

The Critical Combo (Vitamin D and Vitamin K2)

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HIPPOCRATES: 400 B.C.

*“Let your food be your medicine and your
medicine be your food”*

Vitamin K

- In 1929, a Danish researcher discovered that when chicks were fed a fat-free diet, blood leaked out of their arteries and into their body tissues
- A special substance was required for blood clotting
- He dubbed this blood-clotting substance the “(k)oagulation vitamin”

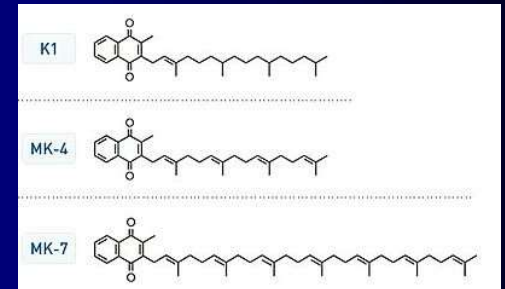
Vitamin K Overview

- Vitamin K is actually a group of fat-soluble vitamins
- K1 and K2
 - the one receiving the most attention is K1, which is found in green leafy vegetables and is very easy to get through your diet
 - My focus will be on K2

Three Types of Vitamin K2

- **Vitamin K1**, or phylloquinone:
 - found naturally in plants, especially green vegetables
 - K1 goes directly to your liver and helps you maintain healthy blood clotting
- **Vitamin K2**, also called menaquinone:
 - made by the bacteria that line your gastrointestinal tract
 - K2 goes straight to your blood vessel walls, bones, and tissues other than your liver
- **Vitamin K3**, or menadione,
 - is a synthetic form
 - it's important to note that toxicity has occurred in infants injected with this synthetic vitamin K3

Nomenclature



- Vitamin K₂, the main storage form in animals, has several subtypes, which differ in iso-pre-noid chain length.
- Vitamin K₂ homologues are called **menaquinones**, characterized by the number of iso-pre-noid residues in their side chains
- Menaquinones are abbreviated MK-n,
 - the M for menaquinone
 - K for Vit K
 - n is the # of iso-pre-noid side chain residues
 - menaquinone-4 is abbreviated MK-4 has four isoprene residues in its side chain

Vitamin K

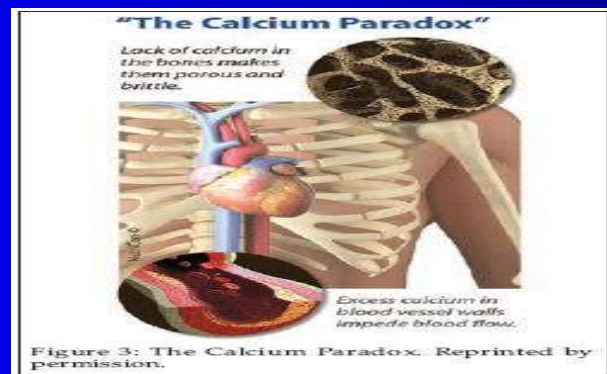
- There are several different forms of vitamin K2:
 - MK4, MK7, MK8, and MK9.
 - The form of vitamin K that has the most significance is MK7
 - a newer and longer acting form with more practical applications.

“Calcium Paradox”

- Countries with the highest calcium consumption have the highest rates of osteoporosis -- namely, the U.S., Canada and Scandinavian countries.
- This is commonly known as the "calcium paradox."
 - ...because nutritional guidelines have been based on an incorrect theory of bone mineralization

“Calcium Paradox”

- When you take the wrong form of calcium, or when your body's ability to direct calcium to the right places becomes impaired (as when you are deficient in vitamin K), calcium is deposited where it shouldn't be



“Calcium Paradox”

- “Calcium Paradox,” harmful calcium deposits form in their arteries at the same time that calcium content of the bones is decreasing
- “Calcium Paradox” is not a result of too little calcium in the diet, but of too little vitamin K2 that largely controls where the calcium goes

“Calcium Paradox”

- The objective is to keep calcium in our bones, not in our arteries
- This is the role of vitamin K—putting calcium in its place!

Vitamin K



- Most vitamin K2 supplements are in the form MK7
- MK7 is extracted from the Japanese fermented soy product called natto
- Natto (fermented soybeans by **natto** bacillus) is abundant in MK7
 - Smelly, slimy texture
 - Not palatable for most people in the USA
 - Excellent source of PQQ

Vitamin K2 (Bones)

- Bone health is directly related to the activation of osteocalcin process is called gamma carboxylation
- If there is not enough vitamin K available to activate this protein, large amounts of inactive osteocalcin will circulate in the bloodstream
- If supplemental vitamin K is given to people with excess inactive osteocalcin, the circulating levels will drop as more of it is made available for incorporation in the bones..

- Sugiyama T, Kawai S. Carboxylation of osteocalcin may be related to bone quality: a possible mechanism of bone fracture prevention by vitamin K. *J Bone Miner Metab.* 2001;19(3):146-9.
- Sokoll LJ, Booth SL, O'Brien ME, et al. Changes in serum osteocalcin, plasma phylloquinone, and urinary gamma-carboxyglutamic acid in response to altered intakes of dietary phylloquinone in human subjects. *Am J Clin Nutr.* 1997 Mar;65(3):779-84.
- Douglas AS, Robins SP, Hutchison JD, Porter RW, Stewart A, Reid DM. Carboxylation of osteocalcin in post menopausal osteoporotic women following vitamin K and D supplementation. *Bone.* 1995 Jul;17(1):15-20.
- Knapen MHJ, Hamulyak K, Vermeer C. The effect of vitamin K supplementation on circulating osteocalcin (bone Gla protein) and urinary calcium excretion. *Ann Intern Med.* 1989 Dec 15;111(12):1001-5

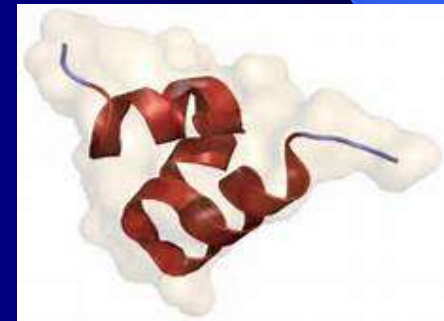
Osteocalcin

- Osteocalcin, also known as *bone gamma-carboxy-glutamic acid-containing protein* (BGLAP), is a noncollagenous protein found in bone and dentin.
- Osteocalcin synthesis is vitamin K dependent because it has gla(gamma carboxyglutimate) domains
- In humans, the osteocalcin is encoded by the BGLAP gene.
- Its receptor is GPRC6A.

– riedman PA, Przysiecki CT (1987). "Vitamin K-dependent carboxylation". *Int. J. Biochem.* **19** (1): 1–7.

Vitamin K

- Vitamin K2 activates osteocalcin, produced by osteoblasts, which is needed to bind calcium into the matrix of your bone
 - Osteocalcin also appears to help prevent calcium from depositing into your arteries



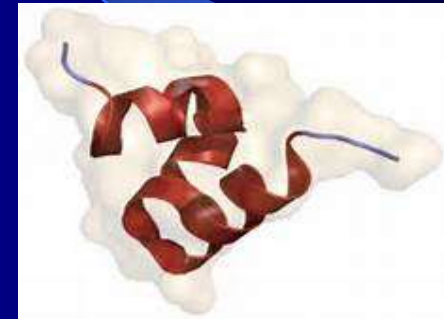
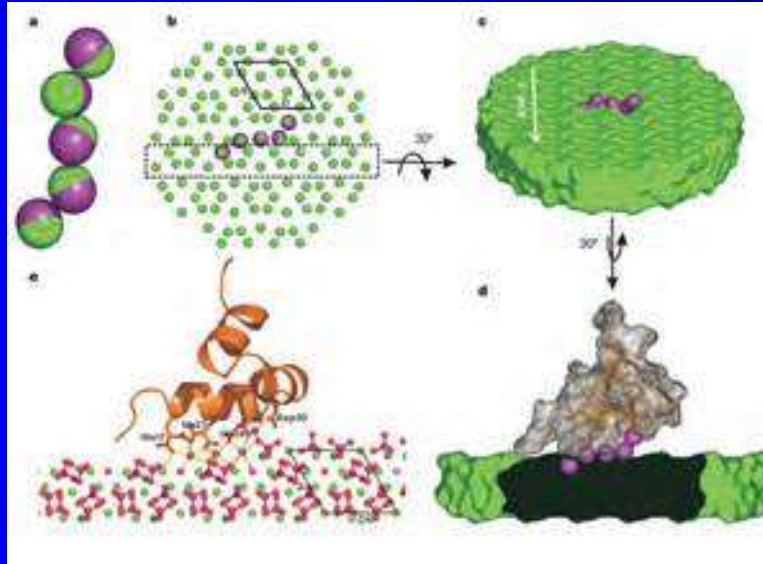
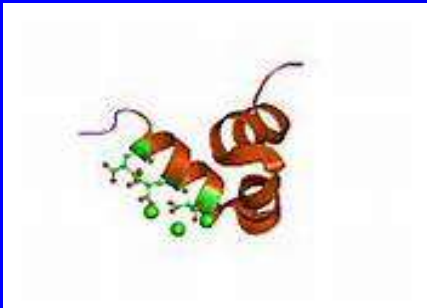
Vit. D-Vit. K2 (Analogy)

- Vitamin D is the gate keeper controlling who gets in
- Vitamin K directs the traffic, directing the traffic to where it needs to go

Vitamin K2 (Bones)

- Osteocalcin is like the studs inside the walls of a house;
 - it is a structural framework that helps hold calcium in place in the bones.
 - osteocalcin cannot do the job until vitamin K converts it into its active, bone-building form.
 - Zittermann A. Effects of vitamin K on calcium and bone metabolism. *Curr Opin Clin Nutr Metab Care*. 2001 Nov;4(6):483-7.

Crystalline Structure of Bone



Vitamin K2 (Bones)

- Vitamin K also helps the body manufacture a protein called matrix Gla protein, another substance that helps build strong bones
- The question is whether vitamin K can prevent osteoporosis and bone fractures?
- Low levels of the Vitamin K were associated with increased risk of bone fractures in studies from the 1980s and early 1990s
 - Hart JP, Shearer MJ, Klenerman L, et al. Electrochemical detection of depressed circulation levels of vitamin K1 in osteoporosis. *J Clin Endocrinol Metab.* 1985 Jun;60(6):1268-9.
 - Hodges SJ, Akesson K, Vergnaud P, Obrant K, Delmas PD. Circulating levels of vitamins K1 and K2 decreased in elderly women with hip fracture. *J Bone Miner Res.* 1993 Oct;8(10):1241-5.

Vitamin K2 (Bones)

- In 1998, researchers used data from the Nurses Health Study to examine the link between vitamin K and hip fractures in women
 - The diets of over 70,000 women, ranging in age from 38 to 63, were analyzed for 10 years
 - The researchers found that consuming about 110 micrograms of vitamin K per day reduced the risk of breaking a hip by approximately 30%.
 - Feskanich D, Weber P, Willett WC, Rockett H, Booth SL, Colditz GA. Vitamin K intake and hip fractures in women: a prospective study. Am J Clin Nutr. 1999 Jan;69(1):74-9.

Vitamin K2 (MK4)

- The FDA has not approved any form of Vit K for the prevention or treatment of osteoporosis
- MK-4 has been shown to decrease the incidence of fractures by 87%
- MK-4 (45mcg/day) has been approved by the Ministry of Health in Japan since 1995 for the prevention and treatment of osteoporosis.
 - Iwamoto, I; Kosha S; Noguchi S-i (1999). "A longitudinal study of the effect of vitamin K₂ on bone mineral density in postmenopausal women a comparative study with vitamin D₃ and estrogen-progestin therapy". *Maturitas* **31** (2): 161–164
 - Sato, Y; Kanoko T; Satoh K; Iwamoto J (2005). "Menatetrenone and vitamin D2 with calcium supplements prevent nonvertebral fracture in elderly women with Alzheimer's disease". *Bone* **36** (1): 61–8

Vitamin D and K2 (CV Disease)

- Vitamin K and vitamin D work together to increase Matrix GLA Protein (or MGP)
 - the protein responsible for protecting your blood vessels from calcification
- In healthy arteries;
 - MGP congregates around the elastic fibers of your tunica media (arterial lining), guarding them against calcium crystal formation
 - http://ndt.oxfordjournals.org/content/28/suppl_1/i352.abstract

Vitamin D and K2

- Some researchers believe that MGP is the most powerful inhibitor of soft tissue calcification presently known.
 - <http://www.ncbi.nlm.nih.gov>

Matrix GLA Protein and CV Disease

- According to Professor Cees Vermeer:
- "The only mechanism for arteries to protect themselves from calcification is via the vitamin K-dependent protein MGP (Matrix GLA Protein).
- *MGP is the most powerful inhibitor of soft tissue calcification presently known, but non-supplemented healthy adults are insufficient in vitamin K to a level that 30 per cent of their MGP is synthesized in an inactive form.*
- *Protection against cardiovascular calcification is only 70 per cent in the young, healthy population, and this figure decreases at increasing age."*

Calcium and the Heart (BMJ July 2010;341:c3691)

- This meta-analysis looked at studies involving people *taking calcium in isolation, WITHOUT* complementary nutrients:
 - magnesium, vitamin D, and vitamin K
- In the absence of those other important cofactors, calcium CAN have adverse effects, such as building up in coronary arteries and causing heart attacks, which is really what this analysis detected.

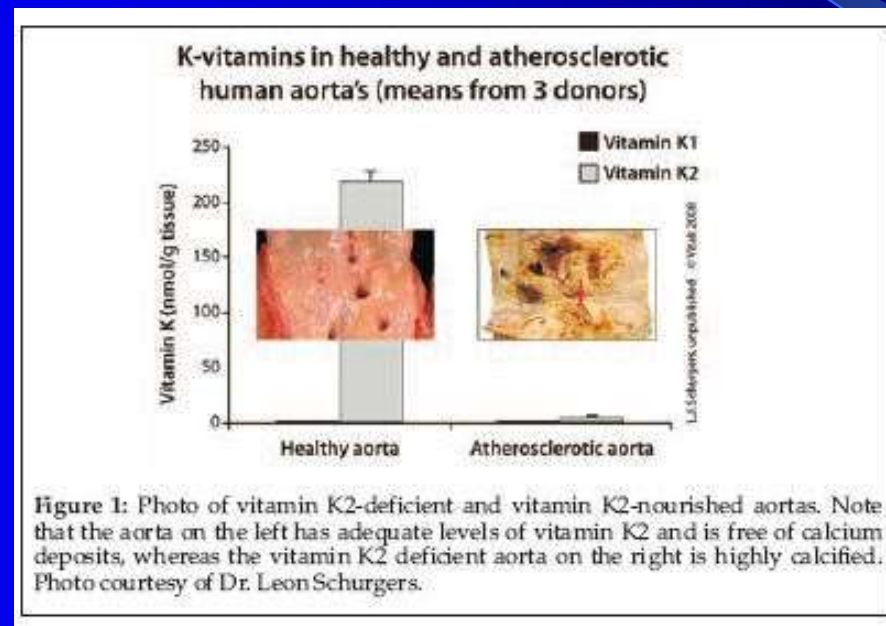
Calcium and the Heart(BMJ July 2010;341:c3691)

- If you take calcium and vitamin D but are deficient in vitamin K
- You could be worse off than if you were not taking those supplements at all...!!!

Calcium and the Heart

- This study did indeed find that people taking calcium supplements were more prone to heart attacks
- However, that doesn't mean that it was the calcium supplements themselves that caused the heart attacks
- Remember that calcium is only ONE of the players in your bone and heart health...

Vitamin K2 and Arteries



Vitamin K-CV Disease

- In 2004, the Rotterdam study was the first study demonstrating the life-extending effects of vitamin K2
 - People who had the highest intake of vitamin K2 had 50 percent lower risk of death from coronary heart disease and calcification than people with the lowest intake of vitamin K2
- The Prospect study, 16,000 people were followed for 10 years.
 - Researchers found that each additional 10 mcg of vitamin K2 in the diet resulted in nine percent fewer cardiac events
 - Nutrition 2001;(10):880-7

Vitamin K2 (Arteries)

- Scientists from the Netherlands have confirmed that vitamin K activates matrix GLa protein, a powerful inhibitor of arterial calcification
- Matrix GLa protein, and perhaps other vitamin K-dependent proteins, are believed to help regulate calcium's movement throughout the body, directing it away from the arteries and into the bones
- Spronk HM, Soute BA, Schurgers LJ, et al. Matrix Gla protein accumulates at the border of regions of calcification and normal tissue in the media of the arterial vessel wall. *Biochem Biophys Res Commun.* 2001 Nov 30;289(2):485-90.
- Schurgers LJ, Dissel PE, Spronk HM, et al. Role of vitamin K and vitamin K-dependent proteins in vascular calcification. *Z Kardiol.* 2001;90 Suppl 3:57-63.

Vitamin K2-CV Disease

- In a 2002 study researchers compared vitamin K status to the amount of calcification in the coronary arteries of 600 men
- Results: men with the lowest vitamin K status had much more calcification in their coronary arteries than did men with better vitamin K status.
 - Lew JB. Vitamin K linked to coronary calcification risk. Fern Pract News 2002;32(1):1-2.

Vitamin K2-CV Disease

- An epidemiological study from the Netherlands showed arterial protection:
- The researchers collected data on the vitamin K intakes of the subjects between 1990 and 1993 and measured the extent of heart disease in each subject, who had died from it and how this related to vitamin K2 intake and arterial calcification.
- They found that calcification of the arteries was the best predictor of heart disease.
- Those in the highest third of vitamin K2 intakes were:
 - 52 percent less likely to develop severe calcification of the arteries
 - 41 percent less likely to develop heart disease
 - 57 percent less likely to die from it
 - Geleijnse et al., 2004, pp. 3100-3105

Vitamin K2-CV Disease

- Intake of K2 is inversely associated with heart disease in humans while intake of K1 is not (Geleijnse et al., 2004, pp. 3100-3105)
- Vitamin K2 is at least three times more effective than vitamin K1 at activating proteins related to skeletal metabolism. (Schurgers et al., 2007)

Scientific Studies (Vit K-CV Disease)

- Animal studies show that vitamin K2 not only prevents hardening of the arteries but can actually reverse calcification of highly calcified arteries by activating MGP
- People with severe calcifications have high percentages of inactive osteocalcin, which indicates a general deficiency of vitamin K2.
 - Nutrition 2001;(10):880-7

Vitamin K2 and Cancer

- Vitamin K1 appears to play a role in cell replication, transformation, and survival and can inhibit cell growth
- Vitamin K2 has an apoptotic effect on pancreatic and ovarian cancer cells
- Vitamin K2 analogs induce the same kind of programmed cell death in leukemia cells
- These preliminary reports suggest that vitamin K may one day be used to “instruct” cancer cells to stop their dangerous, unregulated growth.
- Saxena SP, Israels ED, Israels LG. Novel vitamin K-dependent pathways regulating cell survival. *Apoptosis*. 2001 Feb-Apr;6(1- 2):57-68.
- Carr BI, Wang Z, Kar S. K vitamins, PTP antagonism, and cell growth arrest. *J Cell Physiol*. 2002 Dec;193(3):263-74.
- Shibayama-Imazu T, Sakairi S, Watanabe A, Aiuchi T, Nakajo S, Nakaya K. Vitamin K(2) selectively induced apoptosis in ovarian TYK-nu and pancreatic MIA PaCa-2 cells out of eight solid tumor cell lines through a mechanism different from geranylgeraniol. *J Cancer Res Clin Oncol*. 2003 Jan;129(1):1-11.
- Miyazawa K, Yaguchi M, Funato K, et al. Apoptosis/differentiation-inducing effects of vitamin K2 on HL-60 cells: dichotomous nature of vitamin K2 in leukemia cells. *Leukemia*. 2001 Jul;15(7):1111-7.

Vitamin K2 and Cancer

- A study published by the *European Prospective Investigation into Cancer and Nutrition (EPIC)* has revealed that increased intake of vitamin K2 may:
 - reduce the risk of prostate cancer by 35 percent
 - the benefits of K2 were most pronounced for advanced prostate cancer
 - vitamin K1 did not offer any prostate benefits
- The findings were based on data from more than 11,000 men taking part in the EPIC Heidelberg cohort
 - science supporting the potential health benefits of vitamin K2 for bone, cardiovascular, skin, brain, and now prostate health

Vitamin K2 and Alzheimer's Disease

- Alzheimer's disease has been linked to the apolipoprotein E4 genotype in some studies
- Researchers have found that the vitamin K blood levels may be lower in those with this genotype a discovery that may be linked with evidence that vitamin K helps regulate brain biochemistry
 - Allison AC. The possible role of vitamin K deficiency in the pathogenesis of Alzheimer's disease and in augmenting brain damage associated with cardiovascular disease. Med Hypotheses. 2001 Aug;57(2):151-5.

Vitamin K2 and Blood Sugar

- Relatively large amounts of vitamin K are found in the pancreas
- Japanese researchers(animal study) found that a deficiency of vitamin K interferes with insulin release and glucose regulation in ways similar to diabetes
 - Sakamoto N, Wakabayashi I, Sakamoto K. Low vitamin K intake effects on glucose tolerance in rats. Int J Vit. Res 1999 Jan;69(1):27-31.

Vitamin K2 – Anti-Oxidant

- Vitamin K may also have antioxidant properties making it helpful in preventing the accumulating oxidation damage to cells and tissues associated with aging.
 - Hendler S, Rorvic D, eds. PDR For Nutritional Supplements. Montvale, NJ: Medical Economics Co.; 2001:524.

Vitamin K2 and Skin

- University of Miami researchers looked for ways to prevent the significant bruising that accompanies such cosmetic procedures as pulsed dye laser treatment
- A study of 22 patients, they found that applying topical vitamin K to the face after laser treatment significantly reduced the severity of bruising
 - Shah NS, Lazarus MC, Bugdodel R, et al. The effects of topical vitamin K on bruising after laser treatment. *J Am Acad Dermatol.* 2002 Aug;47(2):241-4.

Vitamin K deficiency:

- A poor or restricted diet (Approx. 75% of US population)
- Crohn's disease, ulcerative colitis and disease states that interfere with nutrient absorption
- Liver disease that interferes with vitamin K storage
- Certain drugs;
 - including broad- spectrum antibiotics, cholesterol-lowering agents, mineral oil, aspirin, and blood thinners

- Life Extension Magazine..March 2004

Vitamin K2 Safety

- According to the Food and Nutrition Board,
 - “No adverse effects associated with vitamin K consumption from food or supplements have been reported in humans or animals.”
 - Food and Nutrition Board. Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc. Washington, DC: National Academies Press; 2002:187.

Vitamin D-Basics

- There are vitamin D receptors throughout the central nervous system and critical regions of the brain including the hippocampus
- Vitamin D activates and deactivates enzymes in the brain and cerebrospinal fluid that are involved in nerve growth, synaptic density and neurotransmitter synthesis

– [Pharmacol Rep. 2013;65\(2\):271-8.](#)

Vitamin D- Basics

- Vitamin D more resembles a hormone than vitamin by function(Tulane University)
- Hormones are chemical messengers that interact with cell receptors to produce specific biological responses
- Calcitriol, the active form of Vitamin D, is arguably one of the most powerful hormone in the body
- It has the ability to activate over 1,000 genes which is roughly 5-10% of the human genome

Vitamin D

- Vitamin D plays a crucial role in disease prevention and maintaining optimal health
- There are about 30,000 genes in our body
 - vitamin D affects nearly 3,000 of them
 - as well as vitamin D receptors located throughout your body

Vitamin D

- According to one large-scale study, optimal Vitamin D levels can slash your risk of cancer by as much as 60%
- Keeping your levels optimized can help prevent at least 16 different types of cancer
 - including pancreatic, lung, ovarian, prostate, and skin cancers

Vitamin D Mis-Calculation

- A calculation error may have skewed the vitamin D recommendations by the National Academy of Sciences (NAS), Institute of Medicine (IOM). *They are far too low, by a factor of ten, say researchers at UC San Diego and Creighton University*
- Robert Heaney, M.D. of Creighton University wrote: “We call for the NAS-IOM and all public health authorities concerned with transmitting accurate nutritional information to the public to designate as the RDA, a value of approximately 7,000IU/day from all sources.” Garland noted, “This intake is well below the upper level intake specified by IOM as safe for teens and adults, 10,000IU/day”
 - Heaney, R.P. et al. 2015. Letter to Veugelers, P.J. and Ekwaru, J.P., A Statistical Error in the Estimation of the Recommended Dietary Allowance for Vitamin D. *Nutrients* 2014, 6, 4472–4475; doi:10.3390/nu6104472
 - Veugelers, P.J. et al. 2014. A Statistical Error in the Estimation of the Recommended Dietary Allowance for Vitamin D. *Nutrients* 2014, 6(10), 4472-4475; doi:10.3390/nu6104472

Vitamin D

- Vitamin D deficiency or insufficiency [25(OH)D < 75 nmol/L] is a common health problem affecting people of all ages and both genders.
- About 1 billion people worldwide have vitamin D deficiency or insufficiency.
- More than 60% of North Americans have blood 25(OH)D levels lower than the acceptable level (75 nmol/L).
 - (Holick, Am J Clin Nutr, 2002).

Vitamin D

- The incidence of deficiency and insufficiency continues to grow because of the:
 - -scarcity of vitamin D in food
 - -sunscreen usage
 - -increasing indoor working habits.
 - (Holick, Am J Clin Nutr, 2002).

Vitamin D

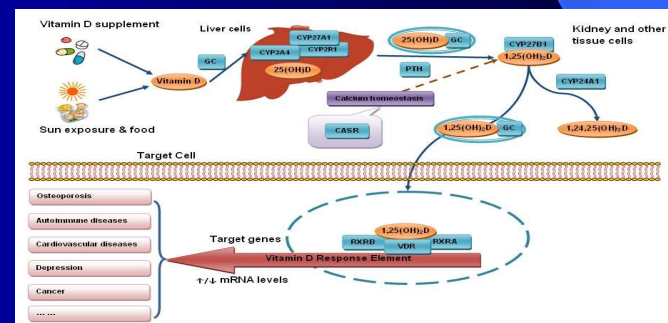
- Given the common vitamin D deficiency and the powerful effect of vitamin D in human beings, "it is reasonable for everyone to have his or her blood 25(OH)D concentration measured once a year" in order to achieve the optimal vitamin D level
 - (Holick, Am J Clin Nutr, 2002).

Genetic and epigenetic studies on Vitamin D (Tulane University)

- Genetic factors are involved in regulation of serum 25(OH)D concentration
- Numerous studies have shown that serum 25(OH)D is highly genetically determined
- Due to inter-individual genetic variation, people who are exposed to a high amount of sunlight or taking high dose of vitamin D supplementation may also suffer from low serum 25(OH)D level (<75nmol/L)..

Genetic and epigenetic studies on Vitamin D (Tulane University)

- The *hypothesis* is that ten candidate genes, functionally important for vitamin D metabolism and signaling pathways, are responsible for variation in serum 25(OH)D levels.
- The roles of the selected candidate genes are depicted below and labeled in blue rectangles



Epigenetic Mechanisms of Vit D Metabolism

- DNA methylation is one of the most common epigenetic mechanisms in humans.

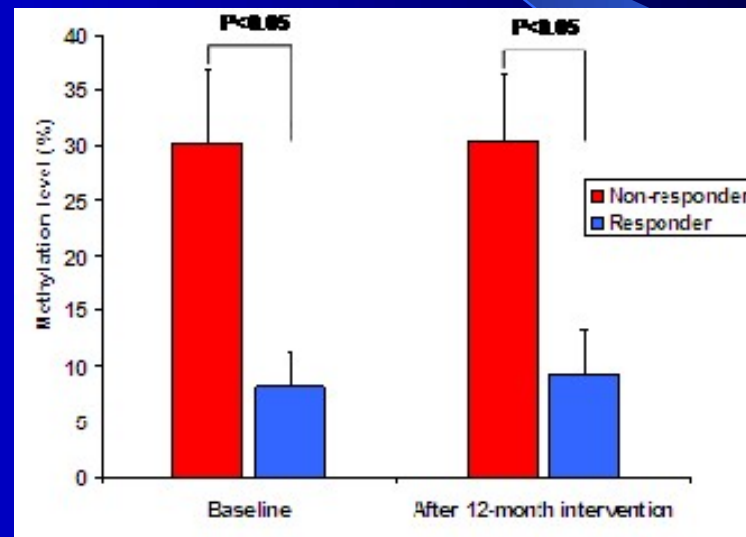


Figure 3. Comparison of DNA methylation level of the CYP2R1 gene between responders and non-responders

Identify cellular biomarkers for Vitamin D dose-response variation

- Circulating monocytes play important roles for vitamin D metabolism.
 - (Enzymes essential for vitamin D metabolism, such as CYP27A1 (25-hydroxylase) and CYP27B1 (1 α -hydroxylase) are highly expressed in monocytes-derived cells.
- The active form of vitamin D, 1,25-dihydroxyvitamin D₃ [1,25(OH)₂D₃], *has the function of inducing monocytes into macrophages (MAC) or dendritic cells (DC)*
- “We hypothesize that the differentially expressed genes, proteins, and DNA methylation levels in circulating monocytes provide biomarkers to predict vitamin D dose-response variation”
 - Tulane University

Tulane University

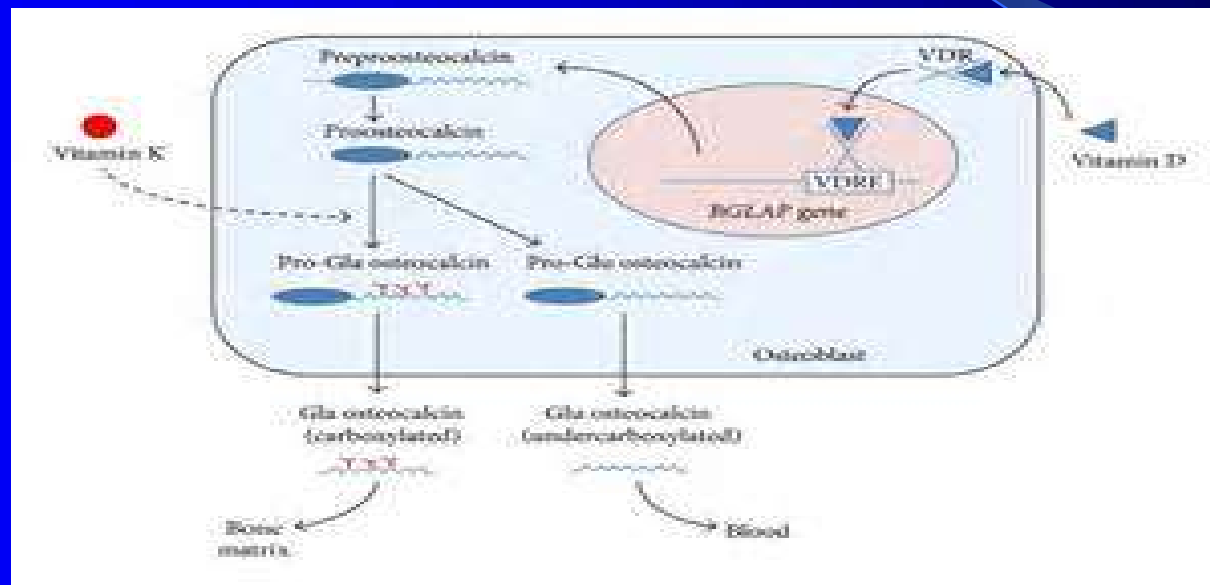
- Lan-Juan Zhao, Ph.D., PI
- -
- Yu Zhou, Research Assistant
- -
- Xiaojing Xu, Research Assistant

Vitamins A, D3 and K2: *A Balancing Act*



- A & D3 are the base.
- D3 is smiling at the camera, everyone can see D3.
- Vitamin A is the brother with his head between D's legs; his face is obscured and his role not as clearly defined.
- K2 is the brother on top, without D and A to hold him up, K2 would fall flat on its face.

Vitamin D and Vitamin K



Vitamin D and K2...

- Supplementing with vitamin D increases your need of vitamin K2, because when you take vitamin D, your body creates more vitamin K2-dependent proteins
 - the proteins that help move the calcium around in your body.
- Vitamin K2 is needed to *activate* those proteins(matrix Gla-proteins)
- Inappropriate calcification that can lead to hardening of arteries.

Vitamin D and Vitamin K2...

- If they're not activated, the calcium in your body will not be properly distributed and can lead to weaker bones and hardened arteries.
- Vitamin K2 deficiency is actually what produces the symptoms of vitamin D toxicity,
 - which includes inappropriate calcification that can lead to hardening of your arteries.

Vitamin D and K2 ..cont

- It's important to maintain the proper balance between all three of these nutrients:
 - calcium, Vit.D and magnesium
 - lack of balance of these nutrients is likely why calcium supplements have been associated with an increased risk of heart attack and stroke

Vitamin D and K2

- The optimal amounts of vitamin K2 are still under investigation
 - 180 to 200 mcg. of vitamin K2 daily should be enough to activate your body's K2-dependent proteins
- Most Americans get nowhere near this amount though
 - estimated 80 percent of Americans do not get enough vitamin K2 in their diet to activate their K2 proteins, which is similar to the deficiency rate of Vit. D

Vitamin D and K2

- One of the undisputed benefits vitamin D provides for you is improved bone development by helping you ABSORB calcium.
- *Vitamin K* (specifically, vitamin K2) that directs the calcium to your skeleton, while preventing it from being deposited where you don't want it -- i.e., your organs, joint spaces, and arteries.
- A large part of arterial plaque consists of calcium deposits (atherosclerosis), hence the term "hardening of the arteries."
 - <http://www.ncbi.nlm.nih.gov>
 - <http://www.ncbi.nlm.nih.gov>

Vitamin D and K2

- Vitamin D3 and K2 play an essential role in calcium uptake into skeletal bone tissue. Several studies have shown a synergistic effect of vitamin K2 and D3
- These studies show that this combination enhanced osteocalcin accumulation in bone cells greater than any one of these nutrients alone
- This increased osteocalcin formation significantly improved bone mineral density
 - <http://www.ncbi.nlm.nih.gov>
 - <http://www.ncbi.nlm.nih.gov>

Vitamin D and K2

- Without the help of vitamin K2, the calcium that your vitamin D so effectively lets in might be working **AGAINST** you -- **by building up your coronary arteries rather than your bones.**
- The safety of vitamin D is dependent on vitamin K, and that vitamin D toxicity (although very rare with the D3 form) is actually caused by vitamin K2 deficiency
 - <http://www.westonaprice.org/abcs-of-nutrition/175-x-factor-is-vitamin-k2.html>

Common Factors in Arterial and Bone Health

- Dr. Linda Demer (University of California, Los Angeles)
 - curious connection by successfully identifying a protein in human atherosclerotic tissue, which was previously believed to reside only in bone tissue.
- This protein, called bone morphogenetic protein-2, plays an important role in bone formation
 - Abedin M, Tintut Y, Demer LL. Vascular calcification: mechanisms and clinical ramifications. *Arterioscler Thromb Vasc Biol.* 2004 Jul;24(7):1161-70.

Common Factors in Arterial and Bone Health

- Since then, several other key regulators of bone formation have been identified in atherosclerotic plaque tissue, such as matrix GLA-protein and osteopontin, suggesting that common factors might influence both arterial and bone health
 - Abedin M, Tintut Y, Demer LL. Vascular calcification: mechanisms and clinical ramifications. *Arterioscler Thromb Vasc Biol.* 2004 Jul;24(7):1161-70.

Vit D and Vit.K2

- For every 1000 IU of Vitamin D/ 100 mcg of Vitamin K2
- There must be a combined use of Vit D and Vit K2 in order for all the correct bio-chemical processes to occur
- Vitamin A also plays a role in preventing the “toxicity” of Vit. D and has a beneficial role for the skin and eyes

Conclusion

St. Francis of Assisi...

...Make me a channel of Your peace, where there is hatred
let me sow Your love, where there is injury pardon, where
there is doubt faith, where there is despair hope where there
is darkness light, and where there is sadness joy...

God Bless You All.....