Vitamin D Nomenclature

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Clinical Name</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-dehydrocholesterol</td>
<td>Previtamin D₂</td>
<td>Lipid in cell membranes</td>
</tr>
<tr>
<td>Cholecalciferol</td>
<td>Previtamin D₃</td>
<td>Photosynthesized in skin or obtained from diet or supplementation</td>
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<tr>
<td>Ergocalciferol</td>
<td>Previtamin D₂</td>
<td>Obtained from diet or supplementation; equivalent to vitamin D₃ as a precursor for calcifediol but less biologically potent</td>
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<tr>
<td>Calcifediol or calcidiol</td>
<td>25-hydroxy-vitamin D or 25-hydroxy-cholecalcifer</td>
<td>Circulating 'storage' form of vitamin D; biologically inactive</td>
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<tr>
<td>Calcitriol</td>
<td>1,25-dihydroxy-vitamin D or 1,25-dihydroxy-cholecalcifer</td>
<td>Biologically active form; metabolized from calcifediol outside the kidney in target tissues and by the kidney in response to parathyroid hormone; can be directly supplied</td>
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found that as many as 62% of samples throughout the United States and Canada contained less than the minimum per quart allowance and found that as many as 14% of skim milk samples had no detectable vitamin D.

Elderly populations have special problems obtaining vitamin D. Sun exposure may be limited because of less time spent outdoors and less skin exposed. Diet also may become less varied, further lowering vitamin D content. Most importantly, the skin’s ability to synthesize cholecalciferol decreases with age as a result of decreasing 7-dehydrocholesterol levels in the skin. By age 50, the levels are generally half that of children; by age 70, the levels decrease by 75%. And, renal calcitriol production decreases with diminishing renal function. These changes in vitamin D metabolism place the aging population at exceptional risk for vitamin D deficiency.

Vitamin D supplements are readily available in multivitamins and as singular preparations, but no consensus exists about optimal daily amounts. The DRI until age 50 is 200 IU/day, increasing to 400 IU/day after age 50 and to 600 IU/day after age 70, but these values are unchanged from when they first appeared as part of the recommended dietary allowances published in 1941 by the National Academy of Sciences.

In 2003, the American Academy of Pediatrics issued new recommended intakes that doubled existing recommendations, and some studies have concluded that even 400 IU/day is insufficient to raise calcifediol levels in deficient persons. In 2007, a controversial and provocative editorial contended that the optimal serum concentration of calcifediol is at least 30 ng/mL, and that intakes of approximately 1,700 IU/day are needed to raise concentrations from 20 ng/mL to optimal.

The Institute of Medicine’s Food and Nutrition Board’s tolerable upper intake level for vitamin D supplementation in adults is 2,000 IU/day, although the body’s photoproduction of vitamin D adjusts downward based on circulating amounts up to 10,000 IU/day, and daily oral doses much higher than 2,000 IU/day have been implemented in some situations. Nevertheless, vitamin D toxicity produces hypercalcemia; thus, moderation and individualized dosing are key.

Calcifediol is a fat-soluble vitamin, but calcitriol, the active form, is a steroid hormone that can affect calcium and phosphorus level maintenance in the blood and bones. Calcitriol binds to the vitamin D receptor (VDR) in the nuclei of target cells, allowing the VDR to act as a modulating transcription factor for the gene expression of transport proteins. VDRs are found in the cells of most organs and in some leukocytes; for example, VDRs in the intestinal wall produce substances that assist with calcium absorption.

The Immune System
Calcitriol regulates the immune system response by modulating expression of interleukins and tumor necrosis factor by macrophages, and by decreasing expression of interleukin by lymphocytes, thereby promoting phagocytosis and anti-tumor activity and preventing excessive or prolonged inflammatory responses. Calcitriol has a potent in vitro antituberculosis effect in infected macrophages and macrophages, and in a recent trial, vitamin D supplementation reduced mycobacterium activity in the infected blood of patients by 20% compared with those who were not supplemented.

Autoimmune diseases, including rheumatoid arthritis and inflammatory bowel diseases such as Crohn’s and multiple sclerosis (MS) and diabetes have a lymphocytic component to their inflammation and have been associated with vitamin D deficiency. Munger and colleagues found that women who took vitamin D supplements were 40% less likely to develop MS than were women who did not take it. VDRs have been identified in pancreatic beta cells, and vitamin D deficiency is known to impair insulin synthesis and secretion. A meta-analysis published in 2007 found that, in patients with baseline impaired fasting glucose, calcium plus vitamin D (Ca/D) supplementation significantly slowed the decline over three years in the group receiving vitamin D.

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Falls & Agility
Increased serum calcifediol is associated with a reduced risk of physical decline and falls in the elderly. Most studies in this area have measured falls as an outcome, and most have found a significant reduction, from 10% to 46% in fall risk among patients receiving vitamin D supplements. However, while these studies generally suggest that older patients receive vitamin D supplements, one study’s authors did not believe that a 17.6% risk reduction for falls was significant enough to suggest it. Another group that found only a 5.8% reduction in fractures concluded that vitamin D should be included in osteoporosis treatment but did not suggest that the older population in general receive supplementation.

Another study, based on the hypothesis that the fall reduction in other studies was a result of prolonged neuromuscular agility, directly measured the physical performance of older persons. It found a 58% reduction in physical decline over three years in the group receiving vitamin D.

Hypertension
More than a decade ago, Krause and colleagues reported that hyperten-