Vitamin D

PRESENTED BY:
CHRISTINE RILEY, R.D., L.D.
CHILDRENS HEART CENTER – NEVADA
APRIL 23, 2016
Some of the Things Sunshine Brings...
And...
Vitamin D3 (cholecalciferol)
The “Sunshine” Vitamin
What is Vitamin D?

- Vitamin D is more like a *hormone (similar to a steroid)* than a vitamin
- Its main role in the body is to **maintain normal blood levels of calcium and phosphorus**
- It helps the body absorb calcium (and phosphorous) from the intestines. This both forms and maintains strong bones. May help prevent osteoporosis
- **Suppresses PTH (parathyroid hormone)**, which causes bone resorption (calcium out of bones and into blood)
- **Prevents rickets** (the main cause of bowed legs, knock knees and weak bones/*ostoemalacia*)
- It is involved in **neuromuscular and immune function, reduction of inflammation**, and modulation of cell growth
What Else Does Vitamin D Possibly Help With?

- **Weight loss**: some studies have suggested that adding vitamin D to a calorie restricted diet may help promote weight loss

- **Mood disorders (including depression, SAD & PMS)**: vitamin D plays a role in brain development and function. May help decrease symptoms of mild depression

- **Type 2 Diabetes**: some studies show a link between low levels of vitamin D and Type 2 DM. It is linked to insulin resistance (possibly through inflammation-related immune cells, which often have vitamin D receptors)

- **Heart attack, stroke, colon cancer & autoimmune diseases**: vitamin D plays a role in BP and immune function. May lower risk of these diseases (still being investigated)

- **Heart function**: the newest, preliminary research suggests that vitamin D may actually improve heart function of people with heart failure (study was on 160 patients with pacemakers and/or ACE inhibitors or beta blockers. Heart pumping function increased from 26% to 34% in patients who took Vitamin D3. Placebo group saw no change. This may help decrease the need for ICDs (implantable cardioverter defibrillator)

Conclusion: more research is needed before conclusions can be ascertained
Who is at Risk for Deficiency?

- **Obese people:** vitamin D is a fat-soluble vitamin and is stored in body fat. Obese people tend to have (up to 50%) lower blood levels of vitamin D because it is trapped in fat cells.
- **Gastric bypass patients:** upper portion of small intestine where vitamin D is absorbed, is bypassed.
- **Dark skinned individuals:** melanin blocks UVB rays and decreases vitamin D production.
- **Milk allergies/lactose intolerance and vegan/vegetarian diets:** reduced intake (elimination or allergy) of vitamin D rich foods.
Who is at Risk for Deficiency (cont.)?

- **Elderly people:** as people age, it is more difficult for their skin to produce vitamin D (skin is thinner)
- **Exclusively /partially breast fed babies (NOT taking vitamin D supplement):** recommended to give 400 IU/day until weaned to fortified formula or fortified milk at 1 yr. Typically included in infant MVI drops.
- **Limited sun exposure/proximity to equator**
- **Cystic Fibrosis (CF) & Inflammatory Bowel Disease (IBD) patients = Crohn’s & celiac** (intestinal absorption is decreased)
- **Kidney or liver disease:** inability to process vitamin D
What Does Vitamin D₃ Look Like?

Like a caterpillar...

Or like this thing...

Vitamin D₃ = CHOLECALCIFEROL
C₂₇H₄₄O
How is Vitamin D Made by the Body?

Vitamin D2 = ERGOCALCIFEROL
Vitamin D3 = CHOLECALCIFEROL
SUN/UVB converts 7-Dehydrocholesterol in the skin to **CHOLECALCIFEROL** (pre-vitamin D₃ or calciole), which is an *inactive form* of vitamin D.

It is then hydroxylated in the liver and turned into **25-HYROXYVITAMIN D₃** (calcifediodiol or calciolel), which is *measured in blood to assess vitamin D status*

It is hydroxylated again in the kidneys and turned into **1,25-DIHYDROXYVITAMIN D₃** (calcitriol), which is the *active form* of vitamin D.
Let’s Try This Again...

<table>
<thead>
<tr>
<th>ORGAN</th>
<th>NAME</th>
<th>OTHER NAMES</th>
<th>WHAT IS IT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin</td>
<td>pre-vitamin D₃ = C₂₇H₄₄O</td>
<td>cholecalciferol, calcidiol</td>
<td>Inactive form of vitamin D</td>
</tr>
<tr>
<td>Liver</td>
<td>25-hydroxyvitamin D₃ = 25(OH)D</td>
<td>calcifediol, calcidiol</td>
<td>Measured in blood to assess vitamin D status</td>
</tr>
<tr>
<td>Kidney</td>
<td>1,25-dihydroxyvitamin D₃ = 1,25(OH)₂D</td>
<td>calcitriol</td>
<td>Active form of vitamin D</td>
</tr>
</tbody>
</table>
Sunlight is the most efficient way to produce vitamin D. It is nearly impossible to get enough vitamin D from food. Supplements may be needed as well.

On average, between 5-30 minutes of sun to *unprotected* face, arms, legs or back between 10 a.m.- 3 p.m. two-three times per week is enough. But, there are no studies to determine whether UVB-induced synthesis of vitamin D can occur without increased risk of skin cancer.

This is highly variable and based upon skin color, where you live, time of year, altitude, and cloudiness (complete cloud cover reduces UV energy by 50%; shade/pollution can reduce by 60%)
How Much Sun Do You Need (cont.)?

- You can not produce vitamin D3 via exposure through glass (blocks UVB)
- Sunscreen with SPF of 8 or more blocks UVB (if applied correctly)
- The body can produce 10,000 – 25,000 IU of vitamin D3 in about 30 minutes
- Your body will not overproduce the vitamin; it will stop when it has made enough
- Tanning beds do work (controversial). Use low-pressure bed (with 2%-6% UBV radiation) rather than high-intensity (UVA), and it takes only a few minutes
## Food Sources of Vitamin D

<table>
<thead>
<tr>
<th>Source</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>Some fish oils also contain high doses of vitamin A which is not good.</td>
</tr>
<tr>
<td>Salmon</td>
<td>Cheese and other dairy foods typically have less.</td>
</tr>
<tr>
<td>Tuna</td>
<td>Cheese and other dairy foods typically have less.</td>
</tr>
<tr>
<td>Sardines</td>
<td>Cheese and other dairy foods typically have less.</td>
</tr>
<tr>
<td>Cod Liver Oil</td>
<td>Cheese and other dairy foods typically have less.</td>
</tr>
<tr>
<td>Beef Liver</td>
<td>Cheese and other dairy foods typically have less.</td>
</tr>
<tr>
<td>Cheese</td>
<td>Cheese and other dairy foods typically have less.</td>
</tr>
<tr>
<td>Eggs</td>
<td>Cheese and other dairy foods typically have less.</td>
</tr>
<tr>
<td>Vitamin D Cereal</td>
<td>Cheese and other dairy foods typically have less.</td>
</tr>
<tr>
<td>Orange Juice</td>
<td>Cheese and other dairy foods typically have less.</td>
</tr>
<tr>
<td>Yogurt</td>
<td>Cheese and other dairy foods typically have less.</td>
</tr>
<tr>
<td>Margarine</td>
<td>Cheese and other dairy foods typically have less.</td>
</tr>
</tbody>
</table>

Fatty fish & fish liver oils are best sources (some fish oils also contain high doses of vitamin A which is not good). Almost all of the U.S. milk supply is voluntarily fortified with 100 IU/cup. Cheese and other dairy foods typically have less.
• Food labels are not required to list vitamin D content unless a food has been *fortified* with this nutrient
• Milk fortification began in 1932 due to the prevalence of rickets in children
• Foods with \( \geq 20\% \) of the DV are considered to be high sources of the nutrient
• **It is nearly impossible to get enough vitamin D from food sources**
• There are some arguments that because of it being a hormone vs. a vitamin, that it does not belong on the food label
• There is concern that by permitting vitamin D to be listed on food labels, it will encourage fortification of foods that would not otherwise be recommended (i.e. high-sugar cereals, ice cream, etc.)
Testing for Vitamin D Deficiency

- **Vitamin D blood test** = 25-hydroxyvitamin D or 25(OH)D level
- **Normal range** = 30-100 ng/mL or ≥ 20 ng/mL
- Generally 1,25 (OH)2D is not a good indicator of vitamin D status, because it has a short half-life (15 hrs) [v. a half-life of 3 weeks for 25(OH)D], and serum concentrations are closely regulated by PTH, calcium, and phosphate. Levels of this do not typically decrease until vitamin D deficiency is severe.
- **Vitamin D3 supplements are not vegetarian.** They often are extracted from fish liver oil, or are extracted from wool oil, which turns into vitamin D3 when exposed to UV light.
Serum 25-Hydroxyvitamin D [25(OH)D] Concentrations and Health

<table>
<thead>
<tr>
<th>ng/mL</th>
<th>Health Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;12</td>
<td>Associated with <strong>vitamin D deficiency</strong> (leading to rickets in infants/children and osteomalacia in adults)</td>
</tr>
<tr>
<td>12-20</td>
<td>Generally considered <strong>inadequate</strong> for bone and overall health in healthy individuals</td>
</tr>
<tr>
<td>≥20</td>
<td>Generally considered <strong>adequate</strong> for bone and overall health in healthy individuals</td>
</tr>
<tr>
<td>&gt;50</td>
<td>Emerging evidence links <strong>potential adverse effects</strong> to such high levels, particularly &gt;60 ng/mL</td>
</tr>
</tbody>
</table>

Table from: https://ods.od.nih.gov/factsheets/VitaminD-HealthProfessional

<table>
<thead>
<tr>
<th>ng/mL</th>
<th>Vitamin D Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;30</td>
<td>Normal</td>
</tr>
<tr>
<td>20-30</td>
<td>Insufficient</td>
</tr>
<tr>
<td>&lt;20</td>
<td>Deficiency</td>
</tr>
</tbody>
</table>

Though there are differing opinions above, it is virtually **UNANIMOUS** that in the U.S. ≤12 ng/mL defines **DEFICIENCY**

**Info from:** http://www.uptodate.com/contents/vitamin-d-deficiency-beyond-the-basics
Vitamin D Supplements

- Though your body is capable of making all the vitamin D3 it needs via sunlight, it’s difficult for most people to get adequate sun exposure.
- *Different organizations recommend different daily intakes*
- **Food & Nutrition Board = U.S. Gov’t recommendations**

<table>
<thead>
<tr>
<th></th>
<th>Vitamin D Council</th>
<th>Endocrine Society</th>
<th>Food &amp; Nutr. Board</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infants</td>
<td>1,000 IU/day</td>
<td>400-1,000 IU/day</td>
<td>400 IU/day</td>
</tr>
<tr>
<td>Children</td>
<td>1,000 IU/day</td>
<td>600-1,000 IU/day</td>
<td>600 IU/day</td>
</tr>
<tr>
<td></td>
<td>per 25# of wt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>5,000 IU/day</td>
<td>1,500 – 2,000 IU/day</td>
<td>600 IU/day</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>800 IU/day seniors</td>
</tr>
</tbody>
</table>

*Table from: Vitamin D Council*
Upper limits set by the same organizations include:

<table>
<thead>
<tr>
<th></th>
<th>Vitamin D Council</th>
<th>Endocrine Society</th>
<th>Food &amp; Nutr. Board</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infants</td>
<td>2,000 IU/day</td>
<td>2,000 IU/day</td>
<td>1,000-1,500 IU/day</td>
</tr>
<tr>
<td>Children</td>
<td>2,000 IU/day per 25# of wt</td>
<td>4,000 IU/day</td>
<td>2,500-3,000 IU/day</td>
</tr>
<tr>
<td>Adults</td>
<td>10,000 IU/day</td>
<td>10,000 IU/day</td>
<td>4,000 IU/day</td>
</tr>
</tbody>
</table>

Table from: Vitamin D Council
Vitamin D Supplements

- The two commonly available forms of vitamin D supplements are:
  1. vitamin D2 (ergocalciferol)
  2. vitamin D3 (cholecalciferol)
- It is suggested to use vitamin D3 when possible (v. D2) because it is the naturally occurring form of the vitamin, and it may raise vitamin D levels more effectively
Treatment of Vitamin D Deficiency

The recommended dose of vitamin D depends upon the nature and severity of the vitamin D deficiency...

In people who do not have problems absorbing vitamin D:

- **25(OH)D = <20 ng/mL = 50,000IU of D2 or D3** by mouth once per week for 6-8 weeks, then 800-1,000(or more) IU of D3 daily thereafter.
- **25(OH)D = 20-30 ng/mL = 800-1,000 IU of D3** daily (usually for 3 months). Once normal level is achieved, continue with 800 IU of D3 daily thereafter.
- **For INFANTS/CHILDREN whose 25(OH)D is <20 ng/mL**, treatment is often 1,000-5,000 IU of vitamin D2/D3 for 2-3 months.
- **Those with normal vitamin D levels**, usually 800 IU/day is recommended.
- **It is important to consume ≥1,000 mg calcium per day during treatment.**

For people with conditions that prevent them from absorbing vitamin D normally, vitamin D dosage should be determined on an individual basis.

# Treatment Options

<table>
<thead>
<tr>
<th>Vitamin D Status 25(OH)D ng/mL</th>
<th>Treatment Dosage</th>
<th>Maintenance Dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20 (deficiency)</td>
<td>50,000 IU per week for 6-8 weeks</td>
<td>800-1,000 IU daily (sometimes more)</td>
</tr>
<tr>
<td>20-30 (insufficiency)</td>
<td>800-1,000 IU daily for 3 months</td>
<td>800 IU daily</td>
</tr>
<tr>
<td>INFANTS/CHILDREN &lt;20</td>
<td>1,000-5,000 IU For 2-3 months</td>
<td>400-600 IU daily</td>
</tr>
<tr>
<td>&gt;30 (normal)</td>
<td>---</td>
<td>800 IU daily</td>
</tr>
</tbody>
</table>

*Test vitamin D [25(OH)D] every 3 months to ensure blood levels are safe and healthy*
Prescription Vitamin D2 v. D3

- Many Rx forms of vitamin D are in the form of D2 (ergocalciferol). This is also the type of vitamin D that is used for fortification of most milk/cereal products.
- It is thought that D2 is at least one-half as effective as vitamin D3.
- Part of the effectiveness of supplementing vitamin D is that it decreases PTH back into normal range. In studies comparing the two, only D3 did this, while D2 did not.
- D3 is preferred.
Vitamin D has the ability to bind to ‘Vitamin D Receptors’ (VDR’s) in the body. They are present in nearly all body tissues.

When active vitamin D binds with VDR’s, it may help prevent expression of disease causing genes.

However, vitamin D2 produces an active hormone that has about 40% less binding ability to VDR’s than the active hormone produced from vitamin D3 (!less ‘biologically active’!).

Vitamin D2 has a shorter half-life (15 hrs) than D3. You need to take more, and higher doses of D2 v. D3. Fat-soluble vitamins (like D) don’t need to be taken daily. The half-life of D3 is 3 weeks (meaning, 3 weeks after one dose you still have half of that dose left in your body).

Vitamin D2 seems to exert greater toxic effects at lower levels than does vitamin D3.
MONITORING:
- Blood test is recommended to monitor 25(OH) three months after beginning treatment. Dose may need to be adjusted, and subsequent testing obtained to assure that normal levels are achieved from the adjusted dose.

SIDE EFFECTS:
- Typically do not occur unless the blood level becomes very elevated (>100 ng/mL) and the person is taking high doses of calcium supplements.
- Avoid taking multiple products that contain vitamin D (i.e. MVI and vitamin D)
- Complications include: high blood calcium/kidney stones
Medication Interactions

- **STEROIDS:** corticosteroids (i.e. prednisone) can reduce calcium absorption, and impair vitamin D metabolism. With long-term use, they may contribute to loss of bone/development of osteoporosis.

- **WEIGHT LOSS MEDS:** like orlistat (Xenical® and alli™)

- **CHOLESTEROL-REDUCING MEDS:** cholestyramine (Questran®, LoCholest®, and Prevalite®) can reduce absorption of vitamin D (and other fat-soluble vitamins).

- **SEIZURE MEDS:** like phenobarbital & phenytoin (Dilantin®) increase hepatic metabolism of vitamin D to inactive compounds, and reduce calcium absorption.
In Conclusion...

- Sunshine makes flowers pretty and people have better vitamin D stores
- Vitamin D helps keep bones strong, and may* help a host of other chronic diseases
- Enjoy your milk, but food sources won’t save you
- Sit in the sun without sunscreen if you so desire (a cold beverage may help)...
- In the battle of D2 v. D3, D3 is the clear winner
- Different organization have differing opinions on supplementation and safe limits
- If you need or want a supplement, you have to actually take it for it to work
Sources

- Google, Images (individually cited)
- Vitamin D Council. “What is Vitamin D?” https://www.vitamindcouncil.org/about-vitamin-d/what-is-vitamin-d/
- Witte, Klaus. “New study finds vitamin D3 improves heart function.” 4 April 2016. *University of Leeds School of Medicine. VINDICATE study.* https://www.leeds.ac.uk/news/article/3851/new_study_finds_vitamin_d3_improves_heart_function