mentally ill and retarded adults, a boys' home and a senior citizens' food program. These experiences were very enlightening and extremely valuable.

I practiced chiropractic medicine for about five years before becoming editor of a California Health & Fitness Magazine. For the last 12 years I've had the opportunity to meet and interview all types of celebrities and top notch doctors and medical researchers while working at the magazine.

I've been a TV show producer and host of my own health show called Health & Fitness Solutions, which aired for over four years. In between, three companies hired me as technical advisor in the area of nutrition: a nutraceutical company, a supplement company and an herb company that specialized in herbs from the Amazon rainforest. I started my own herbal school back in the 1990s.

Over the years, I've helped thousands of people improve their nutrition and thousands more improve their health. One of my strongest callings in life is to reverse illness with diet and herbs.

Although no one ever has the corner on knowledge except God Almighty, we can learn information on health from those who are anywhere on the spectrum of learning: ones with years of experience all the way down to those who just found out about a health topic. The years it takes to become an expert are filled with learning experiences that books and inexperience don't provide. It's that experience I bring to you in this ebook.

To reach Dr. Donna, email her at DrDonna@fastermac.net or visit her website at www.DrDonna.info or www.MillionDollarMemory.net

Introduction

Is your fasting blood sugar 100 or more than 100?

Have you been told that you are a diabetic or a pre-diabetic or that you have metabolic syndrome?

Have you tried your best to stay on a carbohydrate-controlled diet but still your blood sugar levels fluctuate?

If so, this ebook is for you. Inside is information about a little-known correlation that could be one of the root causes of your erratic blood sugar levels or even your diabetes.

This little-known correlation is the relationship between a trace element known as vanadium (pronounced vah – NAY – dee – um) and diabetes.

Vanadium is Good, Right?

If you're an avid health reader, you probably already know that there have been some media reports about research studies that prove that vanadium can be helpful in the case of diabetes. That's only part of the picture. The other part is that vanadium can also be harmful.

Recently, I discovered an alarming trend in the last year – exceptionally high levels of vanadium that is showing up in people's hair analysis reports that can actually be tied to very negative health issues.

Benefits of Reading This Book

In this ebook you will:

- learn about the connection between vanadium and blood sugar regulation
- understand the relationship between vanadium and diabetes
- know how to tell if your supplement has too much vanadium, or too little
- know what happens when vanadium levels are too high or too low
- learn what to do if your levels are too high or too low

The V Phenomenon: Vanadium's Role in Diabetes and in Health

- discover how to avoid developing toxic levels of vanadium
- learn how environmental vanadium exposure affects the body
- find out about a simple test that can be used to monitor your vanadium levels
- learn about natural supplements used in diabetes: why and how they work
- find research report resources for further studies

Chapter 1.

How Dan Helped Uncover the V Phenomenon

Dan is a brilliant writer who used to write for one of the nation's popular and best-selling magazines. It is always amazing to speak to him because his mind works at the speed of lightning, connecting seemingly unrelated ideas together to make his listener laugh. He's not writing for the magazine anymore because new management decided to replace all the old staff, but nevertheless, he keeps busy by building his website.

One day about 10 years ago, Dan called and started relaying his health woes to me. He had diabetes. As an avid health reader, Dan loved to experiment with supplements.

"Hey, Dan, I've been running screens on my patients' essential elements and toxic elements. I have them send in a sample of hair to the forensic type of laboratory and we get back a panel of more than 25 different elements and potentially toxic elements. We run it for research purposes. Often the results will give us a clue as to what's off with the person's nutrition – something's too high or too low, and it can cause disease," I said.

"What kind of things can you find out?" he asked.

Hair Analysis Reports Can Predict Health Problems

"Well, someone can have a leaky tooth filling or exposure to mercury and it will show up on the hair analysis test with high mercury. A lot of times people have thyroid disease that may not respond to thyroid replacement therapy. It's possible that the reason why is because their selenium or manganese levels are low. A hair analysis is a good screen that helps determine where to go next for further testing."

"Really? What about diabetes?" he asked curiously.

"There are a few essential elements that can contribute to the body breaking down with diabetes. Chromium or zinc could be low – these two are elements necessary for the glucose tolerance factor to help regulate the blood sugar. There are others as well."

"I've learned to live with my diabetes," Dan said.

A Supplement History Can Determine Why Health Issues Arise

While asking Dan some questions about what type of supplements he had been taking, the fact came out that he had been experimenting with vanadium, taking 5 mg daily.

Although vanadium is not yet considered an essential element by the experts, only micro amounts are needed in the body. One thousand micrograms is equal to a milligram. Vanadium is recommended in small amounts, less than 100 micrograms a day. Dan was taking 5000 micrograms a day, which is 50 times the amount recommended.

“It helps me with my bodybuilding. I'll never give it up,” he said.

“How long have you been taking it?” I asked, fearful that the high dose could cause toxicity.

“A couple years now.”

My heart sunk. His body was most likely accumulating toxic levels of vanadium. And although there wasn't a lot of data on vanadium toxicity at that time, intuition and my training said something was off kilter in his nutrition by what he was doing.

Testing for Vanadium

In human health, there are many ways to determine how high or how low the level of a vitamin, mineral, trace element, fat, protein, hormone or phytonutrient is. Blood tests are common and can uncover vitamins, minerals, trace elements and hormones. Saliva is used not only for hormones but also for DNA in forensics. Hair testing is commonly used in forensics to determine if someone was poisoned by a potentially toxic element such as arsenic, mercury, or lead and especially useful if the person is dead.

You don't have to be dead to obtain a hair analysis test, though. This noninvasive test is used by many people to monitor their own health. There are countless times that I've discovered through a hair analysis that something a person was doing in their daily life was placing them on a track for serious health problems.

For example, one man in his 60s started using a new type of chemical to clean gadgets in his garage. Cleaning and organizing are always great personal habits, but the chemical he was using was high in beryllium, which causes cancer. On his previous hair analysis test, beryllium was only found at a level of about 3% and the new hair analysis showed it climbing rapidly towards 60%.

Luckily, he knew exactly what the source of beryllium was and stopped using it. His beryllium levels then fell back down to normal.

Had he not stopped using this chemical, he could have ended up with cancer since beryllium promotes cancer.

Dan, the writer, didn't want to provide a hair sample for research purposes to see what might have been going on with his health. Some people do and some people don't.

But the question rolled around inside my head for years – is it possible that high doses of vanadium cause diabetes? If so, how? Why? How long does it take? Can it be reversed?

During the original contact with Dan, research was not widely available about vanadium toxicity. Since that time, we have plenty.

And although it's not possible to say without a doubt that Dan developed diabetes because he took high doses of vanadium, I'd say it's pretty likely that high vanadium contributed greatly to the health problem.

We Know that Detoxification Helps

There are solutions now for high vanadium that never existed before. Health practitioners now know the importance of detoxification and how it works to eliminate toxicities of all different types: trace elements, potentially toxic elements such as lead, mercury, aluminum, and arsenic, minerals such as zinc, copper, boron, manganese, molybdenum and others, chemicals, pesticides, and even particulate matter that is inhaled through the respiratory tract.

The 9-11 First Responders Needed to Use Detoxification

As editor of Health & Fitness Magazine, I interview experts with very credible backgrounds in the health field. One of them was David Root, M.D., who specializes in Occupational Medicine right here in Sacramento, CA.

Many people remember watching the events of Sept. 11th, 2001 on television and one of the most characteristic memories of that day was the smoke. That smoke was filled with tons of particulate matter that caused disease, and the first responders suffered greatly for months and years afterwards.

Some of them participated in a detoxification program that was overseen by Dr. David Root, and they recovered. Others weren't so lucky. The detoxification program used by some of the first responders was created long before 9-11. Its founder was Ron Hubbard, the founder of Scientology. The actual program is used by medical facilities without the Scientology part. This successful detoxification program involves taking nutrients, especially minerals and niacin, and combining them with a little exercise and long hours in a sauna. It's a great way to eliminate residues of street drugs as well as prescription drugs, chemicals and toxins from the body.

The V Phenomenon: Vanadium's Role in Diabetes and in Health

In a matter of weeks, the first responders started coughing up every bit of particulate matter that had lodged itself in their lungs. When the body was finished expelling it, they were free of their respiratory illness and could get back to living a normal life again.

Dr. Root emphasized that many substances that are inhaled as particulate matter can be eliminated by the body under the right circumstances.

Vanadium is a substance that can be inhaled. When vanadium is found in high amounts in the body, it must be detoxified.

Chapter 2. Why You Should Know about Vanadium

Teenage Girl in Medical Crisis

“Hello, Dr. Donna? It's Debbie. My daughter Missy was just diagnosed with diabetes. The kind that needs insulin. She's only 14. Do you think you can do something for her? I want her to at least understand how to eat right.”

“There's no diabetes in your family, Debbie. Isn't that correct?” I asked.

“Yes. No diabetes. This just came out of the clear blue. It's really stressful and the doctor says she has to go on insulin. Can you help us with her diet?”

“Sure. Let's set up an appointment for tomorrow. And let's run the hair analysis for research to see if we can figure out what caused it,” I said.

Missy gladly let us take a sample of her hair the next day.

When the laboratory results came back, there was a surprising finding: high vanadium. Her vanadium wasn't just at the high end of the normal values for vanadium; it was 10 times higher than the highest point of normal.

It was time for extensive searches on the internet in research data bases for vanadium toxicity.

And right there in the research reports were the words:

“High vanadium levels can cause death of the beta cells of the pancreas.”

The beta cells of the pancreas produce insulin. When enough beta cells are killed, the body can't produce enough insulin. Then the person has full-blown insulin-dependent diabetes.

Missy's life would now follow a specific path: one that involved daily injections of insulin. There was little chance of turning back.

The V Phenomenon

Within the next year and a half, I discovered high vanadium levels in at least 30 additional people in their hair analysis reports. This had never occurred before.

And recently in the past few months, at least seven people with clear blood sugar or sugar craving problems, some of them diabetic, pre-diabetic also had high vanadium levels.

The V Phenomenon is that vanadium is touted for helping diabetes; yet diabetics who show high vanadium levels and aren't improving.

Foods That Contain Vanadium

These people weren't eating foods high in vanadium such as dill, parsley, radishes, gelatin, lobster, buckwheat, olive oil, sunflower oil, safflower oil, soy oil, corn oil, oats, rice, green beans, carrots, cabbage, eggs, oysters, and herring.

They weren't taking 60 mg or 120 mg vanadium supplements that weight lifters use to enhance weight training. The vanadium was coming from another source.

Most foods contain low concentrations, less than 1 ng/g.

The total amount of vanadium you get in supplements should be less than 100 mcg/day unless you have a deficiency. Supplements should never be more than 2 mg, and if taken, should only be taken for a very limited time period, from one to six months. A qualified healthcare practitioner should determine the dosage and length of time you should take vanadium, if at all.

What Exactly is Vanadium?

Vanadium is a silver white corrosion-resistant metal found in the earth along with iron, lead, phosphate and uranium in mines.

If you're a chemistry lover, you'll be happy to know that its oxidation states range from -1 to +5. The most common valence states are +3, +4, and +5. The element is used in steel alloys to make steel heat-resistant.

The main uses of vanadium are: iron and steel, high-strength steels, full alloy steels, tool steels, carbon steels, stainless and heat resistant steels, cast irons, titanium alloys, superalloys and hard-facing alloys, aerospace engines and airframe materials. Vanadium was discovered in 1801.

Chapter 3. Sources of Vanadium

Where is Vanadium Found in Nature?

Vanadium is found in coal and petroleum. Whenever there's an oil leak into the environment, you'll find vanadium as a contaminant. In fact, not only vanadium but also mercury and nickel levels increased after a diesel spill in Oaxaca, Mexico.

Source: Bull Environ Contam Toxicol. 2007 Oct;79(4):462-7. Epub 2007 Aug 22. Polyaromatic hydrocarbons (PAHs) and metal evaluation after a diesel spill in Oaxaca, Mexico. Salazar-Coria L, Amezcua-Allieri MA et al.

Environmental studies show that mussels increased their soft tissue accumulations of vanadium from 19% to 41% after the Erika wreck. This means that it's possible to consume high amounts from contaminated fish and shellfish.

Source: Comp Biochem Physiol C Toxicol Pharmacol. 2008 Apr;147(3):378-85. Epub 2008 Jan 15. Influence of field and experimental exposure of mussels (*Mytilus* sp.) to nickel and vanadium on metallothionein concentration. Amiard JC, Journal R, et al.

Vanadium is used to make glass, ceramics, and dyes. Vanadium pentoxide is used as a catalyst in the chemical industry.

Vanadium Used in Batteries

Another source of vanadium is a new type of battery produced in China called the all-vanadium redox flow battery (AVRFB). In one of their demos, they've shown that this new all vanadium battery ran for 8800 hours. It's designed for electricity generation, conversion and storage and can be used with renewable sources including solar power and biogas from algae. Its technology has been tested in small-scale applications with a vanadium fuel-cell bicycle and an energy-saving housing project.

Locations Found High in Vanadium

Elements are found in dirt and the earth. Like other potentially toxic elements and even essential elements, there are regions of the world that contain high amounts of certain elements and lower amounts of other elements. And when an element is found in dirt, it can also be found in dust particles.

In certain occupations, high air concentrations are a risk, such as in boiler-cleaning operations where vanadium oxides are found in the dust. The lungs absorb soluble vanadium compounds (V₂O₅) but the absorption of vanadium salts from the GI tract is thought to be poor. The kidneys excrete vanadium and the half-life is 20-40 hours.

Here are some of the largest mining sources of vanadium worldwide:

- The Bushveld complex in South Africa, in the Rhovan mine of Xstrata Alloys. About 39.5% of total world vanadium production (55,700 tons in 2006 (USGS, 2006)) comes from the Bushveld Complex.
- Rio Negro Province, Argentina.
- Gibellini Vanadium Project in Eureka County, Nevada.
- The Pinon Ridge Mill facility, located about 12 miles west of Naturita, Colorado
- Katanning project, Western Australia
- Province of Quebec, Canada, in the Matagami area in the west-central part, approximately 780 km north of Montreal
- The Lake Dore Complex is the most advanced project and the largest vanadium deposit in North America.
- Uranium mines, Colorado Plateau
- The San Carlos replacement deposit of argentiferous galena lies in desert country in east-central Chihuahua, in the Municipio of Manuel Benavides. This is about 20 air-kilometers SW of the international border at the Rio Grande and 60 km SE of the point where the Conchos River joins the Rio Grande at the twin border towns of Ojinaga (Chihuahua) and Presidio (Texas).
- The Maracas Vanadium-PGM deposit in Brazil

Seaweeds Concentrate Vanadium

Seaweeds have an affinity for heavy metals. In one study examining seaweeds found off the Brazilian coastline, researchers found the heavy metals cadmium (0.29mg/100g), chromium (0.23mg/100g), nickel (0.26mg/100g) and vanadium (3.56mg/100g).

Source: Nutritive and non-nutritive attributes of washed-up seaweeds from the coast of Ceara, Brazil.(Report). Food Chemistry 115.1 (July 1, 2009): p254(6).

Vanadium Manufacturers and Processors

We can also contribute to the amount of vanadium compounds that are released in the air as dust. The U.S., companies or facilities that manufacture or process vanadium that are releasing vanadium compounds to the environment, as cited in a U.S. government report are located in the following cities:

- Hot Springs, AK
- Fort Payne, AL
- Blytheville, AR
- Orange, CA
- Wilmington, CA
- Englewood, CO
- Alton, IL
- Peoria, IL
- East Chicago, IN
- La Porte, IN
- Middlebury, IN
- Syracuse, IN
- Arkansas City, KS
- Desoto, KS
- Hawesville, KY
- Maysville, KY
- Baltimore, MD
- St. Paul, MN
- Wilmington, NC
- Newfield, NJ
- Cambridge, OH
- Canton, OH
- Columbus, OH
- Oregon, OH
- Milwaukie, OR
- Portland, OR
- Blawnox, PA
- Coatsville, PA
- Erie, PA
- Farrell, PA
- Marcus Hook, PA
- Greenville, SC
- Sweeny, TX
- Victoria, TX
- Roanoke, VA
- Milwaukee, WI
- Wheeling, WV

Polluted Dairy Farms

Dairy farms may be polluted with vanadium from contamination from a nearby company using or producing vanadium compounds. It's possible that the cattle then eat the hay and drink the contaminated water and become ill or pass along the vanadium to us in the meat and milk.

When this actually did happen, it gave researchers the idea to test a method that might prevent the cattle from dying of toxicity. In one study, researchers allowed cattle to eat contaminated tef hay derived from the farm of origin. The treatment group received injections of 80 mg calcium disodium ethylene-diamine-tetra-acetate, called CaNa(2)EDTA for short, per kg body weight twice a week over a 10-week period. They discovered that CaNa(2)EDTA could be used as a treatment for cattle living in an environment high in vanadium.

Researchers also compared the concentrations of vanadium in commonly consumed tissues – meat and milk of cattle. The concentrations ranged from <0.05 to 11.51 mg/kg (wet-mass basis). The median concentration of vanadium in milk was 0.23 mg vanadium/kg. They concluded that if people were consuming meat or milk from animals living in an environment contaminated with vanadium, those drinking milk were at highest risk. Their computer model predicted that there is less than a 5% chance that the potential daily intake of vanadium in adults drinking milk will be >0.44 microg/kg/day.

Other Sources of Vanadium

- Oil-fired electrical generating plants
- Used in clinical trials in Europe and America for diabetes
- Petrochemical, steel, and mining industries
- Petroleum refinery fly ash pond, especially one in Delaware

A 2006 Canada goose (*Branta canadensis*) die-off at a petroleum refinery fly ash pond in Delaware was attributed to vanadium (V) toxicity. In 7-day single oral dose trials with mallard drakes (*Anas platyrhynchos*), the estimated median lethal dose (LD50) for vanadium pentoxide was 113 mg/kg body weight, while the LD50 for sodium metavanadate was 75.5 mg/kg. Sodium metavanadate was found to be even more potent (LD50 = 37.2 mg/kg) in male Canada geese.

Source: J Toxicol Environ Health A. 2006 Feb;69(3-4):331-51. Toxicity and hazard of vanadium to mallard ducks (*Anas platyrhynchos*) and Canada geese (*Branta canadensis*). Rattner BA, McKernan MA et al.

Unexpected Sources of Vanadium: Orthopedics

Due to excellent mechanical properties and good corrosion resistance, titanium-aluminium-vanadium (Ti-6Al-4V) and titanium-aluminium-niobium (Ti-6Al-7Nb) are extensively used for orthopedic surgery. Concern has been voiced concerning the implications of the constituent vanadium in Ti-6Al-4V on the surrounding environment. Particularly in osteosynthesis where the alloys stand in direct contact to skeletal muscle, undesirable biologic reactions may have severe consequences. Although gross toxicity of bulk Ti-6Al-4V on surrounding muscular tissue could not be found, the effects on bone were not tested. The commonly used biomaterials Ti-6Al-4V, Ti-6Al-7Nb, and cpTi induce an only temporary inflammatory answer of the skeletal muscle microvascular system.

Source: J Orthop Res. 2006 Mar;24(3):531-40. Short-term microvascular response of striated muscle to cp-Ti, Ti-6Al-4V, and Ti-6Al-7Nb. Pennekamp PH, Gessmann J et al.

Unexpected Source of Vanadium: Nanotechnology

The most surprising source of vanadium is in nanotechnology. Nanotechnology is used more and more to miniaturize substances such as different supplements including omega-3 fats, for the purpose of better absorption.

German researchers J.M. Wurle-Knirsch and K. Kern reported in January 2007 that "Metal oxides may hold, as nanosized particles, a toxic potential to human health and the environment that is not present in the bulk material. Due to the high surface-to-volume ratio, small amounts can lead to strong oxidative damage within biological systems, impairing cellular functions as a consequence of their high surface reactivity."

Source: Environ Sci Technol. 2007 Jan 1;41(1):331-6. Nanoparticulate vanadium oxide potentiated vanadium toxicity in human lung cells. Wurle-Knirsch JM, Kern K, et al.

How Nanotechnology Makes Vanadium

Nanocrystalline vanadium compounds are prepared via a convenient route by the reaction of metallic magnesium powder with vanadium pentoxide (the most toxic vanadium compound) and basic magnesium carbonate in an autoclave at 650 degrees C. The average particle size of the finished nanocompound is about 60 nm. The product created in this study had good thermal stability and oxidation resistance below 350 degrees C in air.

Source: Ma, Jianhua, Meining Wu, Yihong Du, Suqin Chen, Jian Ye, and Liangliang Jin. "Low temperature synthesis of vanadium carbide (VC).(Report)." Materials Letters 63.11 (April 30, 2009): 905(3). Academic OneFile. Gale. Sacramento Public Library. 3 Mar. 2009

Nanoparticles are generally synthesized from vanadium pentoxide, vanadyl sulfate and ammonium metavanadate. They range from 30-90 nm diameter and are 260 - 600 nm long.

Source: Asim, Nilofar, Shahidan Radiman, Mohd Ambar Yarmo, and M.S. Banaye Golriz. "Vanadium pentoxide: Synthesis and characterization of nanorod and nanoparticle V.sub.2O.sub.5 using CTAB micelle solution.(Report)." Microporous and Mesoporous Materials 120.3 (April 15, 2009): 397(5).

Chapter 4. Animal Studies

Health Club Owner Confused about Diabetes

One of my patients who gets annual hair analysis tests for her own research purposes was very happy about the benefits she received after starting her supplement program. She spoke with the owner of her small town health club and I was invited to speak to the club members about how to get and stay healthy for the New Year. The presentation included information about using a hair analysis to track one's health.

"I can't figure out what to do about my diabetes," Mary, the health club owner said.

"What have you been doing?" I asked.

"I watch my carbohydrates when I eat. I lost weight, over 40 pounds. After listening to you speak today, there are a few more things I can cut out – you mentioned some foods I eat that have a high glycemic index. But other than that, I do everything right. I exercise. I don't eat sugar or processed foods anymore. I have a great attitude," Mary said.

"A hair analysis can offer some clues to what's happening," I replied.

"Mary, you'll be happy with the results," said Sue, the client that had arranged the presentation. "I noticed such a big difference in how I was feeling and it didn't take long. I did one for my dad who wouldn't eat and was depressed. He looked like he was going downhill fast and in a month he was out with us on vacation, happy. And then there was my mom. I noticed a huge difference, even a personality change in about two weeks. She was low in some nutrients that can cause depression," Sue said.

A few weeks later Mary's results were sent to me from the lab. Mary had a very high vanadium level. Most likely, it was the reason why she wasn't improving her blood sugar control.

Mary needed a plan to reduce her vanadium level. It's possible that once it was within normal range, she would once again gain control over her blood sugar level. But because there aren't any research studies, we can only make informed speculations on this matter.

Vanadium Not Yet Considered Essential to Human Health

No deficiency disease has been identified in humans from vanadium. No official human or animal deficiency tests have ever been reported.

The average daily vanadium intake of the U.S. population is 10-60 micrograms vanadium. According to one source, environmental exposure shows upper respiratory

tract irritation, producing symptoms such as runny nose, wheezing, nosebleeds, conjunctivitis, sore throat, chest pain, and cough. Asthma is sometimes seen with exposure.

Read on to learn from the animal studies.

Good Element ... or Bad?

Vanadium is a metal that presents great interest from the toxicological point of view, because of the numerous alterations that can take place in different biological systems.

The predominant form of vanadium in extracellular body fluids is the pentavalent form (VO_3^-) and the quadrivalent form (VO^{+2}) is the most common form intracellularly.

Vanadium is an environmentally toxic metal with peculiar and sometimes contradictory cellular effects. It is insulin-mimetic: it can either stimulate cell growth or induce cell death, and it has both mutagenic and antineoplastic properties.

Source: Cell Biol Toxicol. 2007 Nov;23(6):413-20. Epub 2007 Apr 25. Vanadate-induced cell death is dissociated from H_2O_2 generation. Capella MA, Capella LS et al.

Effect on the Heart

Only 10 microM total vanadium of either decavanadate or metavanadate was enough to kill 50% of the neonatal rat cardiac cells in 24 hours. The mechanism of action was mitochondrial membrane depolarization.

Source: Vanadate induces necrotic death in neonatal rat cardiomyocytes through mitochondrial membrane depolarization. Soares SS, Henao F, Aureliano M, et al.

Effect on Reproduction

When injected, vanadium induced reactive oxygen species (molecules that generate free radicals called ROS) on developing germ cells and significantly reduced sperm count and increased lipid peroxidation in the testicles. There was a decrease in the production of serum testosterone and gonadotropins as well as antioxidant enzymes. The good news is that Vitamin E protected the testes from these toxic effects.

Source: Mol Cell Biochem. 2007 Dec;306(1-2):189-200. Epub 2007 Aug 1. Amelioration of vanadium-induced testicular toxicity and adrenocortical hyperactivity by vitamin E acetate in rats. Chandra AK, Ghosh R, et al.

Effect on the Adrenals

Vanadium causes adrenocortical hyperactivity (high levels of stress hormones and enlargement of the adrenal gland. Oxidative stress was the mechanism of action. Researchers concluded that vanadium could act as a stressor metal causing chronic stress effects through excitation of the hypothalamo-pituitary-adrenal axis. These changes were reversed with vitamin E acetate supplementation.

Source: Mol Cell Biochem. 2007 Dec;306(1-2):189-200. Epub 2007 Aug 1. Amelioration of vanadium-induced testicular toxicity and adrenocortical hyperactivity by vitamin E acetate in rats. Chandra AK, Ghosh R, et al.

Effect on Liver Enzymes and Lipid Peroxidation

Vanadium caused the elevated liver enzymes SGOT and SGPT, serum alkaline phosphatase and lactate dehydrogenase. As a result, lipid peroxidation in the liver increased and reduced glutathione was depleted. Glucose-6-phosphatase in the liver also was inhibited. The glycogen content of the liver and kidney increased as well.

Source: J Toxicol Sci. 2007 May;32(2):185-92. Effect of tiron and its combination with nutritional supplements against vanadium intoxication in female albino rats. Shrivastava S, Jadon A, Shukla S.

Effect on the Brain and Nervous System: Spatial Ability and Attention

Austrian scientists at the University of Vienna discovered that urine concentrations of vanadium around 14.2 microgram/L were correlated with decreased visual/spatial abilities and attention.

Source: J Toxicol Environ Health A. 2002 May 10;65(9):677-83 Neurobehavioral effects of vanadium.

Effect on the Brain and Nervous System: Aging

Vanadium increased matrix metalloproteinases in the CNS after inhalation. These enzymes are responsible for the destruction of protein in the body and contribute to aging.

Source: J Appl Toxicol. 2008 Aug;28(6):718-23. Matrix metalloproteinases 2 and 9 in central nervous system and their modification after vanadium inhalation. Colín-Barenque L, Martínez-Hernández MG, et al.

Effect on the Brain and Nervous System: Free Radicals in the Brain

Injections of sodium metavanadate (3 mg/kg body weight) for 5 consecutive days in adult rats enlarged brain cells (astrocytes) and increased free radical generation in the cerebellum and hippocampus.

Source: Drug Chem Toxicol. 2005;28(3):329-44. Vanadium (V)-induced neurotoxicity in the rat central nervous system: a histo-immunohistochemical study. Garcia GB, Biancardi ME, et al.

Effect on the Brain and Nervous System: Myelin Sheath Targeted

Injections of sodium metavanadate (3 mg/kg body weight) for 5 consecutive days in adult rats resulted in changes in locomotor activity. Scientists discovered that the myelin could be a potential target of V(+5)-mediated lipid peroxidation in adult rats.

Source: Drug Chem Toxicol. 2004 Aug;27(3):281-93. Morphological alterations of central nervous system (CNS) myelin in vanadium (V)-exposed adult rats. García GB, Quiroga AD, et al.

Effect on Other Dietary Nutrients

Sodium vanadate added to diets of weanling rats in dosages from 0 to 80 microg V/gram of diet caused cellular accumulation of copper in skin and tendon and reduced the secretion of a copper protein enzyme called lysyl oxidase. This contributes to aging.

Source: Toxicol Appl Pharmacol. 2004 Aug 15;199(1):35-43. Metavanadate causes cellular accumulation of copper and decreased lysyl oxidase activity. Cui CT, Uriu-Adams JY, et al.

Effect on Lung Tissue

It's not just the metal vanadium that acts to destroy lung tissue. Scientists at the University of Arizona tested the impact of five metals: zinc, copper, nickel, vanadium and iron on rat lung epithelial cells. The most toxic of the metals was vanadium. When vanadium was combined with zinc, the negative effects of vanadium were lessened.

Source: Toxicology. 2003 Aug 28;190(3):171-84. Effects of metals Cu, Fe, Ni, V, and Zn on rat lung epithelial cells. Riley MR, Boesewetter DE, et al.

Could There Be Another Reason Why Vanadium Hurts Lung Cells?

We are all inhaling increasing amounts of vanadium each year. Scientists at the National Institute of Industrial Health in Japan found that rats given an acute dose of vanadium

pentoxide powder directly into the trachea developed lung lesions. Dosages were 0.88, 3.0 or 13.0 mg/kg body weight. After four weeks, there were signs of inflammation, alveolar macrophage injury, swelling and degeneration of the mucus in the broncho-bronchiolar epithelial cells. The rats' growth rate was also retarded. Researchers also found that when the vanadium pentoxide was mixed in an artificial biological fluid (Gamble's solution), it was 8 times more soluble than in pure water. The damage to the lungs was thought to be caused by not only the vanadium pentoxide powder, but also by the vanadium ions dissolved from the particles into the lung fluid.

Source: Ind Health. 2001 Jan;39(1):8-15. Lung lesions induced by intratracheal instillation of vanadium pentoxide powder in rats. Toya T, Fukuda K,

Memory Loss Lately?

The concentration of vanadium in the atmosphere is increasing. Does that mean that we can all expect memory loss sooner or later? Researchers in Mexico are concerned.

Vanadium pentoxide (V₂O₅) inhalation 1 hour twice weekly in male mice caused a loss of dendritic spines, necrotic-like cell death and alterations of the hippocampus. There was also spatial memory impairment.

Source: Neurotoxicology. 2006 Dec;27(6):1007-12. Epub 2006 Apr 15. Hippocampal cell alterations induced by the inhalation of vanadium pentoxide (V₂O₅) promote memory deterioration. Avila-Costa MR, Fortoul TI, et al.

Breathe It In, Get Lung Tumors ... If You're a Rat

As mentioned previously, the increasing concentration of vanadium in the atmosphere can be partially attributed to emissions from metallurgical works and oil and coal burning. Vanadium pentoxide (V₂O₅) is one of those vanadium compounds found in emissions.

Scientists at the National Toxicology Program in North Carolina wanted to find out results of whole body inhalation for 2 years on mice and rats. All mice, male and female who were exposed had lower body weights. At 0.5 and 2 mg/m³ exposure levels (exceeding the National Toxicology Program control ranges, slightly above the OSHA permissible occupational limit for dust), male rats displayed an increased incidence of alveolar/bronchiolar neoplasms while females showed a marginal increase.

All rats showed chronic inflammation, interstitial fibrosis and alveolar/bronchiolar cellular changes. Similar findings were seen in the mice exposed to V₂O₅. Vanadium was a clear pulmonary carcinogen.

Source: Toxicol Sci. 2003 Aug;74(2):287-96. Epub 2003 May 28. Carcinogenicity of inhaled vanadium pentoxide in F344/N rats and B6C3F1 mice. Ress NB, Chou BJ, et al.

Factor in Pulmonary Fibrosis?

Pulmonary fibrosis is caused in part by the cyclooxygenase (COX)-2 enzyme. In one mouse study, COX-2 deficient mice inhaled vanadium pentoxide and 3 days later, severe inflammatory responses were seen. Pulmonary fibrosis was diagnosed two weeks after exposure. Scientists concluded that the COX-2 enzyme is protective against pulmonary fibrogenesis and COX-2 generation of PGE(2) is important in resolving inflammation.

Source: Am J Pathol. 2002 Aug;161(2):459-70. Susceptibility of cyclooxygenase-2-deficient mice to pulmonary fibrogenesis. Bonner JC, Rice AB, et al.

Vanadyl sulfate (VOSO₄) causes acute pulmonary vasoconstriction possibly by inhibiting nitric oxide production. Exposure to excessive vanadium may contribute to pulmonary vascular diseases.

Source: Environ Health Perspect. 2004 Feb;112(2):201-6. Vanadyl sulfate inhibits NO production via threonine phosphorylation of eNOS. Li Z, Carter JD, et al.

Vanadium Accumulates in Liver and Kidney

When Canadian geese started dying near a petroleum refinery fly ash pond in Delaware, scientists at the U.S. Geological Survey and the Patuxent Wildlife Research Center in Laurel Maryland suspected vanadium toxicity. They tested different forms of vanadium and found the following:

- Only 113 mg vanadium pentoxide per kg body weight was needed for seven days in an oral dose as an LD₅₀ lethal dose.
- Less was needed for sodium metavanadate in Canadian geese, only 37.2 mg/kg.

Researchers found GI bleeding and vanadium accumulation in the liver and kidney. Once levels reached 10 micrograms/gram dry weight in the liver and 25 micrograms/grams dry weight in the kidney for sodium metavanadate, death resulted. Chronic exposure to daily concentrations of sodium metavanadate over 67 days caused GI bleeding, accumulation in liver and kidney, blood chemistry changes and oxidative stress in the liver.

Source: J Toxicol Environ Health A. 2006 Feb;69(3-4):331-51. Toxicity and hazard of vanadium to mallard ducks (*Anas platyrhynchos*) and Canada geese (*Branta canadensis*). Rattner BA, McKernan MA, et al.

Chapter 5. Human Studies Prove Toxicological Effects

Vanadium Named as a Top Pollutant

If vanadium is so toxic to us when inhaled, why isn't it included in the hazardous air pollutants (HAP) in the Clean Air Act (CAA)?

Scientists are pushing for it to be included. In Feb. 2004, researchers at the University of California at Berkeley analyzed 1086 different HAPs and potential HAPs and ranked them by their emissions to air and by toxicity-weighted emissions for cancer and non-cancer using emissions information from state and federal agencies. If a chemical was considered a persistent bio-accumulative toxin, a reproductive or developmental toxin or a chemical evaluated as a toxic air contaminant in California, it was given separate consideration.

Of the 44 pollutants identified as candidate HAPs, vanadium was one of the nine that qualified in two or three different rankings.

Source: J Air Waste Manag Assoc. 2004 Feb;54(2):157-71. An analysis of candidates for addition to the Clean Air Act list of hazardous air pollutants. Lunder S, Woodruff TJ, Axelrad DA.

Vanadium Causes Free Radical Production

Nanoparticles of V₂O₃ that were inhaled can lead to strong oxidative damage and impaired cell functions in human endo and epithelial lung cells. Even the lowest concentrations of the nanoscaled material (10 microg/ml) led to reduction in cell viability. Other changes seen: induction of heme oxygenase 1, dose-dependent; lipid peroxidation in macrophages. V₂O₃ is nano; V₂O₅ is bulk material.

Source: Environ Sci Technol. 2007 Jan 1;41(1):331-6. Nanoparticulate vanadium oxide potentiated vanadium toxicity in human lung cells. Wörle-Knirsch JM, Kern K et al.

Vanadium Warning to Boiler Makers

What happens to the body when it's exposed to ambient pollutant particles (APP)? Increased number of death from heart disease. The reason why is because APP constricts the systemic arteries and increases blood pressure. The vasoconstriction may be secondary to the release of inflammatory mediators from lung cells, which then activate vascular endothelial and smooth muscle cells.

Vanadium can produce acute vasoconstriction as well. The problem is that soluble metals such as vanadium more easily permeate the alveolar-capillary membrane than the whole particle.

Both APP and its associated metals enhance the release of endothelin 1 and reactive oxygen species, activate epithelial growth factor receptor and mitogen-activated protein kinases and inhibit nitric oxide vasodilator activity. Because of these vasoactive properties, patients with vascular diseases may be more susceptible to adverse health effects. Those regularly exposed to high amounts of metals from dietary and muscle-building regimens or in the air of boiler making plants may have increased risk for vascular diseases.

Source: *Curr Vasc Pharmacol.* 2006 Jul;4(3):199-203. Vascular effects of ambient pollutant particles and metals. Huang YC, Ghio AJ.

A Component of Orthopedic Devices and Implants

Vanadium has been reported to be of concern regarding orthopedic implants. The metal is formed into an alloy with aluminum and titanium. Bone synthesis may be affected, according to researchers at the Department of Orthopedic Surgery at the University of Bonn in Germany.

Source: *J Orthop Res.* 2006 Mar;24(3):531-40. Short-term microvascular response of striated muscle to cp-Ti, Ti-6Al-4V, and Ti-6Al-7Nb. Pennekamp PH, Gessmann J, Diedrich O, et al.

Causes Oxidative Stress, Aging and Cancer

Oxidative stress contributes greatly to aging and the development of cancer. Oxidative stress is marked in the body by reactive oxygen species, called ROS and reactive nitrogen species, called RNS. These molecules can be two-faced, acting as molecular terrorists one moment and creating benefits another moment.

As a molecular terrorist, ROS acts as a secondary messenger to signal cascades of reactions that induce and maintain cancer cells. As a Good Samaritan, ROS can also induce aging and cell death in these same cancer cells. ROS and RNS are produced by various metals such as iron, copper, chromium, cobalt, vanadium, cadmium, arsenic, and nickel and by DNA damage, free radical damage to lipids and proteins, and a lot of other factors.

ROS activates activator protein (AP-1) and nuclear factor kappa B (NF-kappaB) signal transduction pathways, which lead to the transcription of genes, involved in cell growth regulatory pathways.

Source: *Chem Biol Interact.* 2006 Mar 10;160(1):1-40. Free radicals, metals and antioxidants in oxidative stress-induced cancer. Valko M, Rhodes CJ, Moncol J, Izakovic M, Mazur M.

Oxidative Stress and Diabetes

Experimental results have also shown a link between vanadium and oxidative stress in the etiology of diabetes.

Source: *Curr Med Chem.* 2005;12(10):1161-208. Metals, toxicity and oxidative stress. Valko M, Morris H, Cronin MT.

Vanadium Creates Free Radicals

Metals can cause the formation of free radicals in the body. When free radicals attack phospholipids they can further react with redox metals. The result is that mutagenic and carcinogenic compounds are produced, such as malondialdehyde, 4-hydroxynonenal and DNA adducts. Different metals act in different ways. Iron, copper, chromium, vanadium and cobalt undergo redox-cycling reactions. These generate the superoxide and hydroxyl radical primarily associated with mitochondria, microsomes and peroxisomes. Mercury, cadmium and nickel deplete glutathione and bond to the sulfhydryl groups of proteins. Arsenic binds directly to critical thiols and may also form hydrogen peroxide. Nitric oxide is produced in arsenite-induced DNA damage and pyrimidine excision inhibition. All these metals generate ROS and RNS.

Many studies have confirmed that metals activate signaling pathways and the carcinogenic effect of them is related to activation of redox-sensitive transcription factors such as NF-kappaB, AP-1 and p53.

Antioxidants provide protection against metal-mediated free radical attacks. Vitamin E and melatonin can prevent the majority of metal-mediated (iron, copper, cadmium, vanadium) damage. Vitamin C acts as an antioxidant that prevents lipid peroxidation and does not promote protein oxidation. Zinc acts as an antioxidant to reduce oxidative stress and has a neuro-protective role.

Source: *Curr Med Chem.* 2005;12(10):1161-208. Metals, toxicity and oxidative stress. Valko M, Morris H, Cronin MT.

A Potential Cause of Head and Neck Cancers

Researchers at the University of Regensburg in Germany believe that vanadium has a possible role in the development of head and neck cancers. DNA damage was induced by vanadium pentoxide in human nasal epithelial cells and in lymphocytes.

Source: *Int J Environ Health Res.* 2003 Dec;13(4):373-9. Genotoxic effects of vanadium pentoxide on human peripheral lymphocytes and mucosal cells of the upper aerodigestive tract. Kleinsasser N, Dirschedl P, et al.

One Way Vanadium Causes Cancer

One of the ways our body protects us against cancer is through the p53 tumor suppressor that regulates the normal cell cycle. Scientists at the National Institute for Occupational Safety and Health in Morgantown, West Virginia tested the effects of vanadate on mouse p53 fibroblast cells. If vanadium arrested cell growth, it had the potential to cause cancer. This was indeed found.

Source: J Environ Pathol Toxicol Oncol. 2002;21(3):223-31. Vanadate induces G2/M phase arrest in p53-deficient mouse embryo fibroblasts. Zhang Z, Chen F, et al.

Scientists Report Three Ways Metals Cause Cancer

German scientists have uncovered the mystery of how metals cause cancer. In 2008, they reported that cancer is caused by three indirect methods:

- 1) interference with cellular redox regulation and induction of oxidative stress, which may cause oxidative DNA damage or trigger signaling cascades leading to stimulation of cell growth
- 2) inhibition of major DNA repair systems resulting in genomic instability and accumulation of critical mutations
- 3) deregulation of cell proliferation by induction of signaling pathways or inactivation of growth controls such as tumor suppressor genes.

They also found that some metals such as cadmium interrupt cell-cell adhesion, trivalent chromium directly binds DNA, and vanadium interacts with phosphate binding sites of protein phosphatases.

Source: Arch Toxicol. 2008 Aug;82(8):493-512. Epub 2008 May 22. Carcinogenic metal compounds: recent insight into molecular and cellular mechanisms. Beyersmann D, Hartwig A.

How Does Vanadium Get Into the Cell?

Is it actively transported into the cells or does it diffuse into the cells easily? Scientists tested this at Peking University in Beijing. They discovered that vanadium was taken up by Caco-2 cells through simple diffusion. [VO(acac)₂] was transported transcellularly and had the highest rate of permeability. Cells accumulated more [VO(acac)₂] than [VO(ma)₂] and vanadate. All vanadium compounds caused the production of ROS intracellularly, reduced the transepithelial electrical resistance, caused morphological changes in the microvilli and led to changes in the F-actin structure.

Source: Pharm Res. 2004 Jun;21(6):1026-33. The permeability and cytotoxicity of insulin-mimetic vanadium compounds. Yang XG, Yang XD, Yuan L, Wang K,

Vanadium Promotes Red Blood Cell Suicide

When the kidneys aren't working properly, anemia is one of the problems that results. German researchers discovered a correlation to vanadium. Vanadate ($\text{VO}_4(3-)$) is known to interfere with many enzymes, including two of them: Ca^{2+} ATPase and $\text{Na}^{+}/\text{K}^{+}$ ATPase. Vanadate is excreted primarily by the kidney.

When vanadium can't be excreted by the kidneys, it accumulates in the blood. Red blood cells exposed to vanadate increase their concentration of Ca^{2+} in the cytosol, which is a trigger for red blood cells to commit cellular suicide, a process called eryptosis. Eryptosis occurs when cells shrink and expose phosphatidylserine on their surface, which acts as a red flag to the white blood cells, a sign that the cell needs to be cleared from the blood and broken down. By increasing cytosol Ca^{2+} and stimulating red blood cell suicide, vanadium may contribute to the development of anemia in chronic renal failure.

Source: Vanadate-induced suicidal erythrocyte death. Föller M, Sopjani M, Mahmud H, Lang F.

Chapter 6. Should I Consider Supplementation?

The therapeutic use of vanadium is filled with a lot of concern, both from scientists and practitioners because the element can vacillate between being essential to the maintenance of glucose regulation and toxic. The element is not yet considered essential for life.

In the late 1970s the vanadate ion was shown to act as an efficient inhibitor of Na⁺K⁺ATPase as well as of other related phosphohydrolases.

According to researchers, vanadium deficiency accounts for several organ and physiological dysfunctions including thyroid, glucose metabolism and lipid metabolism. Several genes are regulated by vanadium or by its compounds, including genes for tumor necrosis factor-alpha, interleukin-8, mitogen activated protein kinase, activator protein-1, and nuclear factor kappaB.

Source: Toxicol Lett. 2004 Apr 21;150(2):135-43. Vanadium--an element of atypical biological significance. Mukherjee B, Patra B, et al.

Vanadium Imitates Insulin

When you're reading vanadium research, you'll read that vanadium is 'insulin mimetic'. This term means that vanadium mimics the effects of insulin. Insulin's primary action in the body is to decrease high blood sugar; in several studies, you will find that vanadium decreased blood sugar levels.

Because the hormone insulin acts on target tissues of the liver, adipose tissue, and skeletal muscles, if a substance is truly mimetic, it will also act on these three target tissues. Vanadium does show action on all three target tissues. Vanadium's mimetic activity was first reported in 1985 by Heyliger.

The problem with vanadium compounds is that they are environmentally toxic metals with contradictory effects. Vanadium can stimulate cell growth or it can induce cell death. It can kill tumors or it can prevent tumors. Exactly how vanadium will work in your body is unknown because the mechanisms are only partially understood.

The other problem is toxicity. More recently, though, it was shown that organic vanadium compounds were much safer than inorganic vanadium salts and did not cause GI discomfort or liver/kidney toxicity.

Source: Mol Cell Biochem. 2000 Mar;206(1-2):177-82. Anti-diabetic and toxic effects of vanadium compounds. Srivastava AK.

Vanadium Found to Affect Diabetes Positively

Generally speaking, the research reports that show positive benefits on diabetes show an ability to improve glucose homeostasis and insulin resistance in animal models of Type 1 and Type 2 diabetes mellitus. Human studies, although limited, show improvements in liver and muscle insulin sensitivity. The effects in human studies are not as dramatic as those observed in animal experiments. This could be because lower doses of vanadium are used and the duration of the study is not as long as in the animal studies.

At the cellular level, vanadium activates several key elements of the insulin signal transduction pathway, such as the tyrosine phosphorylation of insulin receptor substrate-1, and extracellular signal-regulated kinase 1 and 2, phosphatidylinositol 3-kinase and protein kinase B activation. These pathways are believed to mediate the metabolic actions of insulin. It's possible that vanadium can enhance insulin signaling. Even researchers though are concerned with potential toxicity of inorganic vanadium salts at higher doses and during long-term therapy.

Source: Diabet Med. 2005 Jan;22(1):2-13. Insulino-mimetic and anti-diabetic effects of vanadium compounds. Srivastava AK, Mehdi MZ.

Diarrhea A Common Side Effect

University of Southampton (U.K.) researchers searched for controlled human trials of vanadium that involved the use of a placebo for a minimum of two months in a minimum of 20 diabetics with type 2 diabetes. They found 151 studies but none met their inclusion criteria. They did, however, find five clinical trials where 30-150 mg vanadium was taken daily as an oral supplement in diabetics.

Significant treatment effects were found and the most common side effects were gastrointestinal. The reviewers concluded that vanadium could not be recommended for use on a routine basis until a large-scale randomized controlled trial was performed.

Source: A systematic review of vanadium oral supplements for glycemic control in type 2 diabetes mellitus. Smith DM, Pickering RM, et al.

How Researchers Test Rats with Diabetes

Diabetes is often studied in rats by inducing the disease with the chemical streptozotocin (STZ). One single dose of 65 mg/kg is enough to cause diabetes. When researchers study diabetes, they will analyze biochemical parameters, enzyme activities, peroxidation levels, and glycation compounds both before and after the treatment they are studying.

In a study completed at Istanbul University, STZ-diabetic rats were administered an oral dose of 100 mg/kg vanadyl sulfate. They found a decrease in blood glucose, uric acid, serum catalase, lactate dehydrogenase, lipid peroxidation levels in the brain and glycation levels. They concluded that vanadyl sulfate showed antioxidant benefits and may prevent brain damage caused by STZ-induced diabetes.

Source: Mol Cell Biochem. 2006 Jun;286(1-2):153-9. Epub 2006 Mar 11. Vanadyl sulfate administration protects the streptozotocin-induced oxidative damage to brain tissue in rats. Yanardag R, Tunali S.

Lowers Insulin Requirement

Other studies show that vanadyl sulfate reversed diabetes in rats for up to 20 weeks after supplementation ceases. In Type 2 diabetic rats, vanadyl sulfate lowered the insulin requirement by up to 75%.

In humans with Type 2 diabetes, low doses of vanadyl sulfate increased glucose uptake and glycogen synthesis and suppressed the body's production of glucose. This resulted in decreased plasma fat concentrations and lipid oxidation rates.

Chapter 7. Additional Effects of Vanadium

Vanadium Comparable to Standard Diabetic Drugs?

The type of vanadium compounds that have comparable antidiabetic potential with respect to the standard drugs used vary. Two relatively new complexes proven in animal studies are bisdimethylmalonatoxovanadium (IV) and bisdiethylmalonatoxovanadium (IV).

Source: New diketone based vanadium complexes as insulin mimetics. Sheela A, Roopan SM, Vijayaraghavan R.

What Type of Vanadium Works Best?

Some researchers comment that differences in potency between compounds are due to differences in their insulin-like properties. In one rat study, there was no liver or kidney toxicity noted, although diarrhea occurred in 50% of the rats treated with vanadyl sulfate. No diarrhea was seen in those receiving an organic form of vanadium.

Source: J Inorg Biochem. 2000 May 30;80(1-2):21-5. Insulin-like effects of vanadium: basic and clinical implications. Goldwasser I, Gefel D, Gershonov E, Fridkin M, Shechter Y.

Many studies used vanadium in sulfated form, but the more bioavailable vanadium compounds, bismaltolato vanadium (BMOV) and bis-glycinate oxo vanadium (BVOG) are also available. They appear to be more active than conventional vanadyl sulfate with the benefit of increased safety, say some experts, and also show a greatly decreased risk of GI upset. In animal studies only about half as much BMOV was required to accomplish the same results of that of vanadyl sulfate.

Brain Injury Patients May Benefit

It's possible that vanadium may be beneficial in those with brain ischemia. Researchers in Japan found that administrations of vanadium compounds in the abdomen stimulated pathways in the brain that increased the development of brain cells after ischemia injuries. Authors concluded that vanadium compounds could be useful as a potential therapeutic agent.

Source: Vanadium compounds enhance adult neurogenesis after brain ischemia. Shioda N, Morioka M, Fukunaga K. Yakugaku Zasshi. 2008 Mar;128(3):413-7.

Does Vanadium Have a Role in Cancer?

Vanadium has been found to be effective in certain types of cancers: colon, mammary and liver – in rats.

Male rats given an injection of 1,2-dimethylhydrazine (DMH) developed colon cancer and were subsequently given a standard diet along with water supplemented with ammonium monovanadate. At the end of 32 weeks, all rats treated with DMH developed large intestinal tumors. The rats treated with vanadium contained significantly fewer tumors

Source: World J Gastroenterol. 2003 May;9(5):1020-7. Effect of vanadium on colonic aberrant crypt foci induced in rats by 1,2 dimethyl hydrazine. Kanna PS, Mahendrakumar CB, et al.

Arrested Mammary Cancer in Rats

After female rats were treated with a chemical that induced mammary cancer, they were then given water supplemented with ammonium monovanadate for 24 weeks. Researchers reported a significant reduction in incidence, multiplicity, size of palpable mammary tumors and delay in time that tumors appeared. Cell proliferation decreased and the number of cancer cells dying also increased. Vanadium brought about a prominent cell cycle arrest and chromosomal condensation, leading to apoptosis. Researchers were hopeful that vanadium could be developed into an anti-breast cancer drug in the future.

Source: Int J Cancer. 2007 Jan 1;120(1):13-23. Suppression of cell proliferation, induction of apoptosis and cell cycle arrest: chemopreventive activity of vanadium in vivo and in vitro. Ray RS, Ghosh B, Rana A, Chatterjee M. .

Arrested Liver Cancer in Rats

Researchers from a Calcutta university found that low doses of vanadium inhibited the development of liver cancer in rats. Immunoreactivity was decreased as well. They concluded that vanadium was chemopreventive for diethylnitrosamine-induced liver cancer in rats.

Source: J Cell Biochem. 2007 May 1;101(1):244-58. Molecular basis of vanadium-mediated inhibition of hepatocellular preneoplasia during experimental hepatocarcinogenesis in rats. Chakraborty T, Swamy AH, Chatterjee A, Rana B, Shyamsundar A, Chatterjee M.

Stopped Cancer in Rats

Before a drug or compound can be used in human trials, it must be tested with cells in the test tube, called in vitro testing, and with animal models (called in vivo testing). Often, research studies are set up where cells such as human cancer cells are grafted onto animals to induce cancers. At the present time, cancer cell lines from human leukemia, multiple myeloma, ovarian cancer, prostate cancer, testicular cancer glioblastoma, and breast cancer have been tested in vitro with a vanadium compound called metvan. The vanadium compound induces apoptosis in cancer cells.

Researchers report that metvan is highly effective against cisplatin-resistant ovarian cancer and testicular cancer cell lines. It's also much more effective than standard chemotherapeutic agents dexamethasone and vincristine in inducing apoptosis in primary leukemia cells. Metvan exhibits significant antitumor activity, delays tumor progression and prolongs survival time in mouse models of human malignant glioblastoma and breast cancer. Researchers are hopeful that Metvan could become an alternative to platinum-based chemotherapy drugs.

Source: Expert Opin Investig Drugs. 2002 Dec;11(12):1829-36. Metvan: a novel oxovanadium(IV) complex with broad spectrum anticancer activity. D'Cruz OJ, Uckun FM.

Conclusion by Some Researchers

Vanadium may play a very important role in human health: in the regulation of intracellular signaling, as a cofactor of enzymes needed for energy metabolism, and as a possible therapeutic agent in diabetes.

Source: Biofactors. 1999;10(1):43-51. Vanadium and diabetes. Thompson KH.

However, it's the toxicity of vanadium that really needs to be considered before using it in any way, shape or form.

Chapter 8. Safety

A general rule is that the most toxic vanadium compounds are the ones that are pentavalent. The toxicity of vanadium compounds usually increases as the valence increases.

Treatment of diabetic animals with inorganic vanadium salts has also been associated with some toxic side effects such as gastrointestinal discomfort and decreased body weight gain. In addition, vanadium salts have been reported to exert toxic effects on the liver and kidney. Recent reports have shown that organic vanadium compounds are safer than inorganic vanadium salts and did not cause any gastrointestinal discomfort, hepatic or renal toxicity. However, more research still needs to be done to say that without a doubt these organic compounds are safe.

The toxicity of vanadium compounds dispersed in the air in acute toxic doses is clear: vanadium causes health problems in the lungs. Most of the easily visible toxic effects of vanadium compounds are local irritation of the eyes and upper respiratory tract, rhinitis, wheezing, nasal hemorrhage, conjunctivitis, cough, sore throat, and chest pain. Asthma, pulmonary fibrosis, and even hypertension are possible effects based on animal studies.

Source: J Toxicol Clin Toxicol. 1999;37(2):265-78. Erratum in: J Toxicol Clin Toxicol 2000;38(7):813.

Effective Dose Borders on Toxic Dose

Another source reported, "Even though promising results for the transport of glucose into cells have been gathered, administration of vanadium compounds is accompanied by serious toxicity problems at effective doses.

Administered concentrations must be close to toxic levels, if desired insulin-mimetic effects in animals are to be achieved. Considerable side effects are observed for vanadium-treatment that are independent from the chemical nature of the specific vanadium used for therapy (Domingo et al., 1991, Toxicology 66: 279-87.). Serious problems with vanadium compounds toxicity are observed at any kind of dosage suitable for lowering blood glucose levels, including a significant mortality rate."

Certainly researchers are working on finding the lowest possible effective doses for vanadate and want to avoid negative side effects of treatment due to toxicity. Three new organic forms are vanadyl acetylacetonate, vanadyl 3-ethylacetylacetonate, and bis (maltolato) oxovanadium. These forms appear to be safer than vanadyl sulfate and are well tolerated in diabetic cats.

But a cat is not a human.

Source: Cell Biochem. 2000 Mar;206(1-2):177-82. Anti-diabetic and toxic effects of vanadium compounds. Srivastava AK.

Do We Really Want to Mimic Insulin?

Compounds of the trace element vanadium have been shown to mimic insulin in *in vitro* and *in vivo* systems. These compounds have been found to exert anti-diabetic effects in rodent models of type 1 and type 2 diabetes mellitus as well as in a limited number of studies in human diabetic subjects. Thus, vanadium compounds have emerged as agents for potential use in diabetes therapy. However, This review briefly summarizes the anti-diabetic and toxic effects of vanadium compounds.

Vanadyl sulfate is considered to be safe and relatively nontoxic to both animals and humans. Although vanadyl sulfate can be nephrotoxic (damaging to the kidneys) at very high dosages, one group of researchers stated that vanadyl sulfate may be an alternative to insulin in the near future, due to its low cost, low toxicity and ready availability.

Chapter 9. Where to Go From Here

How To Find Out Your Levels of Vanadium

In vitro and in vivo animal studies indicate that vanadate and other vanadium compounds increase glucose transport activity and improve glucose metabolism. This is very beneficial for diabetics and pre-diabetics and even those with metabolic syndrome.

But if you're thinking of using a vanadium supplement, how much is enough to make a difference? And wouldn't it make more sense to find out what your vanadium levels are before you supplement?

In nutrition, supplements rarely if ever create any health benefits if you have levels of that nutrient that are right where you want them to be. But if your levels of vitamin A, vitamin C, vitamin E or any other vitamin or mineral are at the low part of the normal range or clearly deficient, the chance that you will feel benefits from supplementing with that supplement are great.

This concept holds for vanadium as well. If your levels are extremely low, it's possible you could benefit from the addition of a supplement for a short time frame.

But once those levels are replenished, there's no need to continue supplementing.

Start Monitoring Your Health with a Simple Non-Invasive Test

One simple way to monitor your vanadium levels is through a hair analysis form done for your own research purposes. A hair analysis done annually can supplement your annual medical tests and give you clues as to what is occurring with your present health, and help prevent the onset of other health issues that are on their way to developing into full-blown disease situations.

A hair analysis is a test where a small hair sample, about a tablespoon of hair or 0.20 grams, is sent into the laboratory that is skillful at running the sample. To test for minerals and elements in hair, the hair is burnt in the laboratory and the ash is analyzed. It's a simple test, and it's noninvasive.

The test checks levels of aluminum, antimony, arsenic, bismuth, barium, cadmium, mercury, lead, uranium, thallium, calcium, magnesium, chromium, vanadium, zinc, manganese, copper, germanium, iron, rubidium, boron, molybdenum, lithium, and a few more! A normal range is given and levels can be compared from year to year, much the same as what is done with routine blood tests. By sending in a hair sample, it's possible to discover that your body is accumulating any one of these elements or is very low in any one of them as well.

A Hair Analysis Needs Explanation and Guidance

By having a hair analysis test done annually, you can track your own health progress. But you won't be able to read the test results alone. That's why you'll need someone trained in how to read them, someone who is well-versed in nutrition and knows what would be appropriate nutrient levels to include in your supplement plan for the next six months.

There are many idiosyncrasies about hair analyses that are not evident to the person beginning to read them for the first time. Some indices on the hair analysis may show up high but in actuality, they mean that they are actually low in the body. Similarly, there are many idiosyncrasies about nutrition, such as effective ratios of zinc and copper, calcium and magnesium, calcium and phosphorus, just to name a few, that may not seem important to someone not familiar with the practice of nutrition.

All the time you invest in looking up information on the internet always reveals one fact to the person who believes they can read their own results: without adequate background and training and experience, the information is confusing and can lead to erroneous deductions. How can you keep the information clear in your head about each of over 30 different elements and then the information about how each one of those elements relates to the other 29? That's the main reason why the clinical laboratories won't allow you to get your own hair analysis.

Where to Find Someone to Read the Hair Analysis

You might ask your health care practitioner if he or she is well-trained and experienced in reading hair analysis reports.

If not, you can email me at DrDonna@fastermac.net and I am happy to work with you, leading you to understand the information you receive from the very valuable hair analysis test. I'll help you set up a nutritional protocol that can be used for the next six months. After that time, it's a good idea to get another hair analysis, to compare the results and see what has changed. This is how you use the test properly for research purposes. It doesn't mean you stop seeing your primary care physician. You use the test as a way to test what your body is accumulating or missing, and make appropriate choices on what to do next.

Remember, you're taking a guess whether or not to take a vanadium supplement unless you have some information that is in black and white. Other types of tests may be available, but seeing the whole spectrum of minerals, essential elements and potentially toxic elements all in one place is much more cost-effective than blood tests.

For more info, please email me and I'll send you some links of further information to read and articles I've written on the topic.

Chapter 10. How To Decrease High Vanadium Levels

Medical research has reported on many aspects pertaining to vanadium, including how to decrease toxicity. The following are a partial list of what has been reported:

The Supplement N-Acetyl-Cysteine (NAC) Decreases Toxicity

In a rat study, 100 mg NAC/kg/day was administered subcutaneously daily along with vanadate significantly decreased toxicity of vanadium within two days and continued for the next 16 days.

Source: J Rheumatol. 2007 Sep;34(9):1802-9. Epub 2007 Aug 1. Vanadate, an inhibitor of stromelysin and collagenase expression, suppresses collagen induced arthritis. Oliver SJ, Firestein GS, et al.

Vitamin E Acetate Completely Reversed Vanadium's Detrimental Effects on the Testes

Vanadium damages the body primarily by oxidative stress and the effects are seen quickly on the adrenals and the testes.

In one rat study, oral administration of vitamin E acetate protected the testes from the toxic effects of vanadium. Vanadium also results in adrenocortical hyperactivity, as evidenced by the elevated secretion of glucocorticoids, adrenal gland hypertrophy and increased activity of adrenal Delta(5)3beta-HSD. However, reversibility of these alterations in adrenocortical activities was vividly reflected after vitamin E acetate supplementation.

Source: Mol Cell Biochem. 2007 Dec;306(1-2):189-200. Epub 2007 Aug 1. Amelioration of vanadium-induced testicular toxicity and adrenocortical hyperactivity by vitamin E acetate in rats. Chandra AK, Ghosh R, Chatterjee A, Sarkar M.

Antioxidants Come to the Rescue

Because oxidative damage is prevalent no matter which vanadium compound is used, the antioxidants vitamin E, selenium and lipoic acid were tested in rats receiving vanadyl sulfate injections. Some of the indices that changed after the vanadium injections included alkaline phosphatase, adenosine triphosphatase, glutathione, and triglyceride levels. The supplements were able to restore normal functioning after vanadium exposure.

Source: Chelation therapy and vanadium: effect on reproductive organs in rats. Shrivastava S, Jadon A, Shukla S, Mathur R.

What Happens to Toxicity When You Add Selenium to Vitamin E?

In another study, Tiron, zinc, selenium and vitamin E were administered after vanadium intoxication in female albino rats. The vanadium caused abnormalities in serum transaminases, alkaline phosphatase and lactate dehydrogenase, blood sugar, serum albumin and triglycerides. Lipid peroxidation in the liver was also found, accompanied by reduced glutathione decreases, increased glycogen in liver and kidney, Therapy with Tiron plus selenium produced recovery in all parameters tested, followed by Tiron with vitamin E and lastly, Tiron with zinc.

Source: J Toxicol Sci. 2007 May;32(2):185-92. Effect of tiron and its combination with nutritional supplements against vanadium intoxication in female albino rats. Shrivastava S, Jadon A, Shukla S.

Chelating Agents are Often Used to Lower High Levels of Heavy Metals

Calves aged between 96 and 157 days were removed from a vanadium-polluted dairy farm. They had consumed about 72 mg vanadium per day per calf in the form of contaminated hay derived from the farm of origin and spiked rations. Half of the 16 calves were given CaNa(2)EDTA, which increased the excretion of vanadium but did not appear to have a protective effect against vanadium exposure.

Is Decreasing Inflammation Advantageous?

The COX-2 generation of PGE2 is an important factor in resolving inflammation resulting from vanadium-induced pulmonary fibrosis.

Source: Am J Pathol. 2002 Aug;161(2):459-70. Susceptibility of cyclooxygenase-2-deficient mice to pulmonary fibrogenesis. Bonner JC, Rice AB, et al.

What Chinese Herbs Have Been Tested?

Chinese herbs have long been used to decrease toxicity of the body. One particular Chinese herb, called danshen, was given along with vanadium as a water extract in diabetic rats and was shown to protect animal organs from damage from high blood sugar. No GI stress or metal accumulation was noted, suggesting that the herb protected against vanadium toxicity. A therapeutic effect was noted on the blood sugar, bringing stable and long-lasting control of blood glucose status.

Source: Effective control of blood glucose status and toxicity in streptozotocin-induced diabetic rats by orally administration of vanadate in an herbal decoction. Zhang L, Zhang Y, Xia Q, Zhao XM, et al.

Other Nutrients That Can Impact Vanadium Toxicity

Quercetin also may offer some protection against vanadium toxicity.

Small molecule antioxidants such as Ascorbic acid (vitamin-C), uric acid, and glutathione also play important roles as cellular antioxidants. Similarly, Polyphenol antioxidants assist in preventing ROS damage by scavenging free radicals.

Beta-Cell Destruction by Vanadium: Remedies

Vanadium toxicity causes destruction of the beta cells of the pancreas. Knowing this, one can find some different natural substances that are able to halt the progression of this or help in the regeneration of new cells in the pancreas.

Some studies indicate that the use of niacinamide, a form of niacin or vitamin B3, very early in the disease process can sometimes prevent the destruction of beta cells. Some patients have had complete reversal (Cleary, 1990). Niacinamide inhibits monocyte/macrophage function in the peripheral blood preventing production of the beta-cell destructive cytokines interleukin-12 and tumor necrosis factor-alpha (Kretowski et. al., 2000).

The herb *Gymnema sylvestre* reduces urine glucose in diabetics. Lowers blood glucose when there is residual pancreatic function, but not if animals lacked pancreatic function. Raises insulin levels. Extracts normalize glycosylated hemoglobin and glycosylated plasma proteins. In diabetic animals, GS administration resulted in improved glucose homeostasis and regeneration of the beta cells.

Health experts report that taking insulin isn't without its own side effects. It's always a good idea to try to reduce the dosage, of course, while working WITH your doctor and with reasonable sense of prudence and caution.

One study of 27 insulin-dependent diabetics proved that insulin dosage could be reduced by almost 50% with *Gymnema sylvestre*, about 400 mg per day. Fasting blood glucose, glycosylated hemoglobin and glycosylated plasma protein levels serum lipids and C-peptide levels came closer to normal levels with the use of the herb. The number of islets of Langerhans and number of beta cells both doubled in this study. Pancreas weight increased about 30%.

Both Type 1 and Type 11 diabetes have abnormalities in beta cell number and/or function. About 25% of study participants were able to discontinue conventional oral medication and maintain blood glucose levels in the normal zone with GS extract by itself. It also improved cholesterol, triglyceride and free fatty acid levels.

Bitter Melon has been found to improve glucose tolerance and increases the number of beta cells. In one 1986 study, bitter melon juice improved glucose tolerance by 73%. A 1993 study found a water extract to decrease blood sugar levels by 54%, according to one website.

Source: Phytotherapy Research, Vol. 7, #4, 1993. Pages 285-289, Journal of Ethnopharmacology, Vol. 17, 1986. Page 277-282, Diabetes Research Clinical Practice, Vol. 40, #3, June 1998. Pg. 45-51.

Don't Settle for a Partial Plan

If your levels of vanadium are high (or low), and you have diabetes, blood sugar abnormalities, or metabolic syndrome, doing one or a few things for your health may help but only with a complete protocol will you achieve best results. Many practitioners use the following supplements as part of that plan:

Quercetin
Prickly pear cactus
Gymnema sylvestris
Danshen
Vitamin E
Vitamin C
Lipoic acid

But as mentioned before, it's only when one knows exactly where you're starting from, that a chart of where you're going and how to get there is decided. All nutrients work together and must be consumed simultaneously; otherwise imbalances will be created.

Health care providers can obtain a basic plan for detoxification of vanadium by contacting the author.

For more information, contact Dr. Donna at www.DrDonna.info or www.MillionDollarMemory.net