Vitamin D: An Introductory Guide

I believe [vitamin D] is the number one public health advance in medicine in the last twenty years.

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Introduction

Vitamin D is a hormone. It is not a vitamin. It was discovered back in the 1930s and had a huge public health effect by its addition to food. Rickets, present in up to 80% of children in northern cities virtually disappeared in a few years. Like almost all the vitamins essential to our health and well-being, vitamin D has been added back to our environment in vitamin pills and by its addition to milk and orange juice. Because of that association we've thought of it as a vitamin. It is crucial to change our thinking if we are to understand its importance to our health and well-being. There is some vitamin D in fatty fish such as salmon and mackerel but otherwise it does not exist in food. Hormones are based on the cholesterol molecule. Cortisol, estrogen and testosterone are all based on the cholesterol skeleton. Vitamin D is similarly derived from cholesterol by the activation through sunlight of a cholesterol molecule in our skin to make vitamin D prototype. Vitamins are cofactors in enzymatic processes. Vitamin D doesn't do that. It acts on genes to activate the genes. In that context, it partners with Vitamin A and omega fatty acids to turn on those genes, but it's fundamental action is to turn on genes. That makes it a hormone. And in essence, it is your stem cell modulating hormone.

Because Vitamin D has been found to turn on over 200 different genes in over 900 separate cell types, and because Vitamin D is found throughout nature, it is really one of our fundamental life giving hormones. We get it from sunshine. In fact, plankton that have been dormant at the bottom of the ocean for some 750 years make vitamin D when brought to the surface and exposed to sunlight. That action starts the process of the cell to multiple and turn into a mature cell.

That same process occurs in humans as well. Hence, vitamin D is our Stem Cell Modulating Hormone. It tells mature cells to grow up into the form they were intended to be. Every tissue type (colon cells, brain cells, muscle cells…) in the human body has some stem cells embedded within it. Having sufficient vitamin D becomes crucial for that cell type to mature into its intended mature function. Understanding this principle will explain why its effects are so complex and comprehensive.

A Very Brief History of Vitamin D

Rickets, the archetype illness of Vitamin D deficiency, was first noted in Europe as cities became congested and polluted in the mid 19th century. In the year 1900 as many as 80% of children in Boston and other northern cities had rickets. At that time a tablespoon of cod-liver oil was known to help prevent rickets. Short stature, bowed legs and knobby knees were hallmarks of the disease. The puzzle of solving the Vitamin D mystery was played out in many venues until the mid 1930's when it was discovered that irradiated vegetable were anti-rachitic. Putting kids on top of tall buildings with sunshine, or on boats out in harbors both worked to cure rickets. Once the responsible chemical compound was found, the race was on to add it to many foods. It was so cheap to make and so widely used, even beer had Vitamin D added. With 40,000 units in a milligram it didn't take much to get millions of units. In that environment, some folks likely got very high doses though no one will ever know how much. In any case, the idea of Vitamin D toxicity was born. The phrase "hyper-Vitaminosis D" was invented and just rolled off the tongue so easily that virtually every health care provider remembered it.

Vitamin D was cheap to make. The 400 U of D in a tablespoon of cod liver oil was enough to prevent rickets, and hence was the amount added to vitamin pills. And there we have been. In the 80 years since Americans have started living another 25 years of life and have moved indoors. We have stopped working outside and have become programmed to avoid sun exposure with messages to cover up with sun protection when out in the sun. Without profit from a pill that could be sold entrepreneurially the market did not exist for a drug company to research and market the drug.

How do you make Vitamin D?

Your body makes it from sunshine, only. Caucasian-Americans will make about 10-20,000 U of D after 15-20 minutes of mid-day sun exposure in June. That's when the sun is right overhead (In Milwaukee, at 77° on June 22). But, there are many factors that change your ability to make D.

Factors Affecting Vitamin D Production

1. **Where you live on the planet**. The further north we live in North America the lower the angle of the sun in December. In Wisconsin, the sun gets to 22° in December. When it drops below about 45°, the angle of the sun is such that most UVB is filtered out by atmosphere. Atlanta has about a 2 week period of D "holiday". Milwaukee has about a 5 month period from mid October to March when the sun is too low for UVB radiation to get to our skin. Besides, it's cold and we wear long sleeves.

2. **We live indoors**. It's cold in spring so we stay indoors longer. Plus, we work indoors instead of on farms and outside. For the 7 months of the year when the sun is high enough to make D, most of us are only in mid day sun for some 15 minutes twice a week. That's 14 hours a year, total.

3. **We are outdoors in the evening and the morning,** but only in our cars. Glass cuts out all D production and UVB radiation. Early morning and late afternoon have the sun at an angle that reduces D production just like winter.

4. **Skin Pigment**. The more melanin in our skin, the more time it makes to make adequate D. African Americans need up to 6 times as much sun light time as Caucasian Americans to make the same amount of D. Hispanics, Asians, Native-Americans and any person with skin pigment needs increasing amounts of D to make adequate blood levels.

5. **Age**. As we get older, our skin makes less. By the age of 70 you only make about 25% what you made as a 20 year old. Elder folks are less mobile and get out less often as well

6. **Obesity.** Fat tissue is a sink for D. As we get heavier, we are at more risk of being D-ficient.

7. **Activities and habits**. We used to farm, hunt, garden, walk and play outdoors. Now we play indoors. That reduces time in sun.

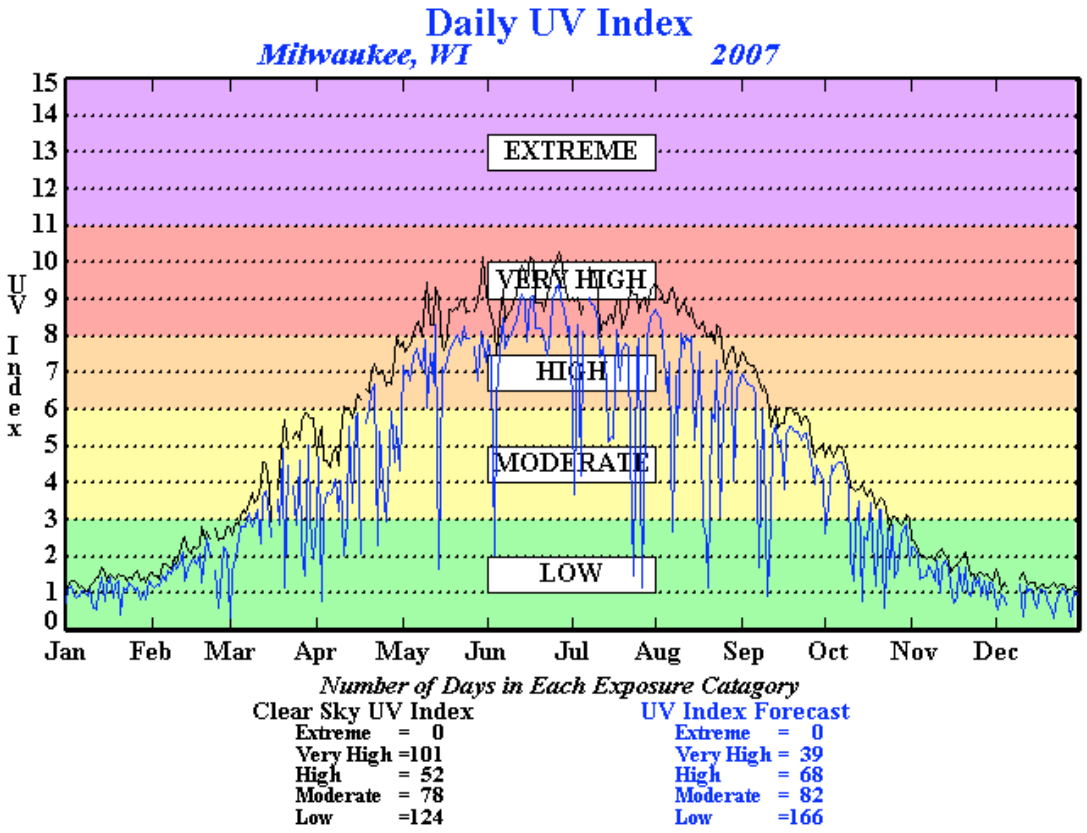
8. **Sun-block on our skin**. We are all used to putting on sun protection despite that there is no evidence that mild sun exposure causes cancer at all. We must avoid blistering sunburn.

9. **Breastfeeding**. Mom's are particularly susceptible to being low and need more D. (About 7,000 U a day)

10. **Infants with sensitive skin.** We cover their baby carriages and keep them out of the sun!

11. **Institutionalized people don't get sunshine.** Nursing homes, prisons, hospitals and any environment that keeps you out of the sun for a long period of time will put you at risk. (US Navy submariners need 4,500 U to keep them up to par when out under the polar ice cap for 3 months.)

12. **Cultural Inhibitions.** Women who are used to being covered in public may get much less vitamin. D. Studies show that Moslem women who wear head scarves in public don't get sufficient sun exposure living in northern climates. Their D level can be very low.



What's a Healthy Amount of D?

Glad you asked. We should be evidence based. Populations living in the tropics tend to have levels around 60 to 70 nanograms. Large hominids living in their native environments have the same levels. Puerto Rican farmers, Nigerian nurses have levels of 50-60 nanograms. So, living in the sunshine in a tropical environment will result in your blood level settling in around 60. Going to a tanning booth 10 times will get you to the same level. (If you are young, have light skin type, are not overweight…)

There is increasing evidence that a blood level of 32 nanograms and above is important. Your cells make toll receptor proteins when your blood level is above 32 but not below. This was elegantly shown in an experimental model of tuberculosis in the journal Science, 2006 by Liu et al where it was shown that white blood cells could gobble up the TB germ below 32, but not kill it[i]. Once the blood level of D exceeded 32, the white blood cells were able to kill the germ too. Remember, D turns on cells to become what they were intended to be. A mature white blood cell can kill germs well. The protein we put out with levels above 32 is called cathelicidin and has been called your "natural antibiotic". (Is this why we get colds in winter?)

What Happens to Us in the Winter?

Our vitamin D level drops. Binkley et al in the Wisconsin Medical Journal in December[ii] of 2007 documented clearly how a northern living population varies in its D level. We peak our blood levels in July through September. The population range of blood level runs roughly in the 40s after the sunny summer. In winter, less sunshine translates into lower D levels. Many of us end up around 20 ng with about a third of us below 15 nanograms.

If 32 is healthy, and many of us drop below 20 nanograms in the winter, what effect does that have? Maybe nothing dramatic in the short term. Or maybe not so. Maybe we are at risk every winter for the 5 months that our D is lower than ideal. Sort of like taking up smoking three packs of cigarettes a day. Maybe being low on Vitamin D is its own separate risk which we accumulate over the years to our peril. After 50 years of wear and tear, we then develop the degenerative illnesses that D might have prevented.

How Can I Prevent that?

Supplementation is the only sure way if you live in Wisconsin to keep your blood level in the healthy range. Otherwise you must drink lots of milk (20 glasses a day) and orange juice, (with added D) or eat nothing but fatty salmon, mackerel and other fatty fish, or better yet, take a week of vacation to warm sunny places once a month….

Short of those drastic procedures you should take a supplement. When you start, if your blood level is low, your tank is quite empty. There is good evidence that taking 2000 U a day will not bring your blood level up to 50 very quickly. It might take as much as a year to get there. So, filling up your tank is an important concept.

Filling up the Empty Tank – Getting to 50-60 ng quickly[iii]

1. Your doctor can prescribe 50,000 U a week for eight weeks. (Preferred method after checking a blood level with your doctor)
2. More aggressive, but found to be safe, is 50,000 3 times a week for a month
3. Finally, just take 10,000 U a day for a month.
4. Literature shows that a 100,000 U dose will actually also get you to therapeutic in about 3 days and will keep you up there above 30 for about 30 days. (AJCN March 2008)[iv]
5. 600,000 U once a year in England to nursing home patients seems to keep them in pretty goo shape.

Maintenance – Keeping you there

1. Routine adults probably need 2,000 U a day for their adult lives. This may go up so stay tuned.

2. Nursing mothers need 7,000 U a day while nursing
3. New born babies should have 2,000 U a day for the first year
4. Elderly should be on 5,000 U a day
5. Heavier folks should be on 5,000 U a day
6. Infection, dialysis, are all special occasions to ask your doctor about
7. The one sure way is to keep checking your level with your doctor. This may be the emerging most important long term health risk measure.

What's the Right Blood Level to Use?

There are two systems. In America we use nanograms. That's what this article uses. 50-60 nano**grams** is the target we espouse. In Europe and Canada, they use nano**moles**. You can convert nanograms to nanomoles by multiplying by 2.5. Hence, 50 ng = 125 nmoles. 32 grams = 80 nanomoles. Or you can go backwards and divide nmols by 2.5. Either way. The literature is from all over the world. This article has converted everything into nanograms. If you are confused, pay attention to the detail when you read outside literature.

And what blood level do you want? Living in the tropics leads to a level of about 60 nanograms. We should consider 50 nanograms the minimum healthy level. Currently, many health systems call anything above 9 normal. Many Vitamin D authors consider 32 nanograms the minimum level you should target for optimal health.

What Blood Test to Check?

Most experts recommend checking the 25(OH)Vitamin D level, not the 1,25 (di-OH) Vitamin D. The Di-hydroxy Vitamin D was used for a while but it has too much variability and does not reflect the longer term baseline status. The cost is typically about $ 100 to check it.

Do I need to get a Blood Test?

We should be evidence based if you have an illness that needs specific measurement. But you don't have to if you are otherwise healthy. You can just get started because you are almost certainly deficient if you have not been in sun for a while. In March 2008, normal folks given a dose of 100,000 units, as reported in the Am J of Clinical Nutrition had 7% who never got to 32 nanograms over the course of a month. That's the equivalent of about 3000 IUs a day. Rather than worry about toxicity, perhaps we should also consider the risks of not getting enough. Your goal should be to get to 60 nanograms.

A recent book by Dr. James Dowd called "The Vitamin D Cure" calls for simply treating everyone who has not been treated with 20-25 IU per pound. For a 200 lb adult, that's 4,000 IU a day, forever. You will not get toxic with that. As stated, there is evidence that at 2,000 IU a day some folks will not get to 50 nanograms even after a year of supplementation.

I Heard Vitamin D could be Toxic. Is it?

Experts in the field are concerned about toxicity. But it's hard to find examples in the literature. We don't have an "LD50". (A dose that would kill 50% of folks) This may be a case of a very interesting medical history error. The house of medicine has labeled D a toxic vitamin for years, possibly in error from times gone by when we didn't have the ability to measure accurately. Considering that 1 mg of D is 40,000 IUs, it could also have been that folks got doses in the millions of IUs by the inadvertent treatment with very concentrated solutions. That may have happened in England after WWII when grocers thought they could keep milk fresh longer by adding more Vitamin D to it. We do have examples in the literature of people getting 1.6 million U a day for 6 months and that was sufficient to cause toxicity. Toxicity was an elevated calcium and confusion that cleared in a few days. In England, nursing home patients are being treated currently with 600,000 IUs as a one-time shot without toxicity.

The New England Journal of Medicine in July of 2007 identified 10,000 IU a day as safe. There are published studies now that show that 20,000 IU a day for three years results only in increasing bone volume. And there are lots of studies showing that 50,000 IU three times a week for a couple of weeks gets you to therapeutic levels quickly without toxicity. In the American Journal of Clinical Nutrition in March of 2008, 100,000 IU dose at one time had no toxicity and got most folks to above 32 nanograms in about 3 days.

What's the Recent Literature that Guides Us about Specific Illnesses

There are over 140 laboratories studying Vitamin D around the world. Every month there are multiple articles showing up. It is the number one studied vitamin now and is right at the frontier of research. We've just learned how to accurately measure blood levels in the last few years, which is part of the reason you are now seeing such interest in it. Here are a few but by no means all.[v]

General Health:

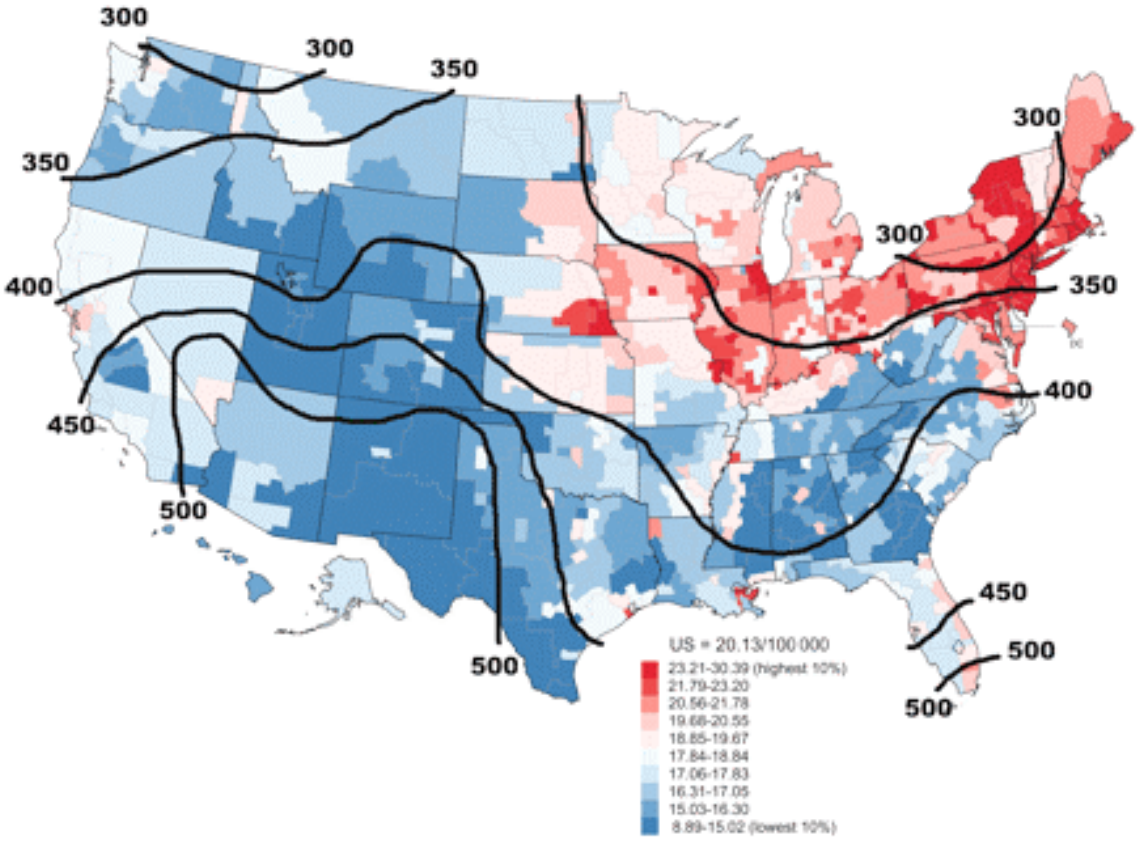
The Archives of Internal Medicine in Sept of 2007[vi] published a compendium of all the first randomized controlled trials (RCT) of Vitamin D. RCT's are the gold standard of medicine because they use placebo to take out the bias of the researcher. This article showed a 7% reduction in all cause mortality from Vitamin D with an average dose of 550 U a day. They could not explain the reason why Vitamin D was so effective, but they found it compelling.

Cancer Prevention

A randomized controlled trial study done out of Omaha with Dr. Lappe from Creighton published in the summer of 2007 in the Am Jr. of Clinical Nutrition[vii] showed that the women getting 1,100 units of Vitamin D and calcium a day had a 76 percent reduction in cancer rates of all kinds. Now, this was lumping all cancers

together but the authors thought is was not ethical to continue and not provide the placebo women with Vitamin D. The study has been criticized for quitting too early when the numbers were too small. But that's what good statistics are meant to do, allow you to quit early when you find a significant event.

Graph of Colon Cancer Rates in America by Amount of Sun Per Year



This graph has bars to show the amount of UVB radiation you get in different parts of America. The dark red color is where the most cancer is. This graph is for colon cancer. You can find more graphs, by cancer at the NOAA website or logging on to: http://www3.cancer.gov/atlasplus/charts.html

In the meantime, Dr. Garland has suggested that breast cancer could be reduced as much as 80% with Vitamin D. If we take the 1,000,000 cases of cancer that occur each year and reduce them 77%, we could save some 770,000 lives a year.

Heart Disease

The American Heart Association official journal Circulation published a report in January of 2008[viii] from our nation's longest running heart study, the Framingham study, that shows that a vitamin D level below 15 ng is associated

prospectively with a 64% increased risk of cardiac events in the next 5 years. With high blood pressure added, the risk rises by 212%. This could be interpreted to argue that Vitamin D deficiency represents as important a risk for cardiovascular disease as all the other risk factors. It will need to be added to the equation in future research. Every cell type in your body needs to mature into its desired state.

Multiple Sclerosis

We have known for a long time that MS is associated with northern climates and that Wisconsin has a higher rate than Florida. Now, since fall of 2008, we have good research that shows that vitamin D, given in doses up to 40,000 Units a day has no toxicity in 13 MS patients, and reduces the number of lesions in the brain in half[ix]. The Harvard Nurses study has shown that women who take any vitamin D at all, even a simple multi vitamin pill, reduce their life time risk of MS as much as 70%[x]. Vitamin D does not seem to cure MS, but it sure seems to prevent it. UVB radiation in childhood is clearly helpful in preventing it.

High Blood Pressure

Forman and Giovannucci in the Journal Hypertension[xi] showed that if you can get your blood level to at least 30 ng, you can likely reduce your risk of hypertension by as much as 50%. With 50,000,000 Americans having high blood pressure, a 50% reduction would have a huge impact on our nation's health. We do know that you can lower your blood pressure another 9% by taking vitamin D. So not only is it good to prevent the illness, but it's actually helpful in treating it.

Depression

Many studies have shown that mood is improved with higher doses of vitamin D. Vieth, in Nutrition Journal, July 2004[xii] showed that 4,000 Units a day resulted in long lasting 45% improvement in "well being" scores. There are many associations found between depression and vitamin D scores. Seasonal affective disorder is worse during winter, and that is associated with lower D levels. There is more suicide in northern hemispheres during winter, and in the southern hemisphere, the same effect is found in their winter (July and August). Folks with fibromyalgia have been found to have low levels of D when they were more depressed (Armstrong, Clin Rheumatology, April 2007)[xiii]

In the journal Archives of General Psychiatry from May 2008[xiv], low Vitamin D was shown to be strongly associated with severe depression. Depression was also associated with elevated parathyroid hormone, which is another way of measuring how much D your body thinks it has or needs. Again, the suggestion of low D with depression is an association, not a randomized controlled trial of treatment, but the question is raised again.

Schizophrenia

There is increasingly literature looking at the increase of schizophrenia that occurs in winter and in northern environments. Some authors have suggested that vitamin D is critical to brain development in utero and that inadequate D during pregnancy plays a part in the development of the early human brain, leading to eventual breakdown later in life.[xvxvixviixviii]

Autism

Animal models with intense D deficiency in pregnancy have the same brain defects as human autistic kids. Studies have shown that eating fatty fish in pregnancy (lots of D in fatty fish) reduces autism. Autism also is higher in environment where there is less sunlight. Children with vitamin D dependent rickets also have several autistic markers that go away with treatment with vitamin D. Like schizophrenia, the lack of D may set in motion the eventual expression of the disease. [xix]

Summary Table of Disease Prevention Possibilities by Blood Level of Vitamin D. Notice that most illnesses start with prevention around a level of 32 or more nanograms.

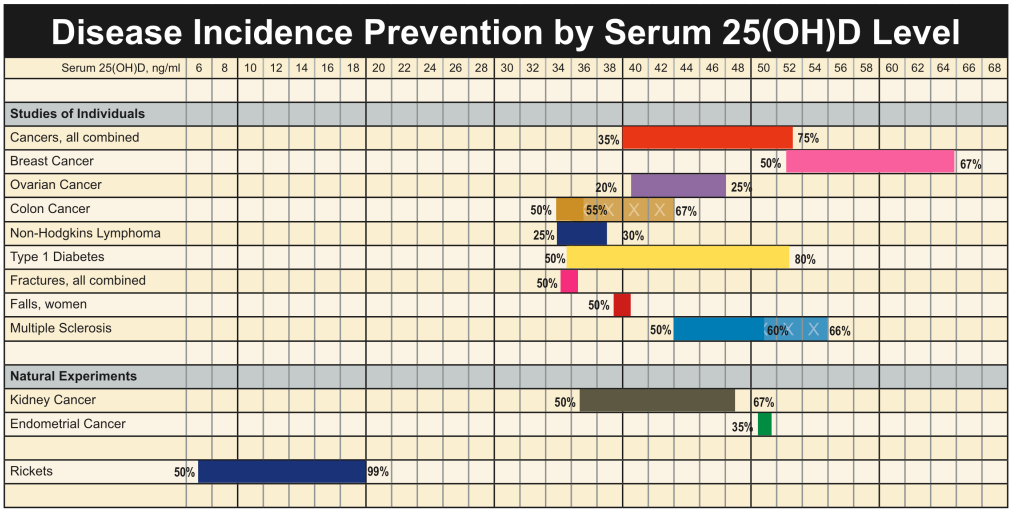


Chart prepared by: Garland CF

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